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ST-8000A FSK MODEM
OPERATOR'S MANUAL

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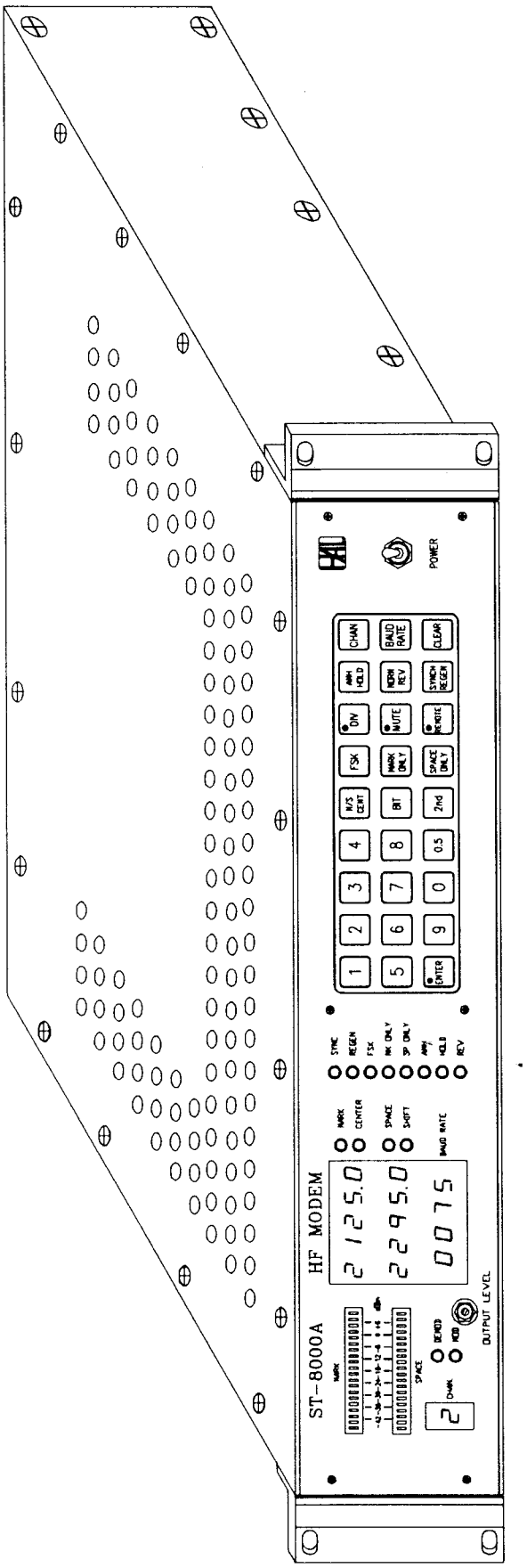

FIGURE 1.1 ST-8000A MODEM

ST-8000A FSK MODEM
OPERATOR'S MANUAL

CHAPTER 1
INTRODUCTION

1.1 PURPOSE

The purpose of this manual is to provide operating and field maintenance instructions for the Model ST-8000A Modem. Individual chapters describe installation, operation, remote control, theory of operation, and field maintenance.

1.2 GENERAL DESCRIPTION

The ST-8000A is a modulator-demodulator (MODEM) device that is an interface between digital data signals and radio or wire-line transmission systems. The modulator section of the ST-8000A converts digital data pulses into audio tones. The frequency of the output tone is shifted according to the MARK or SPACE state of the data pulses. The Modulator FSK output signal is used to drive data transmission lines or as an audio input to a radio transmitter. The ST-8000A demodulator section converts FSK audio tone data into digital pulses that are then used to drive a data terminal device. The ST-8000A FSK MODEM is shown in Figure 1.1.

Modulator and demodulator parameters of the ST-8000A are set by front panel keypad entry or by using remote control commands issued by a computer or controlling data terminal. Microprocessor control circuitry within the ST-8000A interprets these user inputs and generates the required control signals to the modulator and demodulator sections of the modem. The modem may be operated in either "full-duplex" (FDX) or "half-duplex" (HDX) modes.

The ST-8000A front panel includes a 27-key keypad for parameter entry, numerical digital displays, and LED mode indicators. The MARK, SPACE, and CENTER frequencies are displayed to 0.5 Hz resolution and may be set in 0.5 Hz increments from 300 to 3000 Hz. Baud rate is displayed to 1.0 baud resolution and may be set in 1.0 baud increments over the range of 30 to 1200 baud. LED indicators show currently selected operating modes. Two 20-segment Bar Graph displays show the amplitude of the MARK and SPACE signals of both the modulator output and demodulator input audio signals.

The ST-8000A remote control input port may be used with either an RS-232 or MIL-188 compatible terminal or computer at data rates from 110 to 38,400 baud. Remote control commands include HELP messages and summary output features.

The ST-8000A is housed in a rack-mountable aluminum cabinet. The cabinet is 3.5 inches high by 19 inches wide by 18 inches deep. The FSK Modem may be operated from power line sources of 115 VAC ±10% or 230 VAC ±10% at frequencies from 47 to 440 Hz. The modem requires a total of 30 Watts of AC power.

The ST-8000A meets U.S.A., German, and United Kingdom (Host Nation) approval for Safety, Telecommunications, and RFI suppression. The design Mean-Time-Between-Failure (MTBF) of the ST-8000A is greater than 30,000 hours. The ST-8000A may be operated over the temperature range of 0 to 50 degrees C, up to 95% humidity (non-condensing), and up to 10,000 ft. elevation.

1.3 SPECIFICATIONS

1.3.1 Demodulator

Input Impedance:	600 ohm or 10,000 ohm, ±10%, Balanced; impedance set by internal jumper option.
Input Level:	-45 dBm to +6 dBm into 600 ohm.
Data Rate:	30 to 1200 baud, in 1.0 baud increments.
Frequency:	300 to 3000 Hz, in 0.5 Hz increments.
Frequencies Set:	MARK and SPACE or CENTER and SHIFT.
Shift:	30 to 2700 Hz, 30 to 600 baud, 1 Hz incr. 850 to 1200 Hz, 601 to 1200 baud, 1 Hz incr.
Filter Bandwidth:	16 MARK and 16 SPACE bandwidths automatically selected according to data rate selected.
Detection:	MARK Only, SPACE Only, or MARK/SPACE (M/S) differential detection.
Auto Mark Hold:	Automatic MARK Hold (AMH) returns output RXD to MARK state when signal is not present (LOS). AMH Threshold = -42 to 0 dBm, 6 dB incr. AMH Delay = 1.0 to 5.0 seconds, 0.5 sec. incr. AMH Threshold & Delay set via internal option switch.
Low/High Speed:	Two separate demodulators and detectors; Low-Speed = 30 to 600 baud; High-Speed = 601 to 1200 baud. Automatically selected according to data rate.
Receive Data Out:	RS-232C (MARK = -V) and MIL-188 (MARK = +V) on separate output pins.
Data Sense:	Selectable NORMAL or REVERSE.

Carrier Detect:	RS-232/MIL-188 output; LOS = -V or +V, set via internal option jumper.
Receive Clock:	RS-232 Mid-Bit Regenerated Clock, 30 to 1200 baud. Synchronizer tracking range of ±5% of selected baud rate.
Synchronous Mode:	RS-232 and MIL-188, 30 to 1200 baud.
Asynchronous Mode:	RS-232 and MIL-188 for 5, 6, 7, and 8 bit data word length; set via front panel or Remote Control command.
BIT Loop-back:	Internal Built-In-Test (BIT) loop-back of Modulator signal into Demodulator input; BIT levels = 0 dBm, -20 dBm, and -45 dBm.
Diversity Option:	OPTIONAL FEATURE: Connects two ST-8000A FSK Modems for two-receiver combination diversity. Requires OPTION 01.

1.3.2 Modulator

Output Impedance:	600 ohm ±10%, balanced.
Output Level:	-35 dBm to 0 dBm into 600 ohm; set via Front Panel adjustment.
Data Rate:	30 to 1200 baud in 1.0 baud increments.
Modulation:	FSK as defined in MIL-STD-188C (2.347 & 4.5.15) and MIL-188-110A (5.2.1, 5.2.2, & 5.3.1.3).
Harmonics:	All harmonics less than -40 dBm, referenced to 0 dBm output signal.
Spurious Signals:	All non-harmonic spurious outputs less than -60 dBm.
Frequency:	300 to 3000 Hz in 0.5 Hz increments.
Shift:	30 to 2700 Hz in 1.0 Hz increments.
Frequencies Set:	MARK and SPACE or CENTER and SHIFT.
TXD Mute:	Turns Modulator output tones OFF. Mute selected via Front Panel keypad or remote control command. AUTO MUTE may be selected by internal option jumper to turn output tones OFF a delay period after input TXD has ceased. AUTO MUTE Delay: 0.000 to 9.999 seconds in 1.0 msec. increments; set via internal option switches.

Transmit Data In:	30 to 1200 baud; RS-232 (MARK = -V) or MIL-188 (MARK = +V); selected via internal option jumper.
Transmit Clock:	Provides synchronous transmit clock for data terminal devices. RS-232, 30 to 1200 baud; clock frequency = selected data rate.
Data Sense:	NORMAL or REVERSE.
Keyline Output:	Isolated relay contact output for control of transmit/receive function (PTT). Keyline Delay is controlled by Auto-MUTE delay setting.
DRTS/DCTS:	Data I/O connections used to immediately activate Modulator Output tones and Keyline (to transmit condition). Signal input to DRTS enables Modulator output and Keyline. Signal output DCTS is delayed 200 msec. from DRTS activation and may be used to control data flow of the transmit data device.

1.3.3 Modem Control

Control Input:	Set parameters using Front panel keypad and/or rear panel REMOTE port.
Selection:	Front Panel REMOTE keypad switch or via REMOTE Port command (R0/R1).
Memory:	All previously set parameters and conditions are stored and saved. When AC power is interrupted, previously set parameters are restored on power-ON.
Current Parameters:	Front Panel LED annunciators and frequency displays reflect current operating conditions for "Local" (Front Panel) or "Remote" (REMOTE port) control.

1.3.4 Front Panel

Data Entry:	27 Key keypad.
Keys:	0.5, 0 through 9, ENTER, M/S - CENT, BIT, 2nd, FSK, MARK ONLY, SPACE ONLY, DIV, MUTE, REMOTE, AMH HOLD, NORM REV, SYNCH REGEN, CHAN, BAUD RATE, CLEAR.
Indicators:	All indicators are visible on front panel; Keypad annunciators on ENTER, DIV, MUTE, and REMOTE keys. Separate LED annunciators for DEMOD, MOD, MARK, CENTER, SPACE, SHIFT, SYNCH,

FSK, REGEN, MK ONLY, SP ONLY, AMH, HOLD, and REV.

Frequencies: 5-Digit RED LED display for MARK/CENTER;
5-Digit RED LED display for SPACE/SHIFT;
4-Digit RED LED display for BAUD;
1-Digit RED LED display for CHANNEL.

Signal Level: Two 20-segment RED LED Bar Graphs, calibrated from -42 dBm to +6 dBm (600 ohm reference). CH = 1 (Modulator): Bars show MODULATOR MARK and SPACE output levels. CH = 2 (Demodulator): Bars show signal input levels to demodulator.

Other Controls: POWER - Controls AC power to ST-8000A, OUTPUT LEVEL - Continuous adjustment of Modulator output level.

1.3.5 Remote Control

Data Format: RS-232 (MARK = -V) or MIL-188 (MARK = +V), selected by internal option jumpers; compatible with VT-100 and other data terminal devices. Data format: 1 Start bit, 8 data bits (bit 8 = SPACE), 2 stop bits.

Data Rate: 110, 300, 600, 1200, 2400, 4800, 9600, 19,200, or 38,400 baud selected by internal switch.

Unit Address: Selected by internal option switch to Unit 1 through Unit 9 (Channel select C01 - C18).

Multi-Modem: Up to nine ST-8000A Modems may have REMOTE ports "daisy-chain" connected for control by one data terminal. Each modem responds only when addressed.

Commands: All Front Panel features of the ST-8000A may be set via REMOTE port commands (except Modulator Output Level and POWER ON). Commands may be set for "long" or "short" command format. Command echo to controlling terminal may be set ON or OFF. Once given unit is selected (Channel command), further commands may be issued to that unit without repeating Channel number.

Control Commands: Status, Select Channel, Set MARK, Set SPACE, Set CENTER, Set SHIFT, Set BAUD, Select FSK mode, Select MARK ONLY mode, Select SPACE ONLY mode, Select Synchronous mode, Select Asynchronous mode and set character length in bits, Select/disable +0.5 Hz frequency increment, Set NORMAL/REVERSE sense, Set

Channel HOLD mode, Set/disable MUTE function, Select/disable Diversity (only with Diversity OPTION 01), Set/disable Automatic MARK Hold (AMH), Select/disable Regeneration function, Set/disable short REMOTE Control command format, Enable or disable LOCAL/REMOTE mode.

Control Signals: Input Data (RXD), Output Data (TXD), Status Input (CTS), Status Output (RTS) that is a continuous + voltage, Status Output (CTS).

1.3.6 Rear Panel Connections

DATA I/O: Rear panel connector J1 (MS27508E14F35SB); Signals include: Demodulator Undetected MARK output, Undetected SPACE output, Carrier Detect (CD) output, Demodulator analog ground, Keyline Relay (two isolated connections), Data Request to Send input (DRTS), Data Clear To Send output (DCTS), Transmit Clock output (TXC), Modulator Data input (TXD), Demodulator Mid-Bit Clock output (RXC), Demodulator RS-232 Data output (RS-RXD), Demodulator MIL-188 Data output (MIL-RXD), Modulator analog ground, Chassis ground (shield), and jumper to AUDIO I/O (J2).

AUDIO I/O: Rear panel connector J2 (MS27508E14F35SA): Signals include: Modulator FSK Audio output (two balanced connections), Keyline Relay output (two isolated connections), Demodulator FSK Audio input (two balanced connections), Chassis ground (shield), and jumper to DATA I/O (J1).

REMOTE: Rear Panel connector J4 (MS27508E10F35P): Signals include: Data input (RXD), Status input (CTS), Data Output (TXD), Status output, +V, (RTS), Status Output (CTS), and Digital ground.

DIVERSITY: Rear Panel connector J5 (MS27508E10F35S): OPTIONAL, requires inclusion of DIVERSITY OPTION-01.

AC POWER:

MULTI-NATIONAL OPERATION: Rear Panel connector J3 (IEC 320): Signals include: AC Power LINE, AC Power NEUTRAL, and AC Power SAFETY GROUND.

MIL OPERATIONS: Rear Panel Connector J3a (MS27472E12F98P): Adapter cable that plugs into IEC AC Power connector (J3). Signals include: AC Power LINE, AC Power NEUTRAL, and AC Power SAFETY GROUND.

GND Chassis Ground terminal for connection to system safety ground.

1.3.7 Other Rear Panel Devices

FUSE Field replaceable 0.5 Amp. slow-blow fuse.

ACV Switch to change between nominal 115 ±10% and 230 ±10% VAC power input.

FREQ Switch to change between low and high frequency AC power sources (50/60 Hz or 400 Hz).

1.3.8 Physical Data

Cabinet Finish: Front Panel: Light Gray
Cabinet: Natural aluminum iridite finish.

Cabinet Style: 19" rack mounting; rack handles included.

Size: 3.50" High x 18.0" Deep x 19.0" Wide (8.9 cm x 45.7 cm x 48.3 cm)

Weight: 16 lbs (7.3 kg) net, 28 lbs (12.8 kg) shipping.

AC Power: 115 VAC ±10% or 230 VAC ±10%, 47 to 440 Hz; 30 Watts.

AC Protection: Rear panel fuse, 0.5 Amps, slow-blow.

1.3.9 Compatibility

Interoperability: The ST-8000A is fully compatible and interoperable with the Model 1280A/M FSK Modem manufactured by the Frederick Electronics Corporation. Rear panel connectors and signal connections are completely compatible with cabling for the 1280A/M FSK Modem. The ST-8000A REMOTE port is completely compatible and will operate in a multi-unit connection of up to nine 1280A/M and ST-8000A FSK Modems.

Safety: UL1950, EN60950.

RFI: In accordance with FCC Part 15 (Class A), VDE/TUV (Germany) and BS (United Kingdom).

Telecommunications:	FCC Part 68, FTZ and ZZF, BABT and BSI.
Environment:	0 to 50 degrees C, 95% Relative Humidity (non-condensing); Sea level to 10,000 feet. Transport at up to 50,000 ft., unpressurized.
Reliability:	Design Mean-Time-Between-Failure $\geq$ 30,000 hrs. (MIL-HDBK-217E, Method 5.1 (Stress Analysis), at 25 Degrees C, G_B environment.
Maintenance:	Depot repair at HAL Communications in Urbana, Illinois. Built-In-Test (BIT) for field determination of failure. Mean-Time-To-Replace (MTTR) $\leq$ 10 minutes (determine unit failure, remove defective unit, replace with new unit, test new unit). Factory repair time: 30 days.
Warranty:	One year from date of purchase.

CHAPTER 2
INSTALLATION

2.1 GENERAL

This chapter explains how to install the ST-8000A MODEM in a data communications system. Included are: (1) directions for unpacking the modem, (2) setting power and signal option switches and jumpers, (3) making cable connections, (4) and typical connections that may be used between the ST-8000A and other equipment. Close attention to these steps is required to assure proper operation of the MODEM in the data system.

2.2 UNPACKING AND INSPECTION

2.2.1 Unpacking

Each ST-8000A FSK MODEM is packed as shown in Figure 2.1. The unit is double-boxed. The outer box is a special weather-proof box. The inner box is vacuum sealed against moisture penetration. If it is necessary to return the ST-8000A to the factory for repair or otherwise re-ship the ST-8000A, these packing techniques must be followed. See Section 6.7 for re-packing instructions.

Before opening the shipping carton, examine it carefully for evidence of shipping damage. Note all exterior damage. Open the outer shipping carton and remove the inner carton. Retain the outer carton for later use. Examine and note any damage found to the inner carton. Open the water-proof sealed bag around the inner carton and remove the inner carton. The inner carton is sealed with shipping tape. Cut the tape to remove the unit.

Remove the ST-8000A and its cushioning end-caps from the inner carton. Again, examine the packing materials and unit itself for evidence of shipping damage - note all found.

Packed on top of the ST-8000A are the Accessory Bag and packages of desiccant. Discard the desiccant and set the Accessory Bag aside.

At this point, if shipping damage has been found, file a written claim with the shipping agency and forward a copy of the claim to your supplying agency (HAL Communications, shipping depot, etc.).

NOTE: Claims for shipping damage must originate at receiving end. Claims cannot be originated by HAL or the supplying Depot. In case of damage, keep all shipping materials. A representative of the shipping agency will want to examine all items.

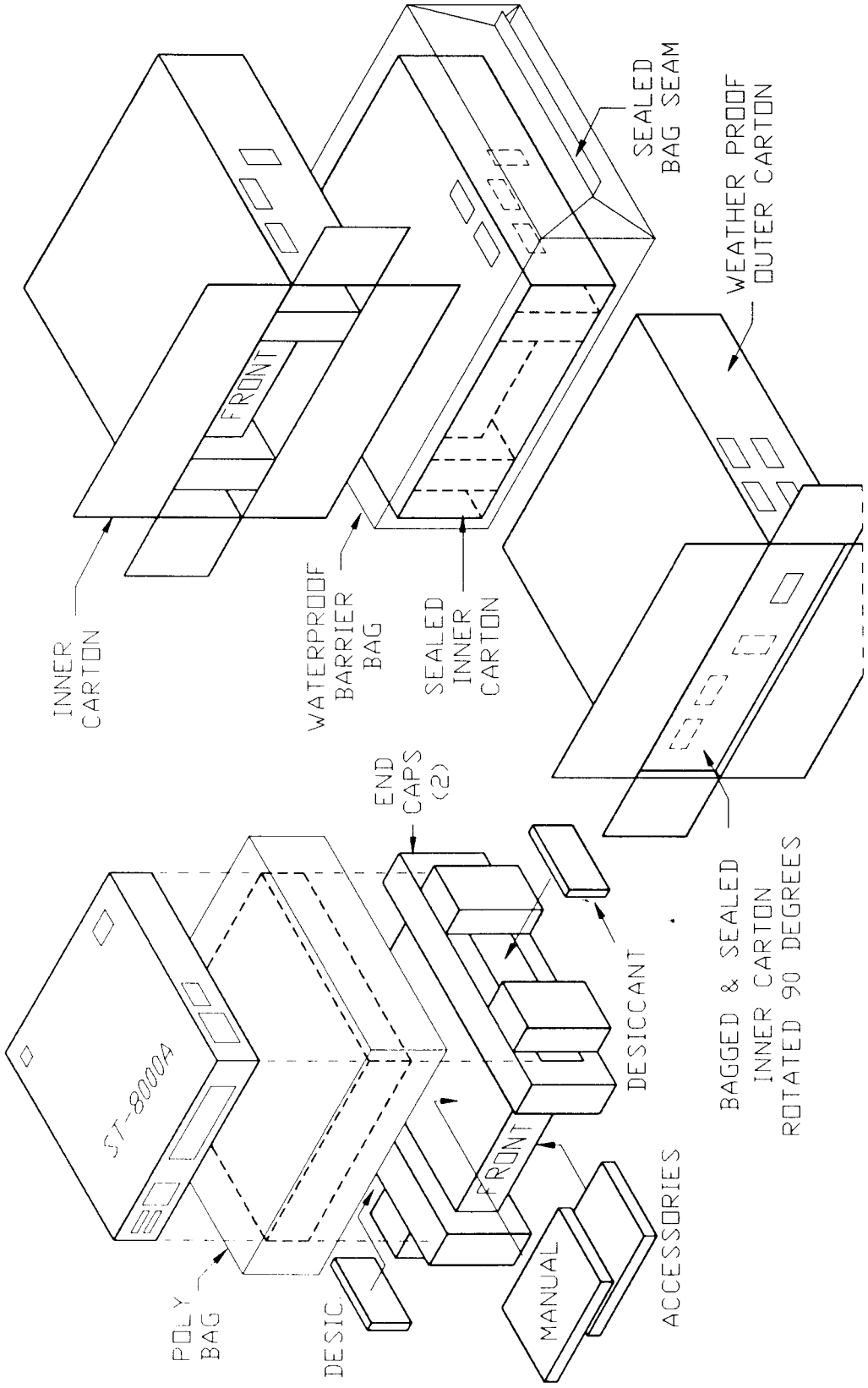

FIGURE 2.1 ST-8000A PACKAGING FOR SHIPMENT

Assuming no shipping damage has been found, remove the ST-8000A from its inner protective bag. Re-assemble all shipping materials and store them in a cool dry location where they may be re-used should it be necessary to re-ship the ST-8000A at a future time.

If the ST-8000A package temperature is substantially different from that of the unpacking room (i.e., the package is much colder than the shipping room), let the unpackaged ST-8000A sit for at least one hour before operating.

2.2.2 ST-8000A Accessories

Open the Accessory Bag (PN970-08005) and check its contents against Table 2.1 below.

TABLE 2.1

ST-8000A ACCESSORIES

QTY	HAL P/N	DESCRIPTION	NOTES
1	333-17250	IEC AC POWER CORD	Std U.S. Power
1	390-10355	MS27473E10F35S CONNECTOR	P4, MATES J4
1	390-10506	MS27506F10-2 CABLE CLAMP	For P4
1	390-12985	MS27473E12F98S CONNECTOR	P3, For MIL Power
1	390-12506	MS27506F12-2 CABLE CLAMP	For P3
1	390-14355	MS27473E14F35PA CONNECTOR	P2, Mates J2
1	390-14356	MS27473E14F35PB CONNECTOR	P1, Mates J1
2	390-14506	MS27506F14-2 CABLE CLAMP	For P1 & P2
1	413-06061	6-32x3/8" RH PHIL SS Screw	Attach MIL Adptr
1	423-06000	No. 6 FLAT-WASHER (SS)	Attach MIL Adptr
1	440-03330	1/4" CABLE CLAMP	Attach MIL Adptr
2	770-05001	FUSE, 0.5AMP SLOW-BLOW	Spare Fuses
1	870-08005	ST-8000A OPERATOR'S MANUAL	This Document
1	960-80015	MIL AC POWER ADAPTER CABLE	Used for MIL PWR

If any of these materials are missing from the ST-8000A Accessory Box, please inform HAL Communications Corp. in writing, stating the HAL Serial Number of the unit and which item(s) is missing. Contact HAL at:

HAL COMMUNICATIONS CORP.
1201 W. KENYON ROAD
P.O. BOX 365
URBANA, ILLINOIS 61801
Phone: (217) 367-7373
FAX: (217) 367-1701

2.3 POWER REQUIREMENTS

2.3.1 Voltage and Frequency

The ST-8000A MODEM may be operated from Alternating Current (AC) power line sources with the following characteristics:

AC VOLTAGE:	115 VAC ±10%	(103.5 - 126.5 VAC)
	230 VAC ±10%	(207.0 - 253.0 VAC)
AC FREQUENCY:	47 Hz to 440 Hz	

Use of an AC power source that has stable voltage and frequency is recommended.

The ST-8000A Rear Panel is shown in Figure 2.2. Devices associated with AC Power input are located on the left end of the rear panel:

J3 - IEC AC Power Input
F1 - AC Power Fuse (0.5AMP SLOW-BLOW)
ACV - AC Voltage Selector Switch (115 or 230)
FREQ - AC Frequency Selector Switch (50/60 or 400)

Before connecting the ST-8000A to AC Power:

1. SELECT THE PROPER INPUT VOLTAGE:

   Set ACV to "115" for AC voltages between 103.5 and 126.5 VAC;
   Set ACV to "230" for AC voltages between 207 and 253 VAC.

2. SELECT THE PROPER INPUT FREQUENCY RANGE:

   Set FREQ to "50/60" for frequencies between 47 and 200 Hz
   Set FREQ to "400" for all frequencies above 200 Hz.

The fuse size (0.5 AMP SLOW-BLOW) need not be changed for different voltages or frequencies.

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WARNING

DO NOT CONNECT AC POWER UNTIL AFTER SETTING THE INTERNAL OPTION SWITCHES AND JUMPERS AS DESCRIBED IN SECTION 2.5.

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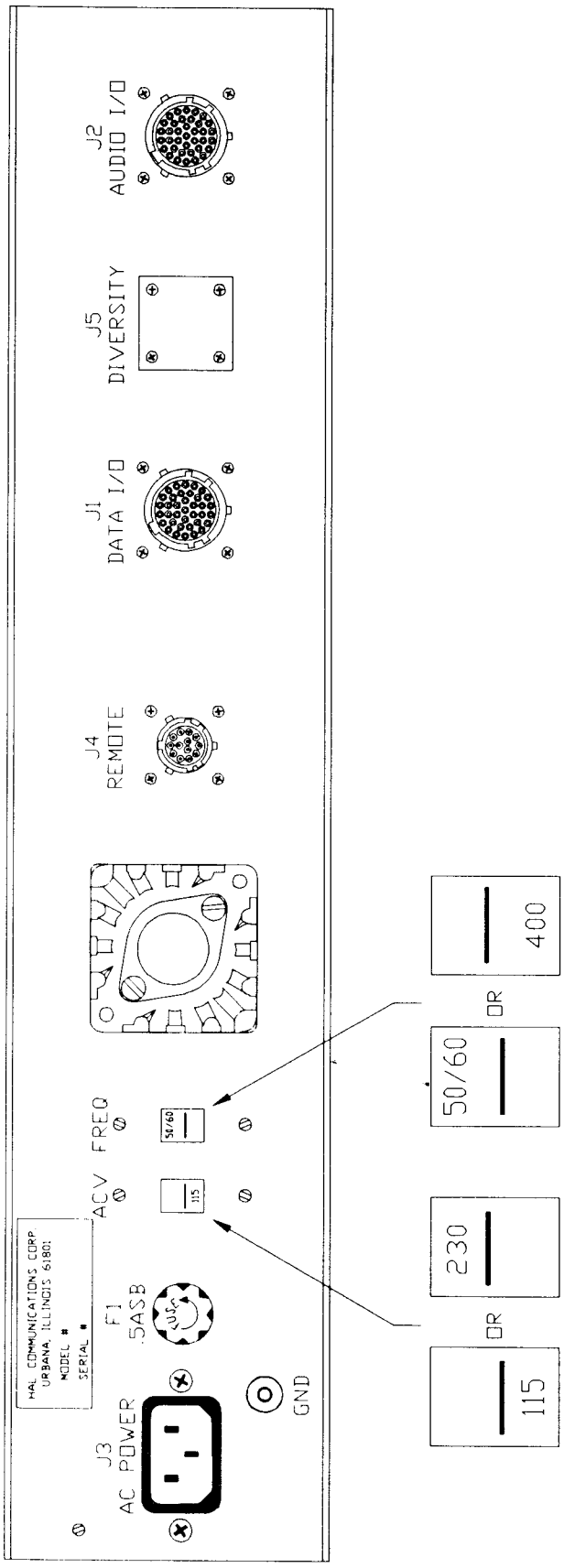

FIGURE 2.2 ST-8000A REAR PANEL

2.3.2 AC Power Cord

The ST-8000A rear panel AC Power connector (J3) is a standard IEC-630 type of internationally approved AC connector. This connector is internationally approved for use in most countries of the world. In particular, the ST-8000A is "Host-Nation Approved" for connection to AC power lines in the United States, Germany, and the United Kingdom. The inlet connector and internal AC wiring of the ST-8000A conforms to UL1950 (U.S.) and EN-60950 (Europe).

2.3.2.1 United States AC Power Connection:

An approved U.S. AC power cord is included in the accessory box of each ST-8000A. This power cord plugs directly into rear panel connector J3 and may be plugged into any standard "U-ground, 3-prong" 115/120 VAC outlet.

NOTE: The ST-8000A may be connected for 230/240 VAC operation in the United States. The supplied U.S. power cord is not approved for 240 VAC use. If the ST-8000A is connected to 240 VAC power sources in the United States, the user must obtain the proper approved cord to plug into J3.

2.3.2.2 Host Nation AC Power Connection:

Rear panel connector J3 and internal ST-8000A wiring meet all requirements of EN-60950. The ST-8000A meets requirements of Germany and the United Kingdom (and many other countries of the world). The user must obtain and use an approved AC power cord for the country in which the FSK MODEM is installed. HAL can provide suggested vendors and part numbers for these cords, but it is recommended that the approved AC cord be obtained in the desired host nation.

2.3.2.3 Military AC Power Connection:

The ST-8000A may be connected into U.S. Military AC power distribution systems that use the MS27473E12F98S connector. In this case, use the supplied MIL POWER AC ADAPTER CABLE (960-80015). This adapter cable should be attached to the rear panel using the 6-32 screw, washer, and cable clamp as shown in Figure 2.3. The Military connector does not meet UL-1950 or EN-60950 and therefore does not meet "Host Nation Approval" requirements. The adapter cable should only be used when required by existing Military system cabling.

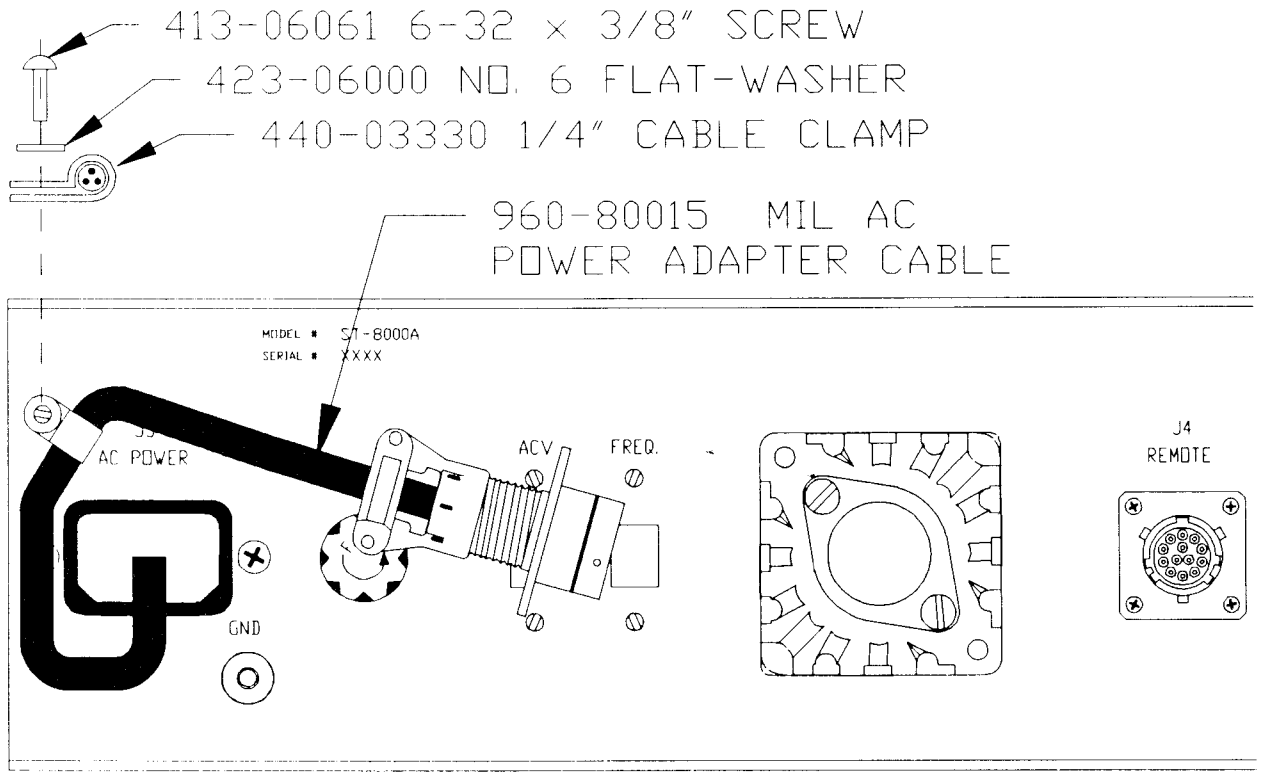

FIGURE 2.3 MILITARY AC POWER ADAPTER CABLE

2.4 RACK MOUNTING

The ST-8000A is designed to mount in a standard 19 inch (48.3 cm) wide rack cabinet. It requires 3.5 inches (8.9 cm) of vertical panel space. The ST-8000A cabinet is 18" deep (45.7 cm). If a fully-enclosed rack cabinet is used, it is recommended that the cabinet have a minimum inside depth of 20 inches (50.8 cm) to leave room for rear panel connectors and cables.

The ST-8000A weighs approximately 16 pounds (7.3 kg). To install the ST-8000A in a rack cabinet, two people are recommended. One should hold the rear and the other the front. The ST-8000A is fastened to the rack cabinet with four screws at the standard RS-310-C77 spacing of 18.5 inches (47 cm) x 3.00 inches (7.62 cm). Mounting screws vary with rack cabinet styles and types and are are not furnished with the ST-8000A.

In some installations, it may be desirable to mount the ST-8000A using chassis slides and/or front and rear mounting. Please consult HAL Communications for details concerning additional rack mounting options. Exact dimensional data for the intended cabinet is required to prepare a quotation for such mountings.

Whenever the ST-8000A is mounted in an enclosed rack cabinet, the user must provide adequate ventilation within the cabinet. HAL recommends that the cabinet be pressurized with a forced-air blower. A major heat source (i.e., transmitter or oscilloscope) should not be mounted directly below the ST-8000A. Multiple ST-8000A MODEMS may be placed in a direct vertical stack arrangement. The cabinet blower system should contain its own air filter system to reduce dirt and dust injected into the ST-8000A.

The ST-8000A may be used in a table-top configuration. Table feet and a front tilt-bail are available from HAL Communications at additional cost.

NOTE: BEFORE MOUNTING THE ST-8000A IN A RACK, SET THE INTERNAL OPTION SWITCHES AND JUMPERS DESCRIBED IN THE FOLLOWING SECTION.

2.5 USER-SET OPTION SWITCHES AND JUMPERS

All user set internal option switches and jumpers are located on two stacked circuit boards. All user set option switches and jumpers can be accessed once the top cover is removed. No further disassembly is required. The ST-8000A includes 6 internal switches and 9 internal jumpers which may be set to tailor modem operations to system requirements. These option switches and jumpers should be set before installing the ST-8000A in a rack cabinet and before connecting AC power. This section describes how to set these options. It is recommended that the user read both this section and section 2.6 (CABLE CONNECTIONS) before changing any option switch or jumper. The required option settings may vary with the intended system applications and cabling.

****

WARNING

The following steps require removal of the protective top cover of the ST-8000A cabinet. AC POWER SHOULD NOT BE CONNECTED WHILE THESE STEPS ARE PERFORMED.

CAUTION

The ST-8000A contains Electostatic Sensitive Discharge (ESD) devices. While all internal parts are grounded to the metal exterior cabinet, it is recommended that an approved ESD work-station be used while making these adjustments.

****

To gain access to the internal option switches and jumpers, place the ST-8000A on the work surface (ESD protected) so that it faces towards you.

REMOVE sixteen (16) 4-40x1/4" Flat-Head Phillips Screws from the top cover. Use a "No. 1 Phillips" screw driver.

Remove the top cover. Set the top cover and the 16 screws aside for later re-installation.

The location of the user-set option switches and jumpers are shown in Figure 2.4. Do NOT change any other jumper or switch that you may view inside the ST-8000A. For clarity, circuit board components not involved in the setup are not shown in Figure 2.4.

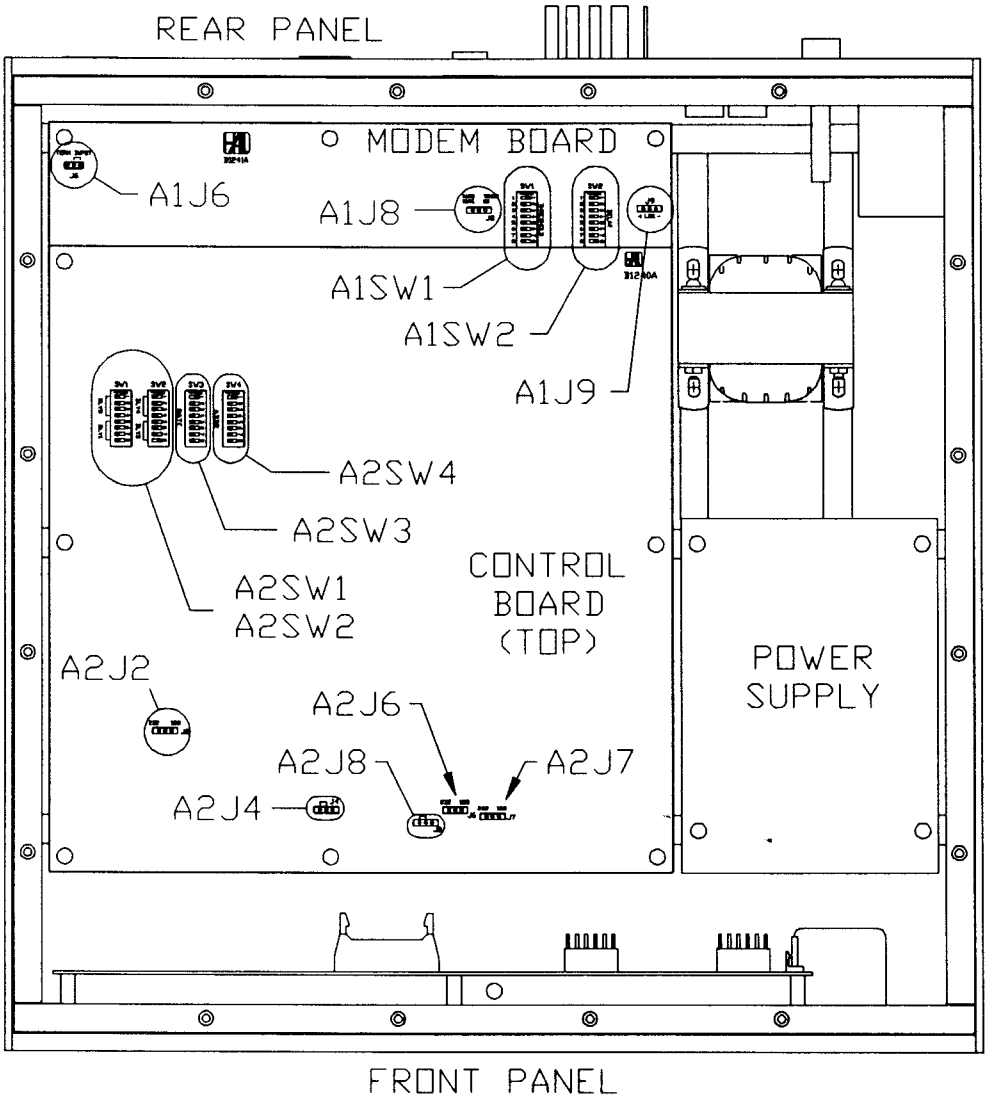

FIGURE 2.4 USER-SET OPTION SWITCHES AND JUMPERS

2.5.1 Demodulator Input Impedance (A1J6)

The demodulator input impedance is set by jumper J6 located in the left rear corner of the MODEM circuit board (lower board). This jumper may be set for an input impedance of either 600 ohms (±10%) or 10,000 ohms (±10%). In both conditions, the demodulator input is balanced to ground and transformer-isolated from other ST-8000A circuitry. The two jumper settings are shown in Figure 2.5. The factory default setting is the right hand position (600 ohms).

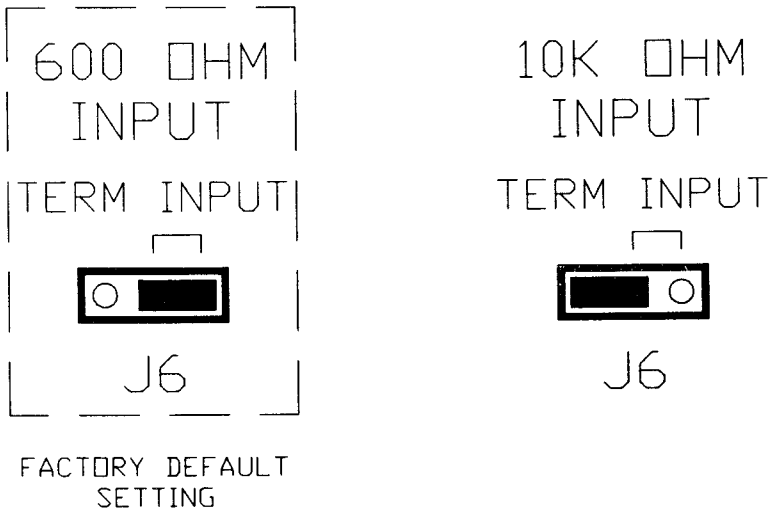

FIGURE 2.5 DEMODULATOR INPUT IMPEDANCE (A1J6)

2.5.2 Automatic Mark Hold (AMH) Settings (A1SW1, A1SW2)

Automatic Mark Hold (AMH) parameters are set by option switches SW1 and SW2 located in the right-hand corner of the MODEM circuit board (lower board).

Switch SW1 sets the AMH Threshold level in 6 dB increments from 0 dBm to -42 dBm. If the AMH feature is enabled (via front panel keypad or remote control command), the demodulator data output will be placed into a MARK-hold state whenever the average demodulator input audio signal level is consistently below the AMH Threshold level set on SW1.

The time delay required for the demodulator to change to the MARK-hold state is set by option switch SW2. SW2 may be set for AMH delays of 1.0 second to 5.0 seconds in increments of 0.5 seconds. The AMH delay time is defined as the time that is required for the demodulator to change to MARK-hold state when the signal level changes from 3 dB greater than the set AMH Threshold level (SW1) to 3 dB less than the set level.

The factory default settings are: -42 dBm for SW1 and 1.0 second for SW2. Setting of SW1 and SW2 is shown in Figure 2.6.

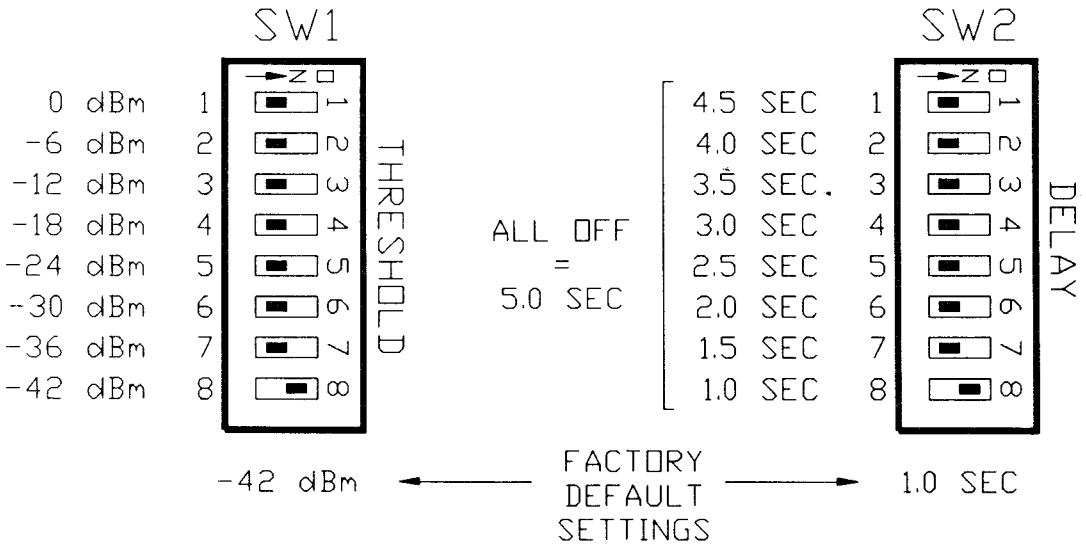

FIGURE 2.6 AMH THRESHOLD AND DELAY (A1SW1, A1SW2)

2.5.3 Demodulator LOS / Carrier Detect (CD) Setting (A1J9)

The demodulator Loss Of Signal (LOS) or Carrier Detect (CD) signal polarity is set via option jumper A1J9. Jumper J9 is located at the right-rear corner of the MODEM circuit board (lower board). The LOS/CD signal output is derived from the AMH circuit and therefore AMH must be enabled to use this output signal. The factory default setting of J9 produces a negative voltage upon LOS (+V for CD). The setting of jumper J9 is shown in Figure 2.7.

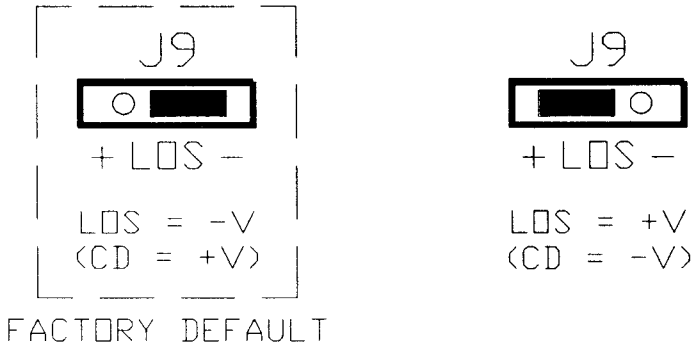

FIGURE 2.7 LOS/CD JUMPER (A1J9)

2.5.4 Modulator Tone Auto-Mute Setting (A1J8)

The modulator Auto-Mute feature provides ON/OFF control of the modulator output FSK tones. In the ST-8000A, Auto-Mute may be turned ON or OFF via an internal option jumper, A1J8. When active, Auto-Mute senses transmit data (TXD) activity, enabling the modulator FSK tone output and closing the keyline relay whenever TXD activity is sensed. The ST-8000A also includes a DRTS input that may be used to instantly enable modulator output and the keyline relay.

The keyline relay is always controlled by the Auto-Mute feature. Jumper A1J8 may be set so that Auto-Mute also turns the modulator FSK tones ON or OFF, or so that the modulator tones are always ON. The factory default setting of J8 is for Auto-Mute control of modulator tone output. Settings of option jumper J8 are shown in Figure 2.8.

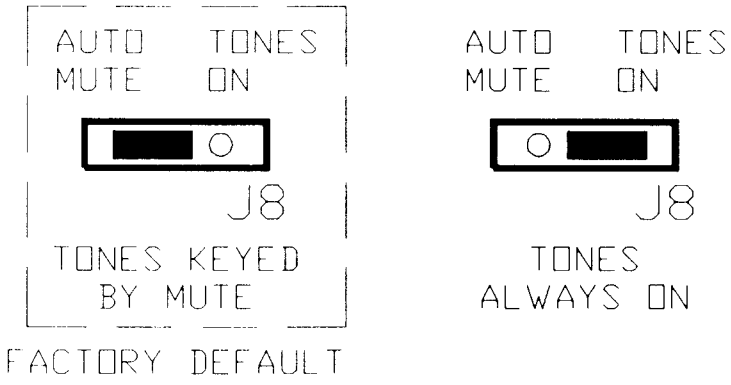

FIGURE 2.8 AUTO-MUTE JUMPER (A1J8)

2.5.5 Remote Control Data Rate (A2SW3)

Option switch A2SW3 is located on the left-rear of the top circuit board, the CONTROL board (Assembly A2). This switch controls the data rate of communications between the ST-8000A and a remote control terminal (not the "radio" or "wire-line" modem data rate). The data rate may be set from 110 baud to 38,400 baud. The factory default setting of SW3 is 9600 baud. Settings for SW3 are shown in Figure 2.9. If more than one switch is ON, the rate is set to the highest rate selected.

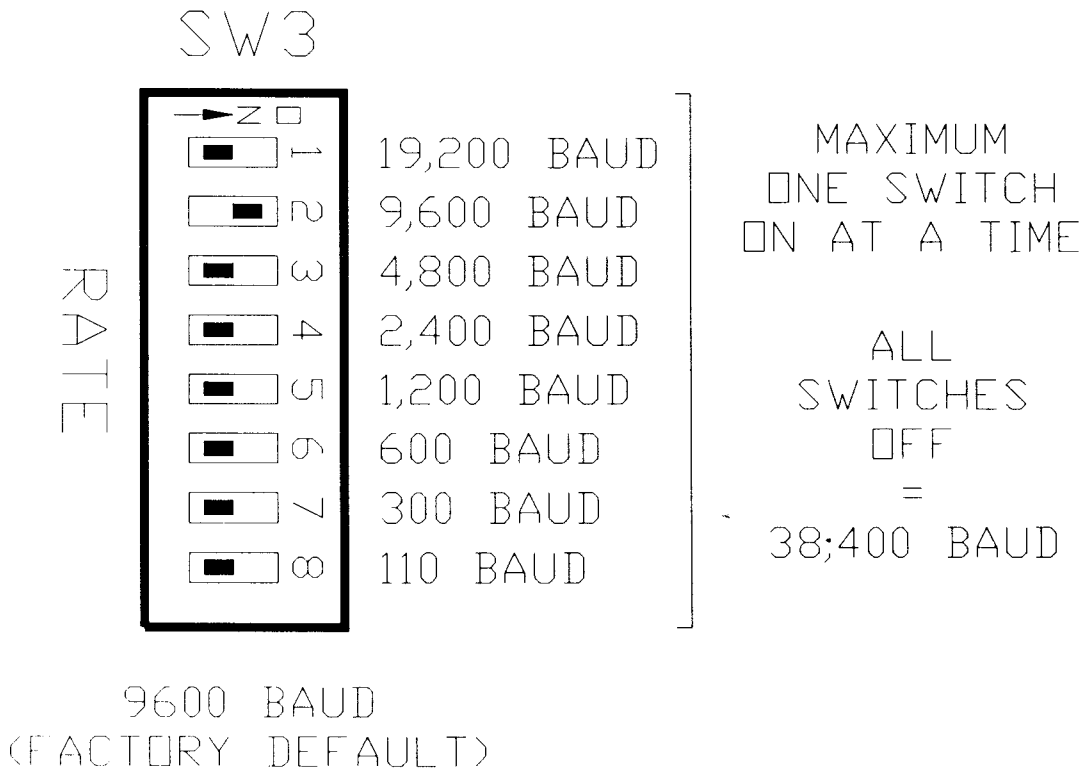

FIGURE 2.9 REMOTE CONTROL DATA RATE (A2SW3)

2.5.6 Remote Control Address (A2SW4)

Multiple ST-8000A FSK Modems may be parallel-connected to a single remote control terminal. When this feature is used, each ST-8000A FSK Modem in the connection must be set to a different remote control address. This remote control address is set with option switch A2SW4. Option switch A2SW4 is located near the left-rear of the CONTROL circuit board (top board). Note that the address set by SW4 sets both the unit address (01 through 09) and the Channel Number for the modulator and demodulator sections of each modem. The remote control commands required to access the different modems and the modulator/demodulator sections of each modem change with each address set. A careful reading of Chapter 4 of this manual (REMOTE CONTROL) is recommended. The factory default setting of A2SW4 is to Unit Address 01, Channel 01 and 02, the normal configuration for a single-modem system. A2SW4 settings are shown in Figure 2.10. If more than one switch is ON, the unit address is set to the lowest unit number switch closed (ON).

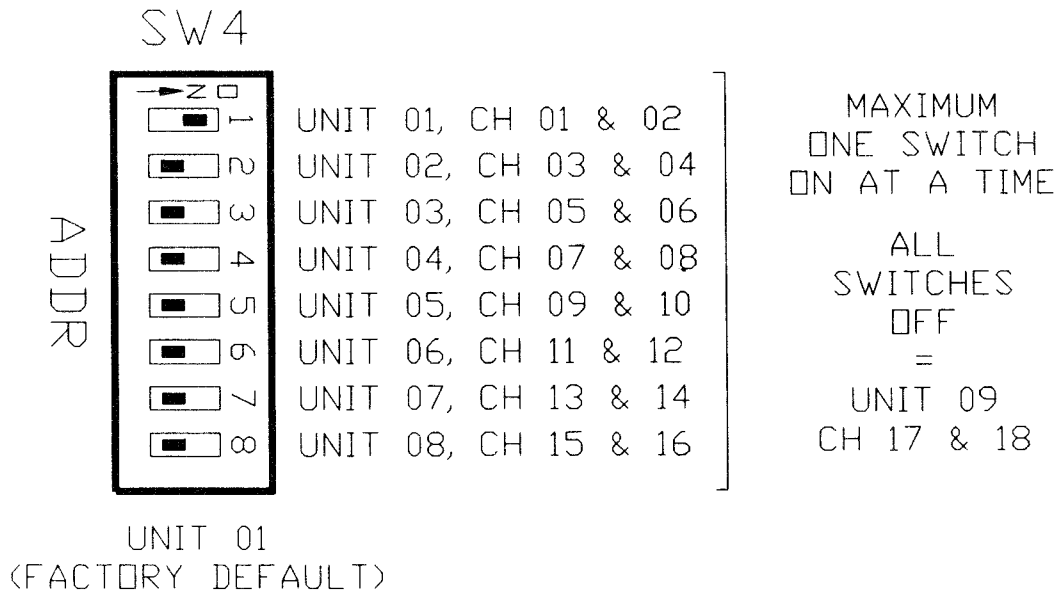

FIGURE 2.10 REMOTE CONTROL ADDRESS (A2SW4)

2.5.7 Auto-Mute Delay (A2SW1, A2SW2)

The Auto-Mute feature senses transmit data (TXD) activity and enables or disables the Modulator FSK tone output. When transmit data activity is detected, the keyline is immediately set to the closed (transmit) condition. When transmit data activity ceases (goes to continuous MARK or SPACE condition), the keyline will open (receive state) after a time delay. The time delay is set by option switches A2SW1 and A2SW2. This delay may be set from 1.0 millisecond (msec, 0.001 seconds) to 9.999 seconds.

Setting of Auto-Mute Delay switches A2SW1 and A2SW2 is shown in Figure 2.11. Note that the switches are arranged in four decimal digits, each digit encoded in "binary-code-decimal" (BCD) format. Therefore, to set these switches, the desired time delay must first be converted to four BCD digits, a total of 16 binary switch settings. The recommended procedure to follow is:

1. Write the desired delay in four digit format to 1.0 ms resolution. For example:

   1 Second = 1.000
   250 milliseconds = 0.250
   2.75 seconds = 2.750

2. Convert each of the four digits into BCD format. For example:

   Desired Delay = 1.327 Seconds

   Units digit = 1
   BCD = 0001 (0x8 + 0x4 + 0x2 + 1x1)
   SW2-1 = OFF, SW2-2 = OFF, SW2-3 = OFF, SW2-4 = ON

   100 ms digit = 3
   BCD = 0011 (0x8 + 0x4 + 1x2 + 1x1)
   SW2-5 = OFF, SW2-6 = OFF, SW2-7 = ON, SW2-8 = ON

   10 ms digit = 2
   BCD = 0010 (0x8 + 0x4 + 1x2 + 0x1)
   SW1-1 = OFF, SW1-2 = OFF, SW1-3 = ON, SW1-4 = OFF

   1 ma digit = 7
   BCD = 0111 (0x8 + 1x4 + 1x2 + 1x1)
   SW1-5 = OFF, SW1-6 = ON, SW1-7 = ON, SW1-8 = ON

A2SW1 and A2SW2 are shown in Figure 2.11. The factory default setting of SW1 and SW2 is for a 250 millisecond Auto-Mute Delay.

Caution must be used when setting very low delays. The Auto-Mute Delay should not be set to be less than twice the period of the character anticipated. For example, if the ST-8000A is used with a 50 baud BAUDOT (7.5 bits per character), set Auto-Mute delay to be greater than 2 X 7.5 X 20 milliseconds (1/50) or 300 ms.

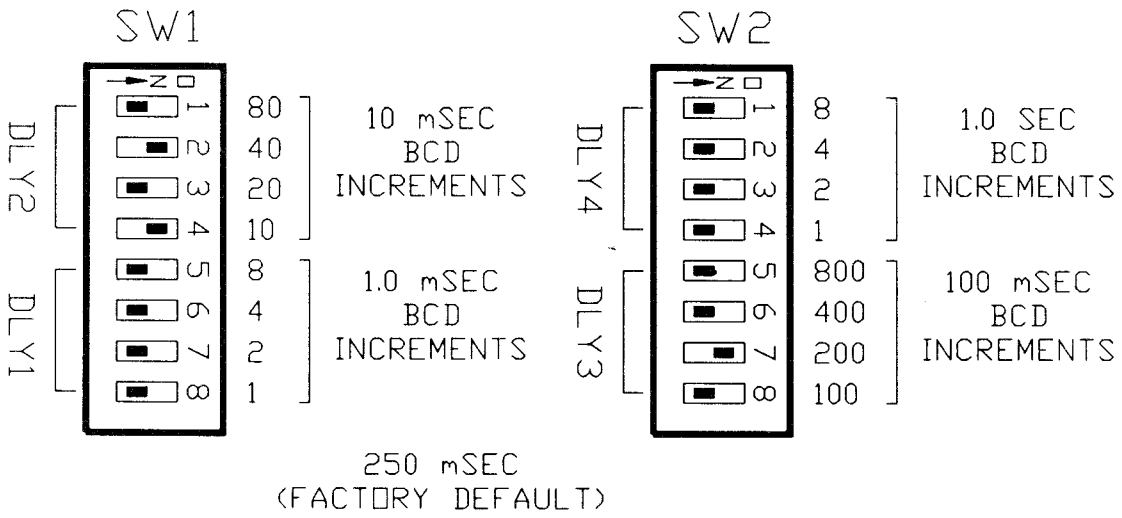

FIGURE 2.11 AUTO-MUTE DELAY (A2SW1, A2SW2)

2.5.8 RS-232 / MIL-188 Data Format (A2J2, J6, J7)

Option jumpers A2J2, A2J6, and A2J7 are located on the upper circuit board (CONTROL, Assembly A2) near the front of the cabinet. Jumper J2 is towards the right-side of the board; J6 and J7 and in the right-front center area of the board.

Jumper A2J2 sets the polarity of transmit data (TXD) that then drives the FSK modulator. Note that this is the DATA I/O port and not the REMOTE port. The factory default setting of J2 is "232", for RS-232 data.

Jumper A2J6 sets the polarity of the demodulator received data mid-bit clock signal. In the "232" position, the mid-bit clock signal has a high-to-low (+V to -V) transition at the center of each received data bit. In the "188" position, the clock transition is "low-to-high" (-V to +V). The normal RS-232 polarity and factory default setting of J2 is "232". This is also standard for most MIL-188 data systems. Some MIL-188 systems may require reverse clock polarity and J6 should should then be set for "188" polarity to be used in these systems.

Jumper A2J7 sets the format of all data lines to and from the Remote Control Terminal. Note that this jumper does not affect the data format of the DATA I/O port. The factory default setting of J7 is "232" for RS-232 data.

Jumpers A2J2, A2J6, and A2J7 are shown in Figure 2.12.

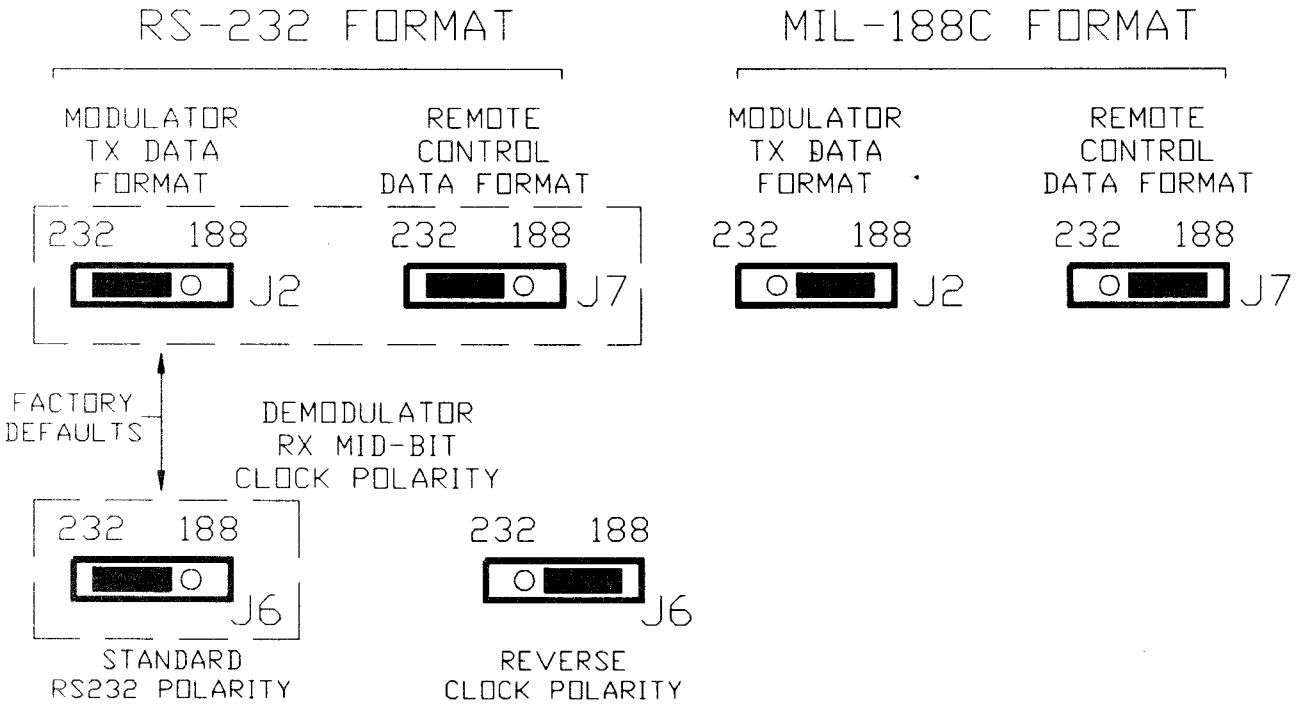

FIGURE 2.12 RS-232 / MIL-188 JUMPERS (A2J2, A2J6, A2J7)

2.5.9 Remote Control Terminations (A2J4, A2J8)

When the ST-8000A is connected in a multi-modem remote control network, one modem in the network must have termination resistors on the signal lines and all other modems must not be terminated. It is recommended that the first modem in the "daisy-chain" Unit 01) be the modem with the termination on the remote signal lines. These terminations are set by jumpers A2J4 and A2J8.

When only one ST-8000A is connected to a Remote Control terminal, the remote control data signal lines should be terminated. The factory default setting of jumpers J4 and J8 is with the termination installed (single unit). Jumpers A2J4, and A2J8 are shown in Figure 2.13 with factory settings.

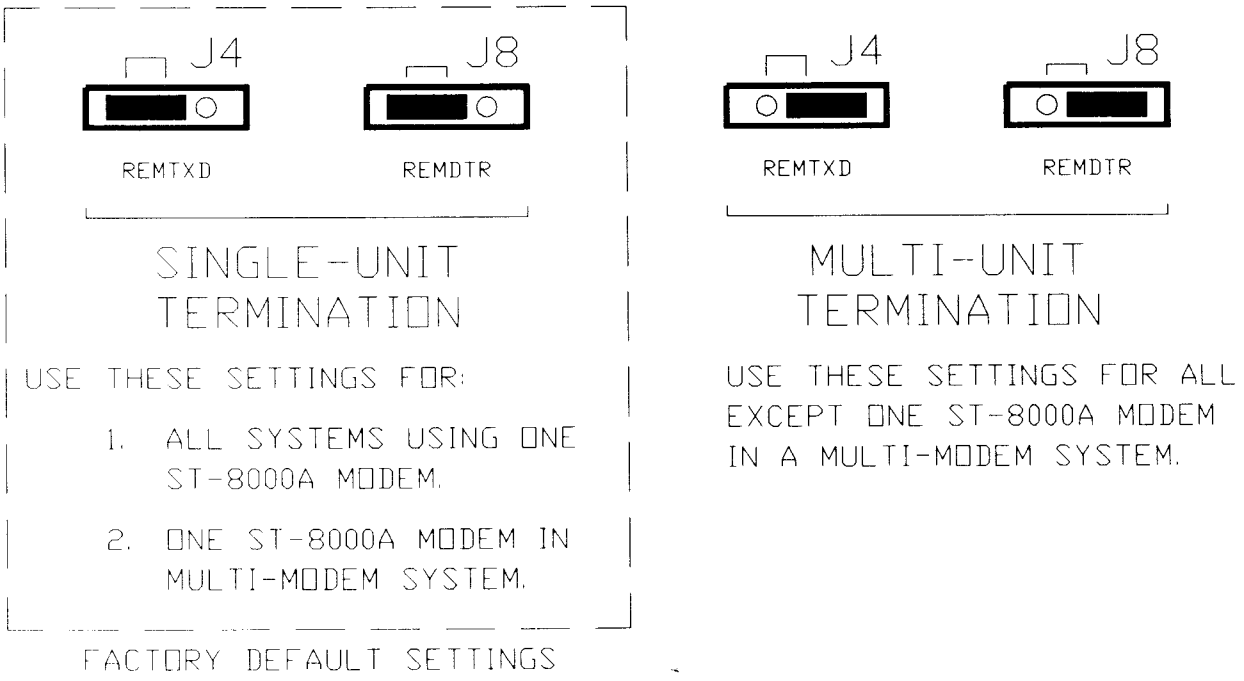

FIGURE 2.13 REMOTE CONTROL TERMINATIONS (A2J4 AND A2J8)

2.5.10 Log Option Settings and Replace Cover

This completes the setting of all internal ST-8000A option switches and jumpers. Before replacing the top cover, it is highly recommended that you record the settings chosen in Table 2.2.

After recording the options chosen, replace the top cover and fasten it with the 16 4-40x1/4" flat-head screws removed in section 2.5. Use a "No.1" Phillips screw-driver. Tighten all screws but avoid over-tightening.

TABLE 2.2

INTERNAL OPTION LOG

ST-8000A Serial No. _____

DATE _____ / _____ / _____

TECHNICIAN _____

PARAMETER	SET	SETTINGS				FACTORY DEFAULT	REFERENCE
AC POWER VOLTAGE:		115	___	230	___	115	(2.3.1)
AC FREQUENCY:		50/60	___	400	___	50/60	(2.3.1)
DEMOD INPUT Z:	(A1J6)	600	___	10K	___	600	(2.5.1)
AMH THRESHOLD:	(A1SW1)		_____	dBm		-42 dBm	(2.5.2)
AMH DELAY:	(A1SW2)		_____	Seconds		1.0 Sec	(2.5.2)
DEMOD LOS:	(A1J9)	-V	___	+V	___	-V	(2.5.3)
MOD AUTO-MUTE:	(A1J8)	AUTO	___	ON	___	AUTO	(2.5.4)
REMOTE RATE:	(A2SW3)		_____	Baud		9600 Bd	(2.5.5)
REMOTE ADDRESS:	(A2SW4)	UNIT	___			01	(2.5.6)
MUTE DELAY:	(A2SW1, SW2)		_____	Seconds		250 ms	(2.5.7)
RX CLOCK POLARITY:	(A2J2)	232	___	188	___	232	(2.5.8)
TXD FORMAT:	(A2J6)	232	___	188	___	232	(2.5.8)
REMOTE DATA:	(A2J7)	232	___	188	___	232	(2.5.8)
REMOTE TERM (TXD):	(A2J4)	TERM	___	OPEN	___	TERM	(2.5.9)
REMOTE TERM (DTR):	(A2J8)	TERM	___	OPEN	___	TERM	(2.5.9)

2.6 CABLE CONNECTIONS

This section describes how to interconnect the ST-8000A to external equipment. Be sure that power is disconnected from all equipment before interconnections are installed.

2.6.1 Audio I/O Connections (Connector J2)

Audio input and output as well as keyline connections are made to ST-8000A rear panel connector J2. Signal connections and ratings for J2 are shown in Table 2.2.

TABLE 2.3
AUDIO I/O CONNECTOR J2

PIN	SIGNAL	RATINGS	NOTES
1	MODULATOR FSK AUDIO OUTPUT	-30 to 0 dBm, 600 ohms.	1
2	No Connection (N.C.)	-----	
3	MODULATOR FSK AUDIO OUTPUT	-30 to 0 dBm, 600 ohms.	1
4	No Connection (N.C.)	-----	
5	KEYLINE RELAY CONTACT	±50V, 0.2A Maximum.	2
6	KEYLINE RELAY CONTACT	±50V, 0.2A Maximum.	2
7	No Connection (N.C.)	-----	
8	Jumper wire to J1, Pin 8	200V, 5A Maximum	
9	No Connection (N.C.)	-----	
10	DEMODULATOR FSK AUDIO INPUT	-45 to +6 dBm, 600/10K.	3
11	No Connection (N.C.)	-----	
12	DEMODULATOR FSK AUDIO INPUT	-45 to +6 dBm, 600/10K.	3
13			
|	No Connection (N.C.)	-----	
36			
37	SHIELD (Ground)	GROUND	

NOTES:

1. Pins 1 & 3 (Modulator Output) are balanced audio output connections.
2. Pins 5 & 6 (Keyline Output) are keyline relay contacts (XMIT = Pin 5 connected to Pin 6). Keyline also connected to J1, Pins 15 & 16.
3. Pins 10 & 12 (Demodulator Input) are balanced audio input connections.
4. Rear panel connector J2 is type MS27508E14F35SA.
5. Mating cable connector is type MS2743E14F35PA.

The ST-8000A may be used in radio systems, 4-Wire line connections, and 2-Wire line connections. These connections are discussed in the following sections.

2.6.1.1 Radio System Connections

Typical radio system connections to the ST-8000A are shown in Figures 2.14 and 2.15. A total of 6 wires and the cable shield must be connected.

USE OF SHIELDED CABLE IS RECOMMENDED WHEN CONNECTING TO RADIO EQUIPMENT.

2.6.1.1.1 Modulator FSK Audio Output:

The ST-8000A Modulator Output is available as a balanced, 600 ohm output on pins 1 and 3 of J2. The output level (voltage) is set by the front panel OUTPUT LEVEL control from less than -30 dBm (24.5 mV rms) to 0 dBm (0.775 V rms). When the ST-8000A is set to display CH2 parameters (MOD), the MARK and SPACE Bar graphs show the modulator output level in dBm.

NOTE: While the Modulator Output may be used with any load impedance of 600 ohms or greater, the bar graphs are calibrated for a 600 ohm output load impedance. The open-circuit (no load or very high impedance) output level is approximately 6 dB greater than the bar graph indication.

The ST-8000A Modulator Output should be connected to the radio transmitter audio input as shown in Figure 2.13. The impedance and voltage level requirements vary widely between different transmitter units. Transmitters equipped with a special 600 ohm audio input (often labeled "LINE IN") will typically require an output voltage of -10 to 0 dBm (245 mV to 775 mV rms).

2.6.1.1.2 Keyline Connection:

Pins 5 and 6 of ST-8000A connector J2 are isolated relay contacts that may be used to automatically control the transmit/receive mode of the radio system. Observe the maximum voltage and current limitations shown in Table 2.3 (50V, 0.2 Amperes).

The ST-8000A Keyline is controlled by the MUTE DELAY parameters. The delay is set with internal option switches A2SW1 and A2SW2. Section 2.5.7 provides a detailed description for setting these switches.

2.6.1.1.3 Demodulator FSK Audio Input:

Pins 10 and 12 of connector J2 are the audio input to the ST-8000A demodulator circuit. This input to the ST-8000A should be connected to the radio receiver audio output. The ST-8000A requires audio input signals with voltage levels from -45 dBm (1.4 mV rms) to +6 dBm (1.5 V rms).

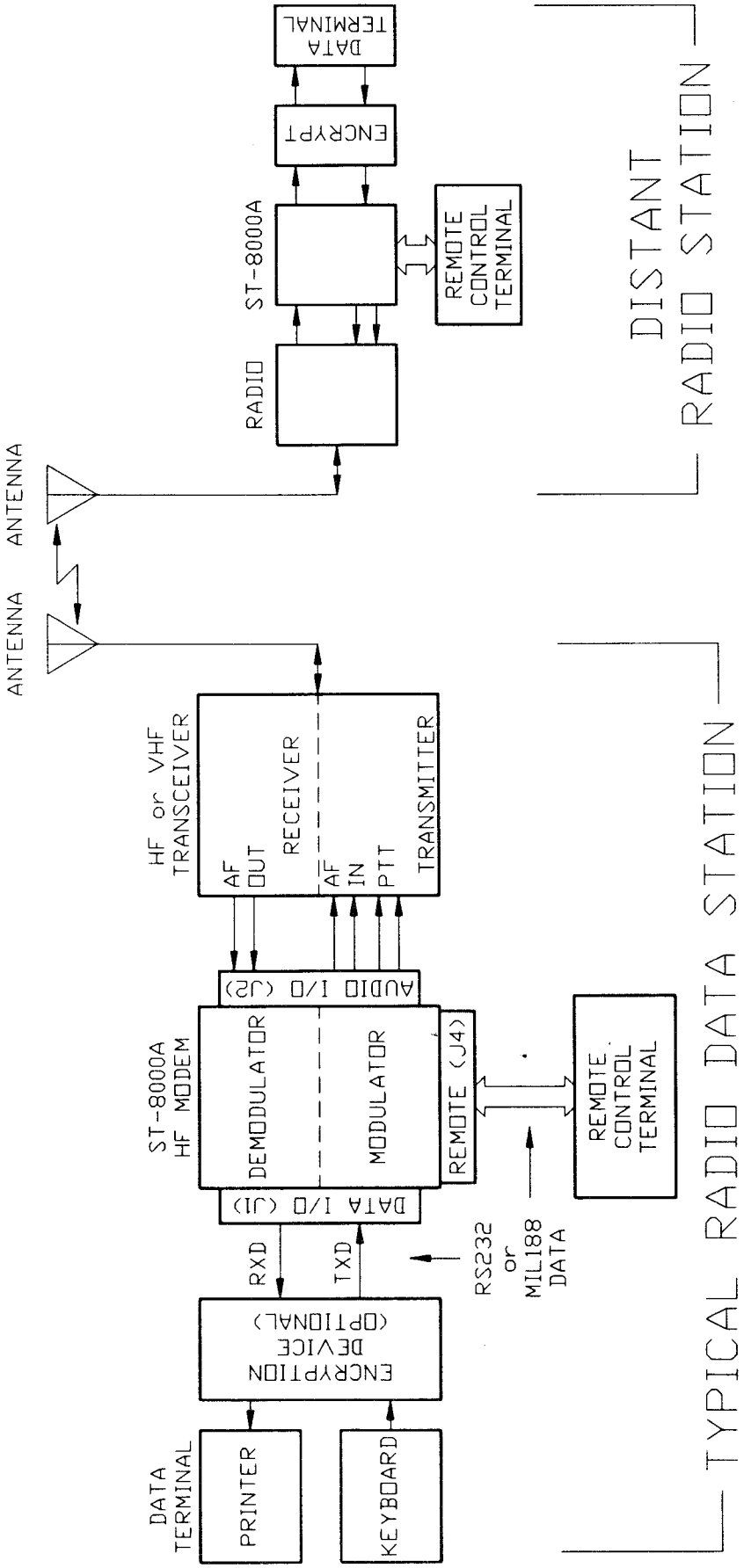

FIGURE 2.14 TYPICAL RADIO DATA SYSTEM

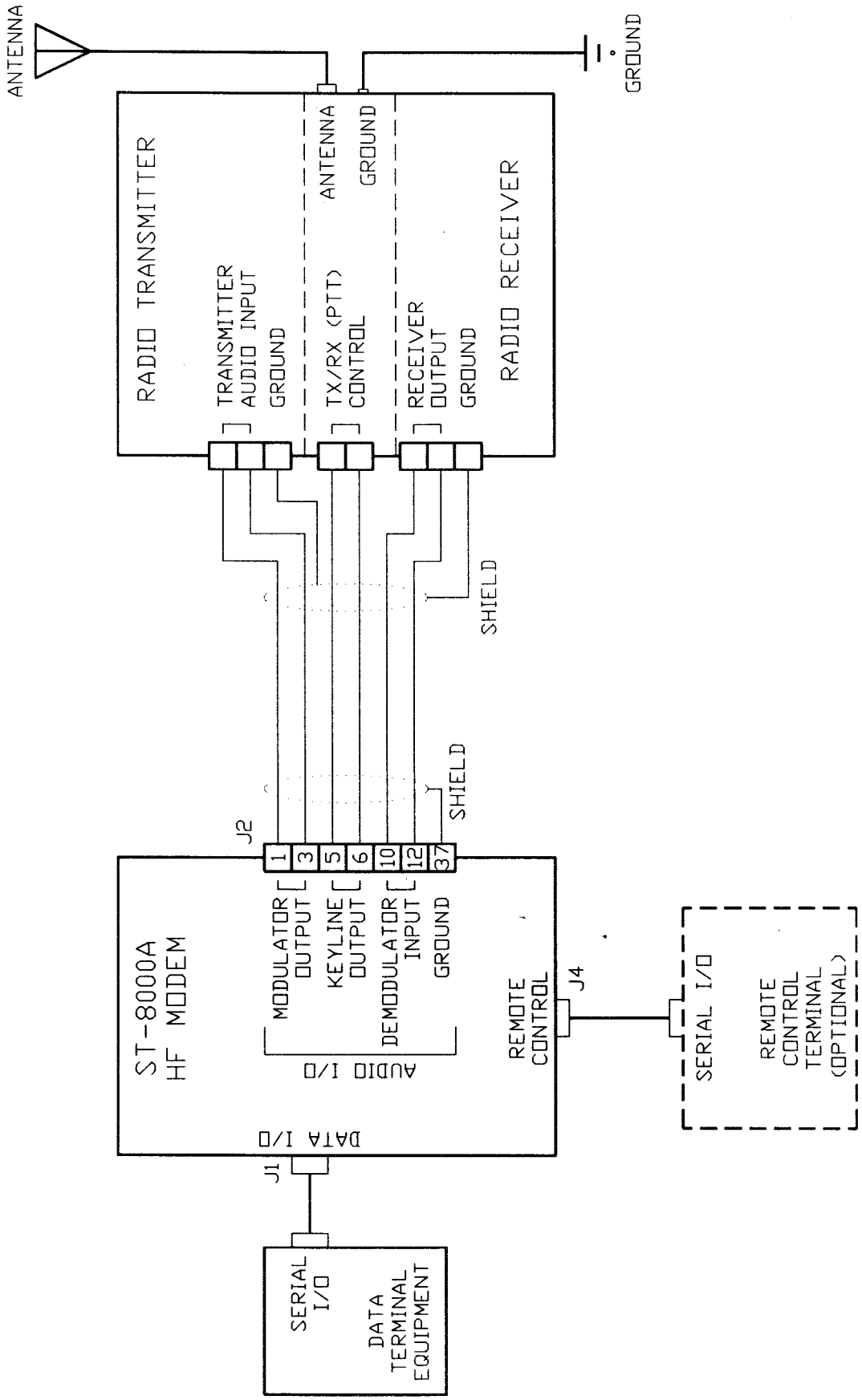

FIGURE 2.15 RADIO SYSTEM CONNECTIONS

Two different matched audio input impedances may be selected by jumper A1J6, 600 ohms or 10,000 ohms (see Section 2.5.1). The audio input may be either balanced or unbalanced. For unbalanced connections, ground the wire connected to pin 12 at the receiver.

When multiple ST-8000A audio inputs are connected to one receiver (as when decoding individual channels of a Frequency Division Multiplex signal), it is recommended that the 10K ohm input impedance be set on all ST-8000A demodulators.

2.6.1.2 4-Wire Line Connections.

ST-8000A Modems may be connected to dedicated 4-wire transmission lines as shown in Figures 2.16 and 2.17. The Modulator Audio Output terminals (Pins 1 & 3) of one ST-8000A are connected to the Demodulator Audio Input terminals (pins 10 & 12) of the other unit. Set the demodulator input impedance to 600 ohms (A1J6) in both units. Set each OUTPUT LEVEL control to "0 dBm" (775 mV - full Clockwise rotation).

Care should be taken to ensure that modulator output tone frequencies match the demodulator tone frequencies of the other unit. Set both units so that MARK and SPACE frequencies match. Data may transferred in both directions simultaneously (Full Duplex, FDX). The AUTO-MUTE feature may be set either ON or OFF for 4-wire FDX connections (A1J8).

Since all audio signal wires in Figure 2.17 are balanced with respect to ground, use of shielded cable is optional. However, shielded cable is highly recommended, particularly when the wires must run in near proximity to noisy power lines or transmitter cables and antennas.

The keyline output of the ST-8000A (J2 Pins 5 & 6) is not used in typical 4-wire line connections.

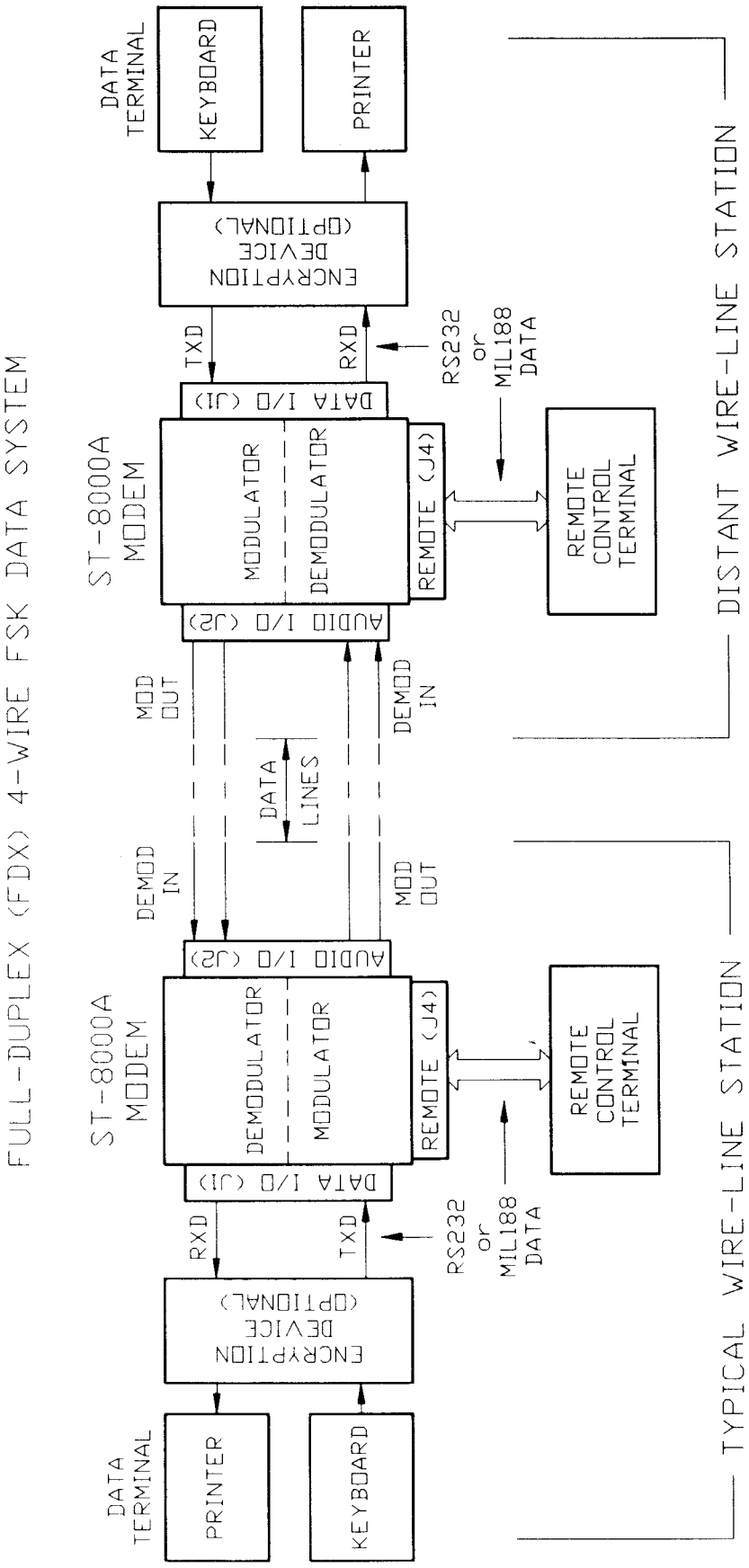

FIGURE 2.16 TYPICAL FDX WIRE-LINE SYSTEM

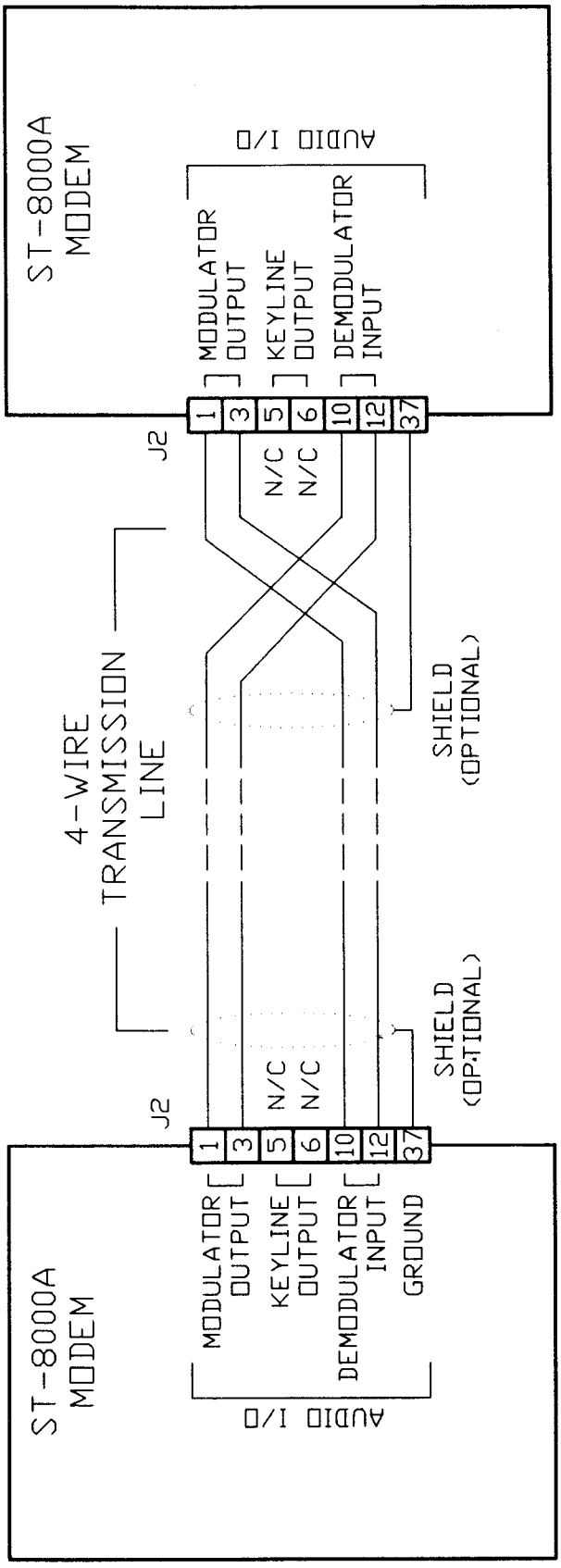

FIGURE 2.17 4-WIRE LINE CONNECTIONS

2.6.1.3 2-Wire Line Connections:

The ST-8000A may be used with 2-wire transmission lines as shown in Figure 2.18. In this case, set the demodulator input impedance of both units to 10K ohms (jumper A1J6).

ST-8000A Modems may be operated in either Full Duplex (FDX) or Half Duplex (HDX) modes with the following considerations.

To operate Full Duplex (FDX), a different set of MARK and SPACE tone frequencies must be used for each direction of data flow. For example, a 300 baud FDX system may be operated on 2-wire lines by setting 1070 and 1270 Hz as the MARK and SPACE frequencies of Unit 1 modulator and Unit 2 demodulator. Set 2025 and 2225 Hz as the MARK and SPACE frequencies of Unit 2 modulator and Unit 1 demodulator. Different frequencies and a separation between the MARK/SPACE frequency pairs must be maintained. This technique should be used only for data rates up to 300 baud.

The 2-wire line connection may also be used in Half Duplex (HDX) mode. This mode operates much like the radio system previously described. In this case, all MARK and SPACE frequencies may be set to be the same. The modulator AUTO MUTE feature must be enabled and A1J8 must be set as described in Section 2.5.4. AUTO MUTE automatically turns the modulator output tones OFF when there is no more transmit data to be sent by a station. This allows the other station to send data.

In many half-duplex systems, Carrier Detect (DCD or CD, J1 pin 10) is used to determine if the channel (wire line) is busy. RTS (Request To Send) is used to turn on the modulator audio output signal. Transmit data is then started 200 ms later. This operation requires that AMH be turned ON. These connections are discussed in detail in Section 2.6.2.

NOTE: The ST-8000A cannot be directly connected to the public switched telephone network.

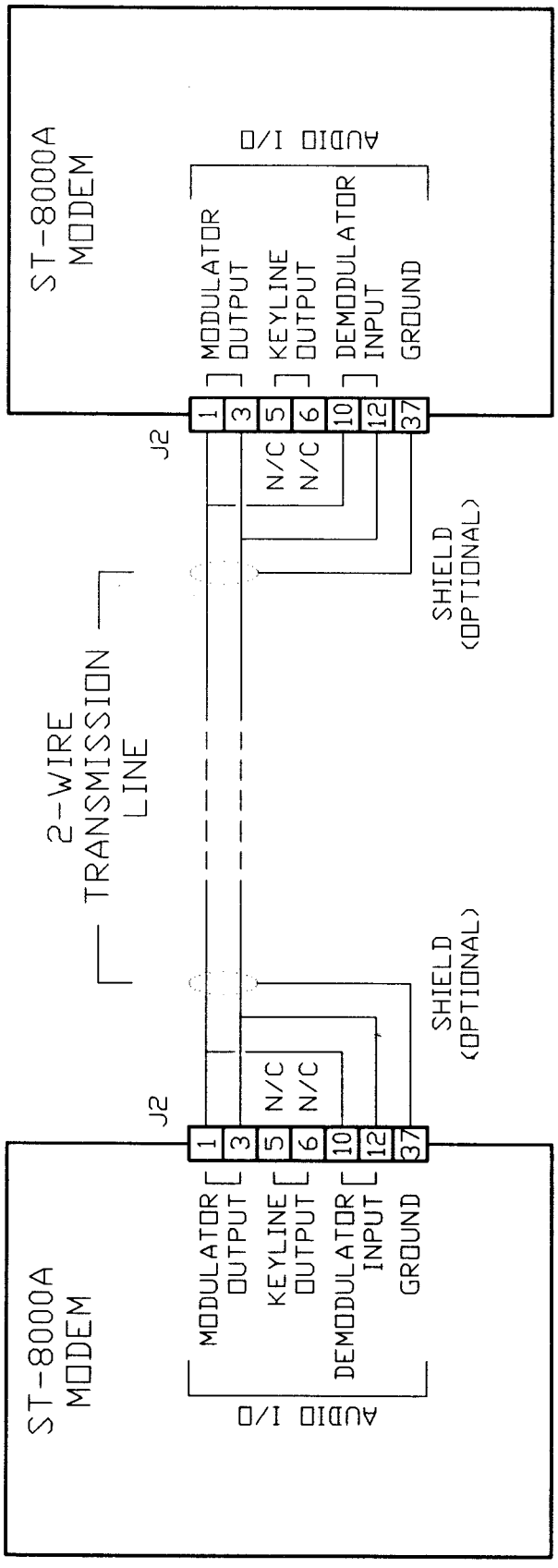

FIGURE 2.18 2-WIRE LINE CONNECTIONS

2.6.2 Data Terminal Connections

Data I/O connections to the ST-8000A are made via rear panel connector J1. Signal connections and ratings for J1 are shown in Table 2.4.

TABLE 2.4
DATA I/O CONNECTOR J1

PIN	SIGNAL	RATINGS	NOTES
1 | 6	No Connection (N.C.)	------	
7	DEMOD UNDETECTED MARK	0 dBm MARK Audio Output	1
8	Jumper wire to J2, Pin 8	200V, 5A Maximum	
9	DEMOD UNDETECTED SPACE	0 dBm SPACE Audio Output	1
10	CARRIER DETECT OUTPUT	±6 VDC, Polarity via A1J9	
11	No Connection (N.C.)	------	
12	DEMODULATOR ANALOG GROUND	GROUND	
13	GROUND	GROUND	
14	GROUND	GROUND	
15	KEYLINE RELAY CONTACTS	±50V, 0.2A Maximum	2
16	KEYLINE RELAY CONTACTS	±50V, 0.2A Maximum	2
17	DATA I/O RTS INPUT	±18 VDC, RS-232	3
18	DATA I/O CTS OUTPUT	±6 VDC, RS-232	3
19	TRANSMIT CLOCK OUTPUT	±6 VDC	4
20	MODULATOR DIGITAL DATA INPUT	±18 VDC, RS-232/MIL-188	5
21	DEMOD MID-BIT CLOCK OUTPUT	±6 VDC, RS-232	
22	DEMOD DIGITAL DATA OUT (RS)	±6 VDC, RS-232	6
23	DEMOD DIGITAL DATA OUT (MIL)	±6 VDC, MIL-188	6
24	MODULATOR ANALOG GROUND	GROUND	
25	GROUND	GROUND	
26	GROUND	GROUND	
27 | 35	No Connection (N.C.)	------	
36	MODULATOR ANALOG GROUND	GROUND	
37	SHIELD (Ground)	GROUND	

NOTES:

1. DEMOD Undetected Outputs (pins 7 and 9) are 0 dBm audio output signals.
2. Keyline connections (Pins 15 & 16) are paralleled by connections to J2 (Pins 5 & 6).
3. DRTS (Pin 17) and DCTS (Pin 18) are available for external transmit/receive and data flow control.
4. Transmit Clock at Modulator Data Rate (CH2).
5. Modulator data input RS-232/MIL-188 selection set by Option Jumper A2J2 on Control Board.
6. Demodulator RS-232 (Pin 22) and MIL-188 (Pin 23) data outputs available simultaneously.
7. Rear panel connector J1 is type MS27508E14F35SB.
8. The mating cable connector is type MS27473E14F35PB.

Typical connections between the ST-8000A and an RS-232 data terminal device are shown in Figure 2.19. Connections to the standard DB-25 style connector are shown, but connector type and sex may vary among terminal devices. Consult the manual of the intended data terminal and confirm these connections before preparing a cable. A shielded cable for Data I/O connections is highly recommended.

NOTE: Connector J1 provides data input and output (I/O) only for data passed via the audio modulator and demodulator sections -- radio or wire-line data. Connector J4 (REMOTE CONTROL) is used for connection of a <u>different</u> data terminal device to control parameters of the ST-8000A.

Typical minimum connections between the ST-8000A and the data terminal device are shown as solid lines in Figure 2.19. Additional signals that may be used in some data terminal connections are shown as dashed lines. These signals are not required in many applications. If the ST-8000A is used in a receive-only connection, only receive data (pin 22 or 23), signal ground (pin 13) and cable shield (pin 37) need be connected.

The Carrier Detect signal (J1 Pin 10) has RS-232 and MIL-188 compatible levels and may be set for either polarity (LOS = -V (factory default) or LOS = +V) via Option Jumper A1J9.

The transmitter clock output (J1 Pin 19) is compatible with RS-232 and MIL-188 levels ($\pm$6V) and may be used to synchronize external devices to the ST-8000A transmit data clock.

The receiver mid-bit clock output (J1, Pin 21) is compatible with RS-232 and MIL-188 levels and may be used to synchronize external devices with timing recovered by the ST-8000A when the SYNC feature is used.

The Data RTS and CTS (DRTS and DCTS) signals have RS-232 compatible levels. Data RTS may be used to externally force transmit condition (Modulator tones ON, MUTE OFF, keyline closed). Setting DRTS "high" (V > 2.5V) sets transmit condition. The DCTS signal is driven by the DRTS signal, producing a +V output approximately 200 ms after DRTS is pulled "high". DCTS may be used to control transmit data flow out of the data terminal device. This prevents data output until the transmitter RF output has stabilized.

The demodulator undetected output signals (MARK = Pin 7, SPACE = Pin 9) are usually not connected to data terminals. These are filtered audio signals recovered from the demodulator input signal. These signals may be used for further data processing or for connection to an external tuning display (oscilloscope). When connecting to Pin 7 or 9, use Pin 12 as the ground return and use shielded cable (Pin 37). The external load to ground on Pin 7 or 9 should be 10,000 (10K) ohms or higher.

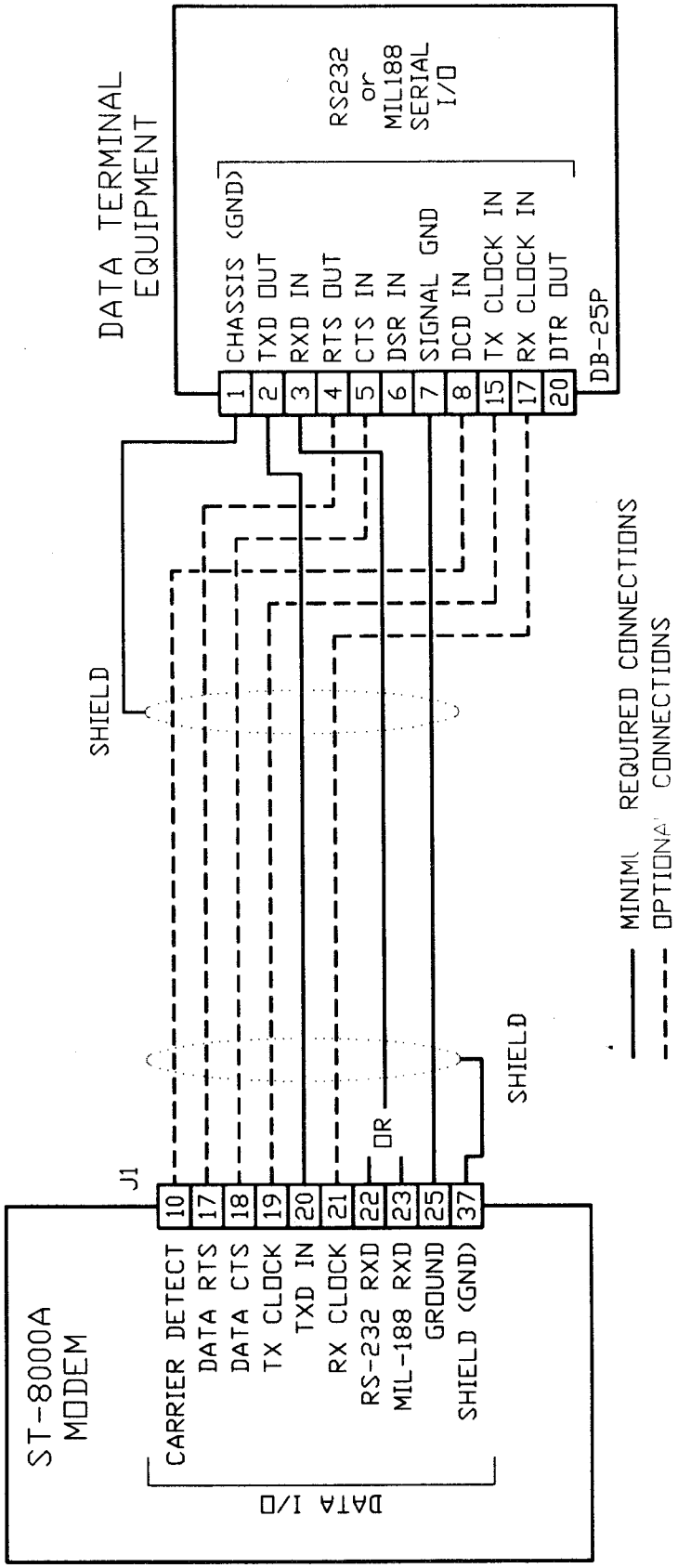

FIGURE 2.19 DATA I/O CONNECTIONS

2.6.3 Remote Control Terminal Connections

Remote Control connections to the ST-8000A are made via rear panel connector J4. Signal connections and ratings for J4 are shown in Table 2.5.

TABLE 2.5
REMOTE CONNECTOR J4

PIN	SIGNAL	RATINGS
1	DATA INPUT	±18 VDC Max, RS-232/MIL-188
2	BUSY INPUT (Status In: CTS)	±18 VDC Max, RS-232/MIL-188
3	DATA OUTPUT	±6 VDC, RS-232/MIL-188
4	+V OUTPUT	+6 VDC, 470 ohm impedance
5	BUSY OUTPUT (Status Out)	±6 VDC, RS-232/MIL-188
6	GROUND	GROUND
7 | 13	No Connection (N.C.)	-----

NOTES:

1. Select RS-232 or MIL-188 via Option Jumper A2J7 on Control Board (see section 2.5.8)
2. In multi-modem "daisy-chain" connections, use Option Jumpers A2J4 and A2J8 to set terminating resistor on one unit and open on all other modems (see section 2.5.9).
3. Rear panel connector J4 is type MS27508E10F35P.
4. The mating cable connector is type MS27473E10F35S.

Typical connections of the ST-8000A to a remote control device are shown in Figure 2.20. Connections to a standard DB-25 style connector are shown, but connector type and sex may vary among terminal devices. Consult the manual of the intended remote control device before preparing the cable. A shielded cable for remote control connections is recommended.

The remote control data rate of the ST-8000A must be set via option switch A2SW3 (see section 2.5.5). The ST-8000A remote control data rate must match that of the remote terminal.

Figure 2.20 shows a simple 3-wire (plus shield) connection that may be used if "hardware handshaking" flow-control is not required. While this is a simpler circuit to install, hardware flow-control is recommended, particularly if the remote control port is operated at high data rates (greater than 1200 Baud). Some data terminals may not support operation at high data rates without the use of hardware flow-control.

Some data terminals or terminal software require connection to the Carrier Detect (DCD) input. Alternate connections for use with these terminals are shown in Figure 2.21.

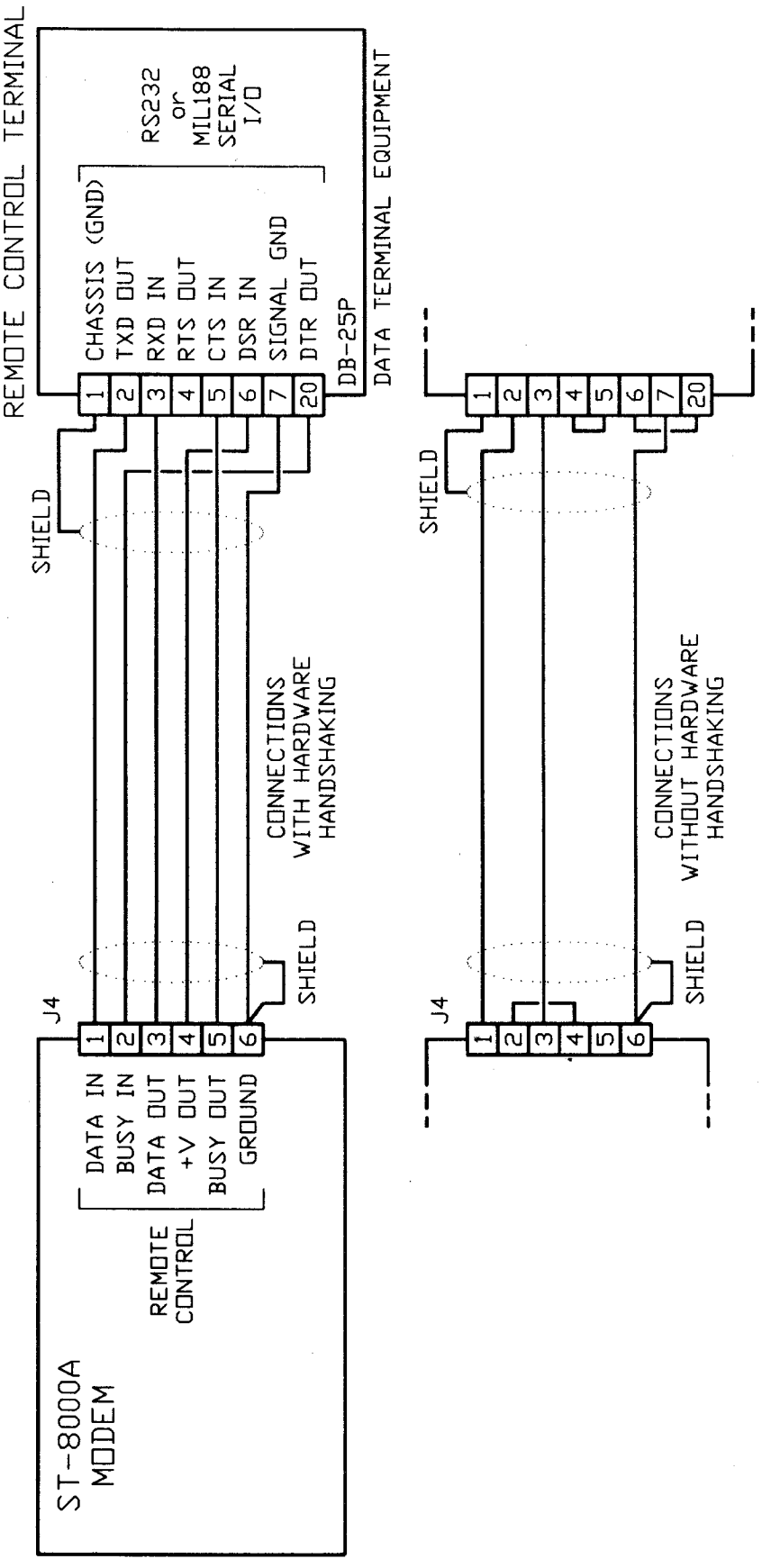

FIGURE 2.20 REMOTE CONTROL CONNECTIONS

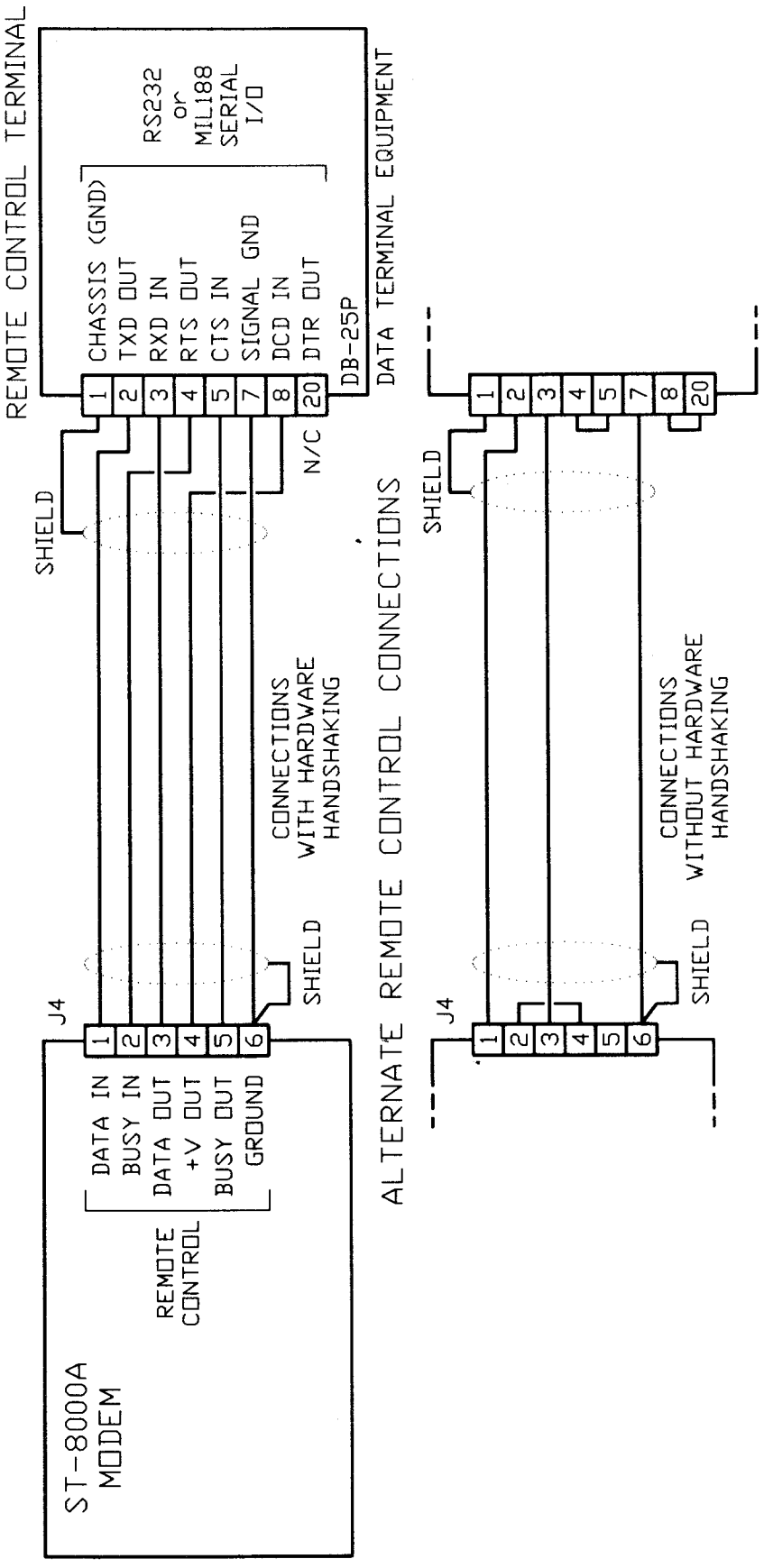

FIGURE 2.21 ALTERNATE REMOTE CONTROL CONNECTIONS

Multiple ST-8000A FSK Modems may be connected in a "Daisy-Chain" network in which up to nine (9) modems are controlled by a single Remote Control Terminal device. This connection is shown in Figure 2.22.

When multiple modems are connected in this fashion, they must all use the same data format (RS-232 or MIL-188, see section 2.5.8) and all must operate at the same data rate as the Remote Control Terminal (section 2.5.5). Further, the terminating resistors must be set "ON" in one ST-8000A and "OFF" in all other modems in the network. The terminating resistors are set using option jumpers A2J4 and A2J8 (see section 2.5.9). If echo of transmit data (TXD) is required by the terminal, it must be enabled in only one modem of the network. This one modem will then echo TXD commands sent to all modems in the network.

The ST-8000A will operate in a remote control network that contains one or more 1280A/M FSK Modems.

Each ST-8000A connected in the network must have a unique address, set via option switch A2SW4 (see 2.5.6). As shown in Figure 2.22, each modem remote control channel address is then unique. For example, "C01xxxxx" commands set Unit 1 Demodulator parameters, "C02xxxx" commands set Unit 1 Modulator parameters, "C03xxxx" sets Unit 2 Demodulator, and so on to "C18xxxxx" commands which set Unit 9's Modulator parameters. A given modem and modem channel will respond to commands only when it has been addressed. A given modem and channel remain selected until a new channel command is issued. A detailed description of REMOTE commands is provided in Chapter 4.

2.7 FACTORY DEFAULT PARAMETERS

The factory default parameters are set whenever there is a checksum error detected by the BIT in the EEPROM that stores the operational settings of the modem when power is OFF. These settings may be recalled during the Power-On Self Test (POST) by pressing the CLEAR key while the software version message is being displayed. The default settings are:

```
Display Channel is 1 (DEMOD)
Display Mode is MARK/SPACE
REMOTE is not selected/LOCAL mode is selected
Remote ECHO is ON
Remote format is LONG
MARK  = 1575.0     SPACE = 2425.0      BAUD  = 50
AMH is ON          DIVERSITY is OFF    HOLD is OFF
Polarity is NORMAL  REGEN is OFF       SYNCH is OFF
MUTE is OFF        ASYNC character length is 5
```

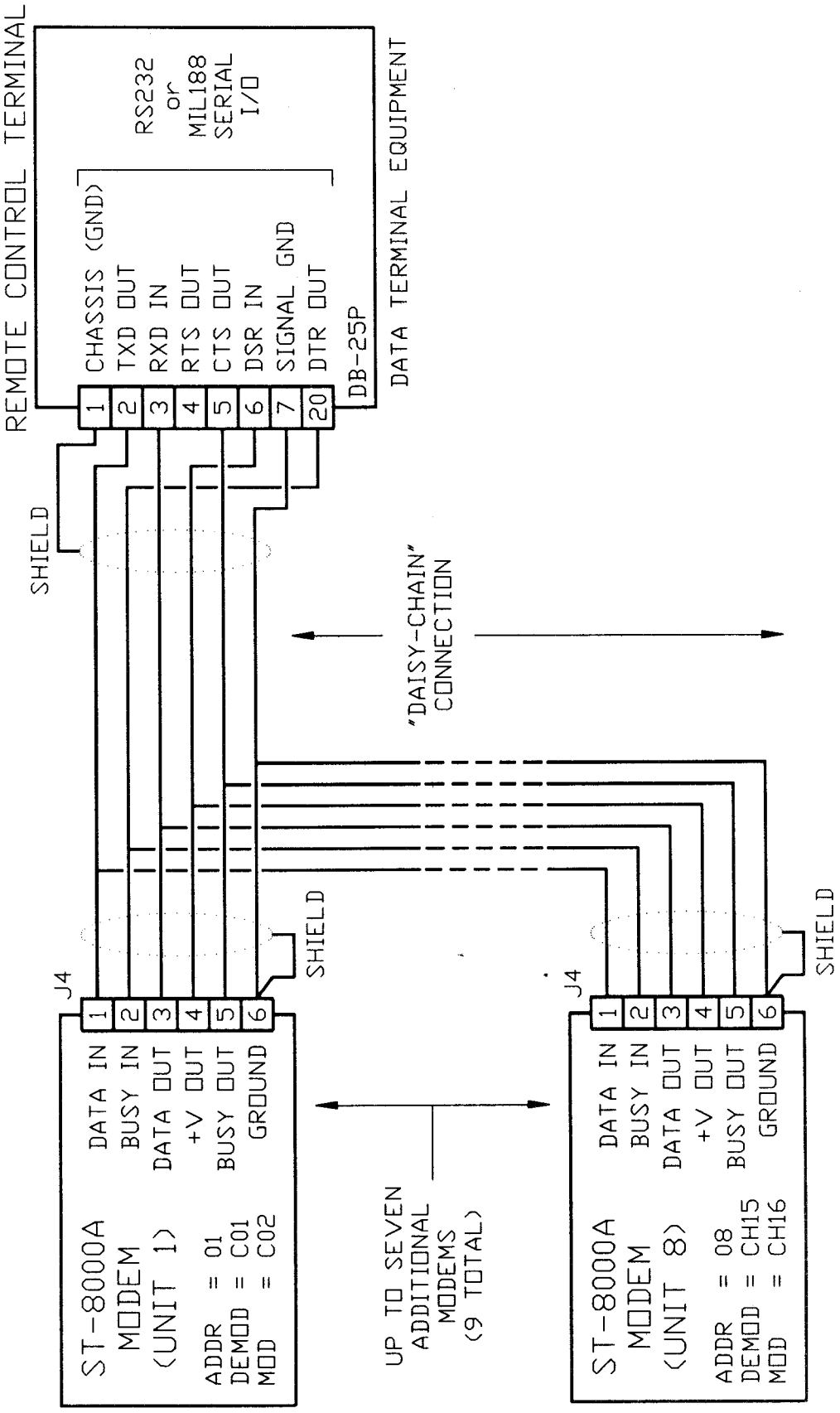

FIGURE 2.22 MULTI-UNIT REMOTE CONTROL CONNECTION

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CHAPTER 3
OPERATION

3.1 GENERAL

This Chapter explains how to operate the ST-8000A using the front panel keypad and indicators. The operation of each front panel feature is described. Use of the REMOTE port to control and operate the ST-8000A is described in Chapter 4.

3.1.1 Start-Up

The ST-8000A is turned ON with the POWER toggle switch on the front panel. A Power On Self Test (POST) is performed each time the modem is turned ON. The operational state stored in memory prior to power OFF is set up following the POST. Section 3.10.1 provides additional details on start-up operation of the modem. The built-in test (BIT) feature of the ST-8000A allows a more in depth determination of the operational state of the modem than the POST. Section 6.5 provides a detailed description of the BIT.

3.1.2 Local Operation

The control of the ST-8000A in the LOCAL mode of operation provides control of the operational state and parameters of the modem to be set and changed. The front panel controls, keypad and displays provide access to all functions controlled by remote commands. Section 3.2 provides a description of the front panel. Sections 3.3 through 3.7 provide detailed descriptions of the functions of all front panel controls and indicators. Section 3.8 contains a description of various LOCAL operations.

3.1.3 Emergency Operations

The ST-8000A can be operated, to a limited degree, in some failure modes. However, operating the ST-8000A with any known failure is not recommended. Section 3.8.4 contains descriptions of "non-fatal" failure modes and the operational constraints for the ST-8000A associated with each.

3.1.4 Power-Down

The ST-8000A does not require any special procedures for power down. The front panel power switch may be used at any time to turn the power OFF. The operational setup of the ST-8000A is stored in non-volatile memory when the ENTER key is pressed during LOCAL operation. If a parameter has been changed but not ENTERed, the ENTER key's LED will be flashing ON and OFF. Prior to turning the power OFF, press the ENTER key to store the applicable parameter.

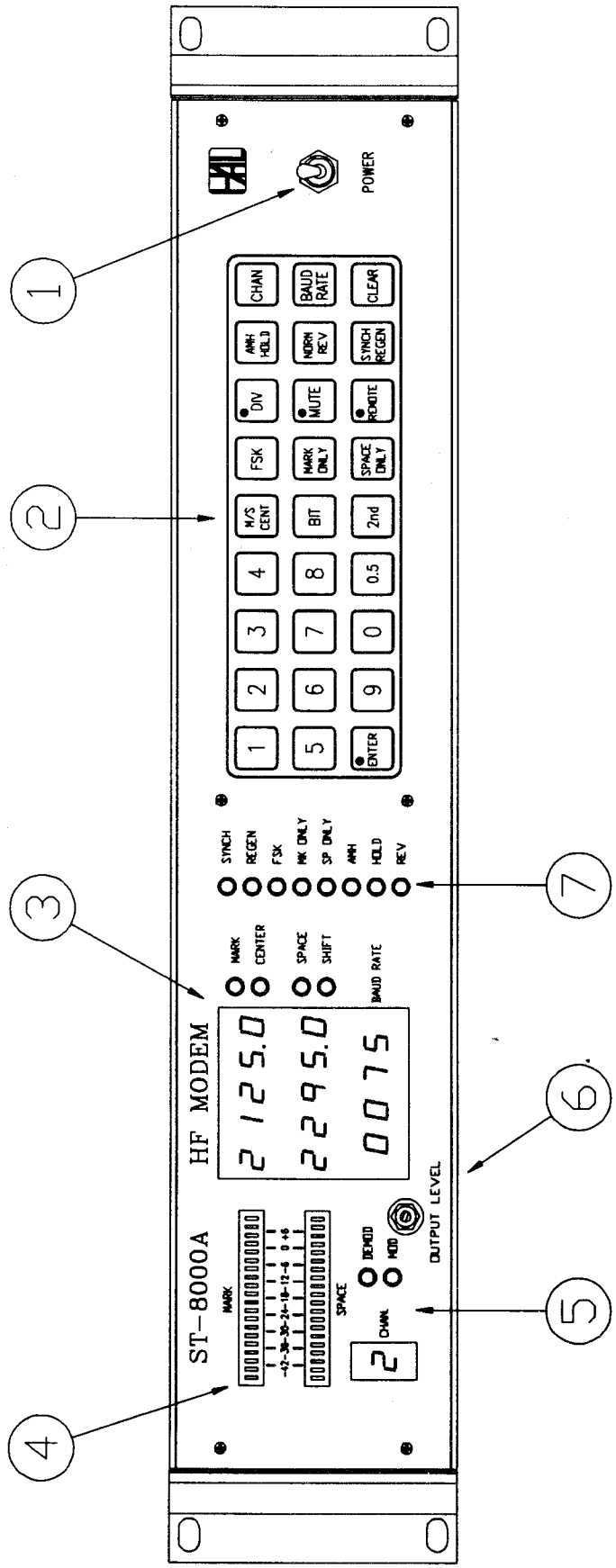

FIGURE 3.1 ST-8000A FRONT PANEL

3.2 ST-8000 FRONT PANEL

The front panel of the ST-8000A MODEM is shown in Figure 3.1. The following is a brief description of major front panel controls and indicators. Each item will be discussed in greater detail in following sections of this Chapter. Item numbers correspond to circled "call" numbers in Figure 3.1

1 POWER:

This is the main AC power switch for the ST-8000A. When the switch handle is in the UP position, AC power is turned ON.

2 KEYPAD:

The keypad is the means for front-panel entry of all user-set parameters. Keypad operation is discussed in section 3.3.

3 MARK, SPACE, BAUD Displays:

The MARK and SPACE or CENTER and SHIFT frequencies are displayed in 5-digit format on the two upper numerical display fields. The selected data rate is shown on the four digit BAUD display.

4 MARK and SPACE Bar Indicators:

These bar-graph indicators show the amplitude of the demodulator input signal or modulator output signal.

5 CHANNEL Indicators:

The CHAN indicator and DEMOD and MOD LED's show the modem channel currently being displayed and/or controlled by data entry.

6 OUTPUT LEVEL:

Sets the modulator output level.

7 MODE Indicators:

These eight LED indicators (plus 3 keypad indicators on the DIV, MUTE, and REMOTE keys) show currently selected modes of operation.

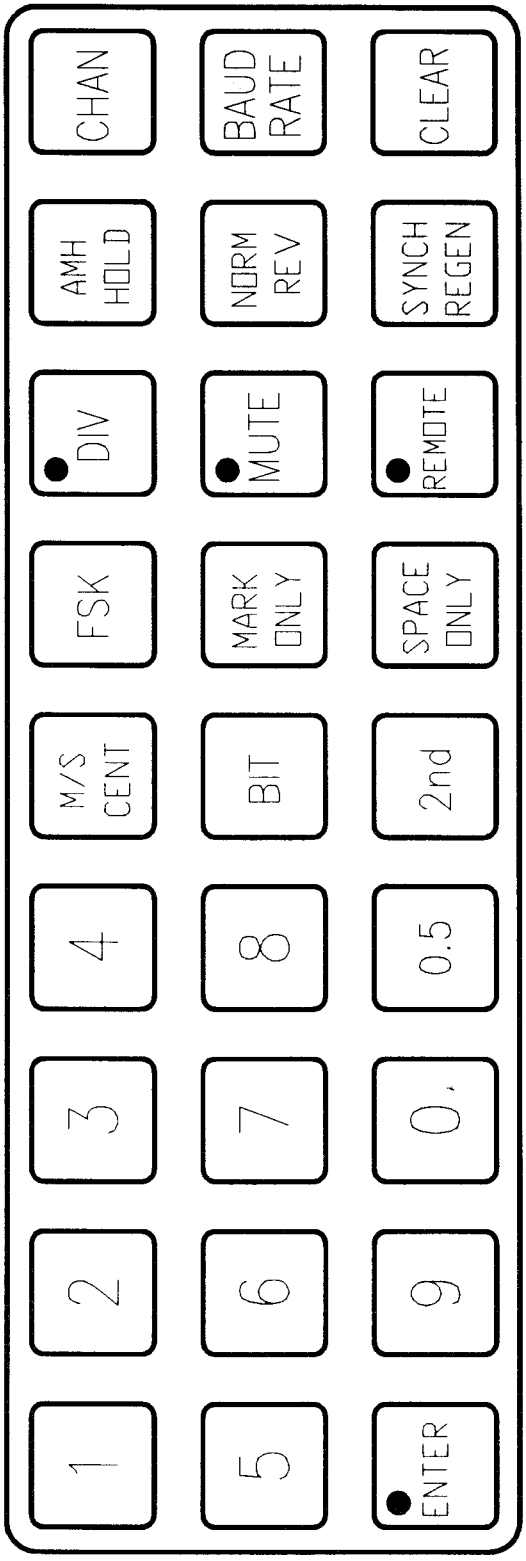

FIGURE 3.2 ST-8000A FRONT PANEL KEYPAD

3.3 KEYPAD ENTRY

The ST-8000A keypad provides control over operation of the modem. It is used to set the operational parameters of the modem for both channels. The keypad is used to activate built in test routines. The ST-8000A keypad is shown in Figure 3.2.

Whenever parameters are entered, the ENTER key indicator flashes to signal the change. To save this new parameter in non-volatile memory, press the ENTER key. At any time before ENTER is pressed, the CLEAR key may be pressed to ignore the new setting and return to the previously saved parameters.

In the following sections, the operation of each of the keypad function keys is summarized. The keys are presented in keypad order starting with the left hand column.

3.3.1 Number Keys

The number keys, 0 to 9 and 0.5, are used to enter new frequencies, baud rates, regeneration word length, and select internal BIT tests. The number keys are only active after one of the following function keys has been pressed: MARK, SPACE, BAUD RATE, or SYNCH. When entering a number, the corresponding display window shows the new setting, but the new parameter is not activated until the ENTER key is pressed. If the CLEAR key is pressed before ENTER, the modem will return to the previously stored settings and will ignore the new setting.

3.3.2 ENTER Key

The ENTER key stores the current modem parameters in non-volatile memory and turns OFF the flashing ENTER indicator. Pressing any operational parameter key causes the ENTER indicator to flash. If the CLEAR key is pressed before ENTER, the modem returns to the previously stored parameters.

NOTE: The REMOTE, M/S-CENT, and CHAN keys do not require the ENTER key.

3.3.3 M/S CENT Key

The M/S key determines the front panel display mode and the parameter entry mode. Pressing the M/S key turns ON the MARK and SPACE indicators and displays the MARK and SPACE filter center frequencies when channel 1 is selected, or the transmit tone frequencies when channel 2 is selected. In this mode, the MARK and SPACE keys set the MARK and SPACE frequencies directly for the selected channel.

Pressing 2ND then M/S changes the front panel display to show the CENTER and SHIFT frequencies for either channel 1 or 2. In this mode, the indicators next to the CENTER and SHIFT labels are turned ON. In addition, the MARK and SPACE keys load the CENTER and SHIFT frequencies, respectively, for the selected channel.

Whenever the display mode changes, the new setting is immediately stored in the non-volatile memory.

3.3.4 BIT Key

The BIT (Built-In-Test) routines are activated by pressing 2ND then BIT followed by ENTER or a number and ENTER. If ENTER alone is pressed, the automatic BIT procedure is performed. The table below summarizes the available test features and the corresponding BAUD display message.

TABLE 3.1

BIT ROUTINES

KEY	DESCRIPTION	BAUD DISPLAY
ENTER	Automatic BIT procedure	--
1	Automatic BIT procedure	--
2	Constant MARK	"/~~~"
3	Constant SPACE	"/___"
4	Alternating MARK/SPACE at TX BAUD	"Alt "
5	Analog Loopback at 0 dBm	"LP 1"
6	Analog Loopback at -20 dBm	"LP 2"
7	Analog Loopback at -45 dBm	"LP 3"
8	(reserved)	
9	(reserved)	
0	(reserved)	
0.5	Remote Port Echo	"Echo"
REMOTE	Remote Port QBF	"Port"
CHAN	Control Board Options	--

3.3.4.1 Internal BIT

When BIT #2 to #7, 0.5, or REMOTE is selected, the test continues until another key is pressed to terminate the test.

When 2ND - BIT - 0.5 or 2ND - BIT - REMOTE is activated, the remote port operation is disabled for the duration of the test. Remote port ECHO enables a remote port digital loopback and all characters received from the remote control terminal are immediately echoed. Remote port QBF transmits a continuous QBF message to the remote port until another key is pressed. Tests 2, 3, and 4 close the keyline and turn on the transmit tones even if MUTE is on.

3.3.4.2 Internal Options

When the 2ND - BIT - CHAN sequence is entered, the internal control board switch and jumper settings are displayed on the front panel. Pressing ENTER selects each option display. A summary of the display information follows:

TABLE 3.2

DISPLAY OF INTERNAL OPTIONS

KEY	DISPLAY	DESCRIPTION
ENTER	Unit	Display Title
	1	Current Unit Number
	4	Set by SW4
ENTER	ChAn	Display Title
	01-02	Current Channel Numbers
	4	Set by SW4
ENTER	Port	Display Title
	19200	Remote Control Port Rate
	3	Set by SW3
ENTER	Port	Display Title
	rS232	Remote Control Port Data Type
	J7	Set by J7
ENTER	dAtA	Display Title
	188	Data Port Type
	J2	Set by J2
ENTER	dELAY	Display Title
	1000	Keyline Delay in MS.
	1-2	Set by SW1 and SW2

3.3.5 2ND Key

The 2ND key accesses the second level functions on certain keys. The ST-8000A has second level functions only on the following keys: M/S CENT, BIT, MARK ONLY, SPACE ONLY, AMH HOLD, NORM REV, CHAN, and SYNCH REGEN. Pressing any key other than those listed above returns the keypad to first level functions.

3.3.6 FSK Key

The FSK key is used with MARK ONLY and SPACE ONLY to set the demodulator discriminator mode. Pressing FSK turns ON the FSK indicator and selects the MARK/SPACE discriminator mode. This key is functional whether channel 1 or channel 2 is selected.

KEYS	ACTION
FSK	Select demodulator MARK/SPACE mode. Turns ON the FSK indicator.

To save the new demodulator mode, the ENTER key must be pressed.

3.3.7 MARK ONLY Key

The MARK ONLY key has both a first and a second level function.

3.3.7.1 MARK (first level):

Press MARK alone to enter the MARK filter frequency (channel 1) or the MARK transmit tone (channel 2) when the MARK/SPACE display mode is active. The following example assumes that the demodulator, channel 1, is selected.

KEYS	ACTION
MARK	Blank the MARK display window, ENTER turns ON
2125	"2125.0" shows in the MARK window
ENTER	"2125.0" flashes, ENTER turns OFF The MARK filter is set to 2125.0 Hz

When the display mode is set for CENTER/SHIFT, the MARK key sets a new CENTER frequency for the demodulator filters, channel 1, or the transmit tones, channel 2. The following example assumes that the demodulator, channel 1, is selected.

KEYS	ACTION
MARK	Blank the CENTER display window, ENTER turns ON
2210	"2210.0" shows in the CENTER window
0.5	"2210.5" shows in the CENTER window
0.5	"2210.0" shows in the CENTER window
ENTER	"2210.0" flashes, ENTER turns OFF The demodulator center frequency is set to 2210 Hz

Note: When the center changes, the previous shift frequency is maintained. If previous MARK and SPACE were 1000.0 and 1200.0 Hz (Shift = 200.0 Hz), setting center to 2210 Hz will maintain 200 Hz shift and change MARK to 2110.0 Hz and SPACE to 2310.0 Hz.

To save the new center frequency, the ENTER key must be pressed.

3.3.7.2 MARK ONLY (2nd level):

Pressing 2ND then MARK enables the MARK ONLY demodulator mode and turns ON the MK ONLY indicator. If the FSK indicator was ON, that indicator turns OFF. If the SP ONLY indicator was on, that indicator turns OFF.

KEYS	ACTION
2nd	Enable second level function
MARK	Select demodulator MARK ONLY mode. Turn ON the MK ONLY indicator.

To save the new demodulator mode, the ENTER key must be pressed.

3.3.8 SPACE ONLY Key

The SPACE ONLY key has both a first and a second level function.

3.3.8.1 SPACE (first level):

Press SPACE alone to enter the SPACE filter frequency (channel 1) or the SPACE transmit tone (channel 2) when the MARK/SPACE display mode is active. The following example assumes that the demodulator, channel 1, is selected.

KEYS	ACTION
SPACE	Blank the SPACE display window, ENTER turns ON
2295	"2295.0" shows in the SPACE window
ENTER	"2295.0" flashes, ENTER turns OFF The SPACE filter is set to 2295.0 Hz

When the display mode is set for CENTER/SHIFT, the SPACE key sets a new SHIFT frequency for the demodulator filters, channel 1, or the transmit tones, channel 2. The following example assumes that the demodulator, channel 1, is selected.

KEYS	ACTION
SPACE	Blank the SHIFT display window, ENTER turns ON
200	" 200.0" shows in the SHIFT window
ENTER	" 200.0" flashes, ENTER turns OFF The demodulator shift frequency is set to 200 Hz.

Note: When the shift changes, the previous center frequency is maintained. If previous center and shift were 2210.0 and 170.0 Hz, setting shift to 200 Hz will retain the 2210 Hz center frequency and change MARK to 2110.0 Hz and SPACE to 2310.0 Hz.

To save the new shift frequency, the ENTER key must be pressed.

3.3.8.2 SPACE ONLY (2nd level):

Pressing 2ND then SPACE enables the SPACE ONLY demodulator mode and turns ON the SP ONLY indicator. If the FSK indicator was ON, that indicator turns OFF. If the MK ONLY indicator was on, that indicator turns OFF.

KEYS	ACTION
2nd	Enable second level function
SPACE	Select demodulator SPACE ONLY mode. Turn ON the SP ONLY indicator.

To save the new demodulator mode, the ENTER key must be pressed.

3.3.9 DIV Key

The DIV key toggles the demodulator diversity option ON and OFF. When ON, the DIV indicator turns ON.

KEYS	ACTION
DIV	Turn DIVERSITY option ON; turn ON DIV indicator
DIV	Turn DIVERSITY option OFF; turn OFF DIV indicator

This option works ONLY when the diversity option is installed. If the diversity option is not installed, the DIV key is ignored.

To save the new demodulator mode, the ENTER key must be pressed.

3.3.10 MUTE Key

The MUTE key toggles the modulator mute feature ON and OFF. When MUTE is ON, the front panel MUTE indicator turns ON and the transmit tones are disabled. The keyline operates as before. When the MUTE option is OFF and transmit data stops, the transmit tones are turned OFF with the keyline output after the keyline delay expires.

KEYS	ACTION
MUTE	Turn MUTE option ON; turn ON the MUTE indicator
MUTE	Turn MUTE option OFF; turn OFF the MUTE indicator

To save the new mute setting, the ENTER key must be pressed.

3.3.11 REMOTE Key

The REMOTE key selects local and remote control of the ST-8000A. When REMOTE is enabled, the REMOTE indicator turns ON and all parameter control is via the rear panel REMOTE port. The REMOTE LED is ON whenever Remote control is active. When remote control mode is enabled, all keypad keys are disabled except for the REMOTE key. Keypad or local control is restored by pressing the REMOTE key.

KEYS	ACTION
REMOTE	Enable REMOTE control; turn ON REMOTE indicator
REMOTE	Enable LOCAL control; turn OFF REMOTE indicator

The local or remote control status is saved in the non-volatile memory immediately; no ENTER key press is required.

3.3.12 AMH HOLD Key

The AMH HOLD key has both a first and a second level function.

3.3.12.1 AMH (first level):

The AMH key toggles the Automatic Mark-Hold receive feature ON and OFF. When AMH is ON, the AMH indicator is turned ON.

KEYS	ACTION
AMH	Turn AMH option ON; turn ON the AMH indicator
AMH	Turn AMH option OFF; turn OFF the AMH indicator

To save the new AMH setting, the ENTER key must be pressed.

3.3.12.2 HOLD (2nd level):

Pressing 2ND then HOLD toggles the MARK hold feature for the selected channel. When channel 1 is selected, the demodulator output is held in the MARK condition. When channel 2 is selected, the transmit tone output is held in the MARK state and the DATA I/O TXD is disabled. The HOLD indicator on the front panel shows the current state for the selected channel. The following example assumes that the transmit channel 2 is selected.

KEYS	ACTION
2ND	Enable second level function
HOLD	Turn HOLD option ON; turn ON the HOLD indicator
2ND	Enable second level function
HOLD	Turn HOLD option OFF; turn OFF the HOLD indicator

To save the new HOLD setting, the ENTER key must be pressed.

3.3.13 NORM REV Key

The NORM REV key has both a first and second level function.

3.3.13.1 NORM (first level):

The NORM key sets the selected channel polarity to NORMAL and turns OFF the REV indicator.

KEYS	ACTION
NORM	Enable NORMAL polarity; turn OFF REV indicator

To save the new polarity setting, the ENTER key must be pressed.

3.3.13.2 REV (2nd level):

Pressing 2ND then REV sets the selected channel polarity to REVERSE and turns ON the REV indicator.

KEYS	ACTION
2ND	Enable second level function
REV	Enable REVERSE polarity; turn ON REV indicator

To save the new polarity setting, the ENTER key must be pressed.

3.3.14 SYNCH REGEN Key

The SYNCH REGEN key has both a first and second level function.

3.3.14.1 SYNCH (first level)

The SYNCH key toggles the clocked synchronous data mode ON and OFF. When ON, the SYNCH indicator turns ON and the modem receive data outputs are internally re-clocked with a recovered mid-bit clock. When OFF, the SYNCH indicator turns OFF and the modem receive data outputs are directly connected to the demodulator output.

When the SYNCH indicator turns OFF, the BAUD display prompts for the receive data regeneration word length. The current setting is shown, and it may be set to 5, 6, 7, or 8 bits. If the current setting is correct, ENTER only is pressed.

KEYS	ACTION
SYNCH	Enable SYNCH mode; turn ON the SYNCH indicator
SYNCH	Disable SYNCH mode; turn OFF the SYNCH indicator "L=5 " is displayed in the BAUD window.
8	"L=8 " is displayed in the BAUD window.
ENTER	"L=8 " flashes, then restore BAUD RATE The new configuration is saved immediately.

To save the SYNCH mode, the ENTER key must be pressed.

3.3.14.2 REGEN (2nd level)

Pressing 2ND then REGEN toggles the receive data regeneration mode ON and OFF. When ON, the REGEN indicator turns ON, the SYNCH indicator turns OFF, and data characters received from the demodulator are regenerated for the receive data outputs.

When REGEN turns ON, the BAUD display shows the current regeneration word length. This length may be set to 5, 6, 7, or 8 bits by pressing the corresponding number key. If the current setting is correct, press ENTER.

KEYS	ACTION
2ND	Enable second level function
REGEN	Enable REGENERATION; turn ON the REGEN indicator "L=5 " is displayed in the BAUD window.
8	"L=8 " is displayed in the BAUD window.
ENTER	"L=8 " flashes, then restores BAUD RATE The new configuration is saved immediately.
2ND	Enable second level function.
REGEN	Disable REGENERATION; turn OFF the REGEN indicator

To save the regeneration mode, the ENTER key must be pressed.

3.3.15 CHAN Key

The CHAN key has both a first and second level operation.

3.3.15.1 CHAN (first level)

The CHAN key alternately selects channel 1 and channel 2 for the front panel display and parameter entry.

KEYS	ACTION
CHAN	Display channel 1, the demodulator
CHAN	Display channel 2, the modulator

The channel selection is saved in the non-volatile memory immediately; no ENTER key press is required.

3.3.15.2 CHAN (2nd level)

Pressing 2ND then CHAN copies parameters from the currently displayed channel into the other channel. The MARK, SPACE, BAUD, HOLD, and REVERSE settings are copied. This command simplifies ST-8000A setup by eliminating the need to setup both channels directly. After channel 1 is configured, 2ND then CHAN will copy all of the channel 1 parameter settings into channel 2.

KEYS	ACTION
2ND	Enable second level function
CHAN	Copy current channel parameters into other channel

To save the new configuration, the ENTER key must be pressed.

3.3.16 BAUD RATE Key

Press BAUD RATE to enter the baud rate for the selected channel. If channel 1 is selected, the BAUD RATE sets the bandwidth for the receive filters, the regeneration data rate, and the receive data mid-bit clock center frequency. When channel 2 is selected, BAUD RATE loads the new synchronous transmit clock frequency.

KEYS	ACTION
BAUD RATE	Blank the BAUD display window, ENTER turns ON
110	" 110." shows in the BAUD window
ENTER	" 110." flashes, ENTER turns OFF
	The BAUD RATE is set to 110 bits per second.

3.3.17 CLEAR Key

The CLEAR key restores the last saved modem parameter settings whenever the ENTER key indicator is flashing. This key may be used to restore the old MARK, SPACE, and BAUD RATE settings if CLEAR is pressed before ENTER as a new value is entered.

During the power-on self test (POST), the CLEAR key sets factory defaults for all keypad entered parameters. The CLEAR key must be pressed while the software version is displayed. See Section 6.4 for a detailed description of the POST.

3.4 NUMERICAL DISPLAYS

The ST-8000A has four numerical display fields on the front panel (Figure 3.1, call numbers 3 and 4, and Figure 3.3).

The MARK and SPACE fields have five digits that are used to show the MARK and SPACE channel frequencies between 300 and 3000 Hz to 0.5 Hz resolution. These fields are also used to display and enter the CENTER and SHIFT frequencies as explained in sections 3.3.7 and 3.3.8. When the MARK/SPACE display/entry mode is active, the MARK and SPACE LED indicators are turned ON. The CENTER and SHIFT LED indicators show when the frequency display and entry mode is set for CENTER and SHIFT.

The BAUD display field shows 4 digits that correspond to the Baud rate for the selected channel, as explained in section 3.3.16. The Baud rate may be set to any value between30 and 1200 BPS in 1 BPS increments.
The CHAN display is a single digit that indicates "1" (demodulator) or "2" (modulator). This digit, as well as the DEMOD and MOD LED indicators to the right show which channel of the modem is currently active for display and data entry. Changing the active channel is discussed in section 3.3.15.

All four numerical display fields (MARK/CENTER, SPACE/SHIFT, BAUD, and CHAN) are also used during BIT routines to show current test parameters. Refer to section 3.3.4 for full details.

3.5 MODE INDICATORS

The ST-8000A front panel has 11 mode LED indicators, 3 within the keypad on DIV, MUTE, and REMOTE keys and 8 in a vertical line to the left of the keypad. The indicators show the current operating mode of the selected channel. Mode operation is discussed in detail in section 3.3.

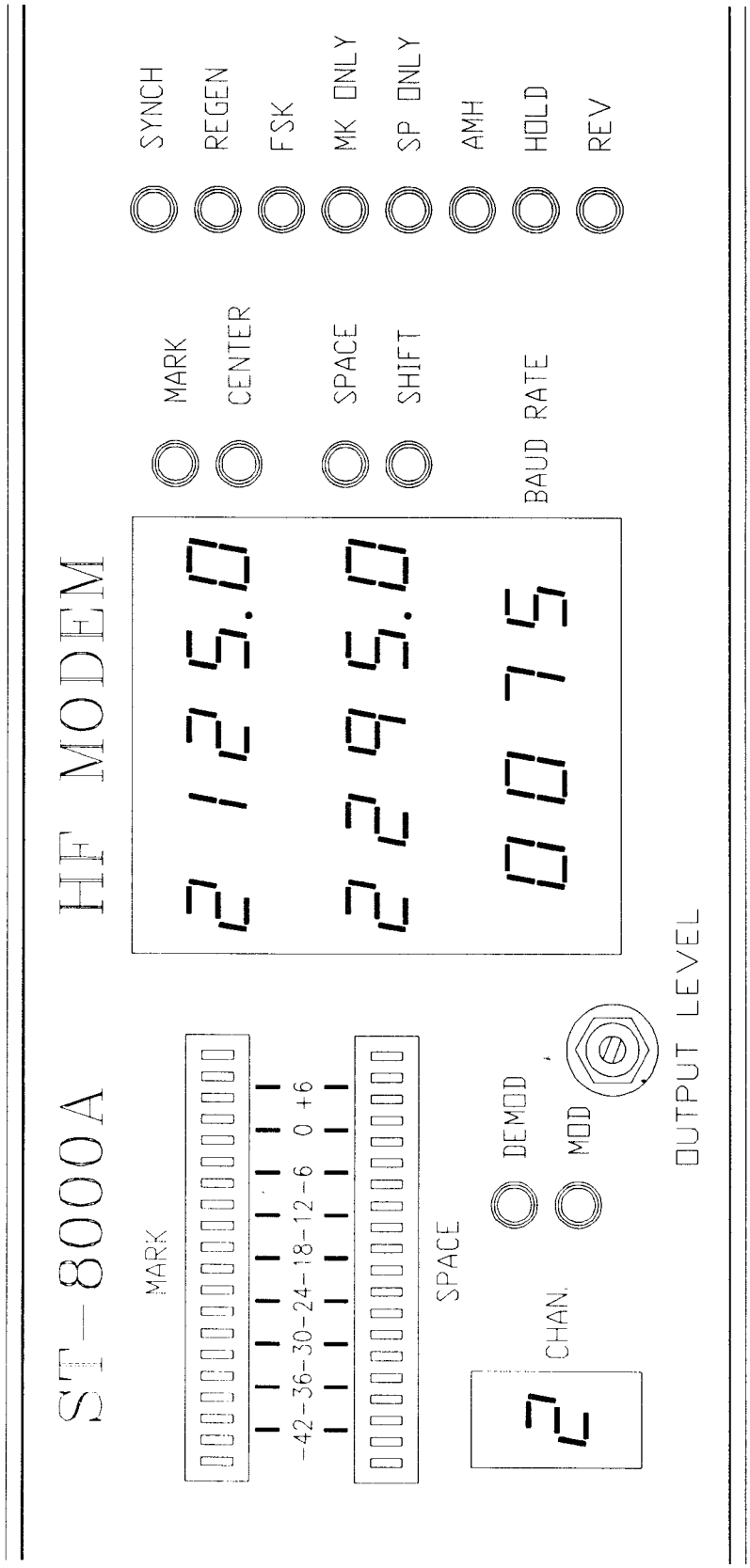

FIGURE 3.3 ST-8000A FRONT PANEL DISPLAYS

3.6 BAR INDICATORS

There are two 20 segment LED bar-graph indicators on the top left of the front panel. They show the MARK and SPACE tone amplitudes. When channel 1 (demodulator) is selected for display and entry, the bars show the amplitude of the FSK signal input to the demodulator. When channel 2 (modulator) is selected, the bars show the amplitude of the FSK signal output from the modulator.

The amplitude scale of each bar-graph is calibrated in dBm, referenced to 600 ohms. They are calibrated from -42 dBm (6.3 mV rms) to +6 dBm (1.52 V rms). When channel 1 is selected, this corresponds to a measurement of the input voltage across pins 10 and 12 of rear panel J2 (Audio I/O). This is the input to the demodulator. When channel 2 is selected, the bar-graph voltages correspond to the output voltage across pins 1 and 3 of rear panel J2 (AUDIO I/O). This is the modulator output signal. Both demodulator (channel 1) and modulator (channel 2) assume a 600 ohm terminated system is used. If the modulator output is not terminated in 600 ohms, the modulator output voltage will be about 6 dB higher than shown on the bar graphs.

3.7 MODULATOR OUTPUT LEVEL

The OUTPUT LEVEL front panel control (call 7 in Figure 3.1) allows user adjustment of the amplitude of the modulator (channel 2) FSK output signal. To adjust modulator output level, use the CHAN keypad to select CHAN 2 as the active channel (see 3.3.15.1). The bar-graphs show the current modulator output level. Use a small screw-driver to adjust the bar-graph display to the desired signal level. A full clockwise rotation of this control produces 0 dBm (775 mV rms) output into a 600 ohm load. Counter-clockwise rotation of the control reduces the output level to amplitudes well below -30 dBm (24.5 mV rms).

3.8 OPERATIONAL MODES

3.8.1 Start-Up

****

CAUTION

Prior to powering the ST-8000A ON, ensure the set-up procedure described in Chapter 2 has been completed.

****

The ST-8000A executes a Power On Self Test (POST) when the power is turned on. See section 6.4 of this manual for a detailed description of the POST. The ST-8000A settings on Power-Up are the same as when it was last turned off. This memory feature is controlled by the ENTER key when changes are made to the ST-8000A

set-up. Unless changes are "ENTERed", they are not stored in memory. If a checksum error is detected in the memory during the POST, the ST-8000A defaults to a factory set state. The MODEM may be operated with this failure but will require set-up of operational parameters at each power-ON.

3.8.2 Local Operation

The ST-8000A front panel keypad and the OUTPUT LEVEL control are used for local operation. Keypad keys are explained in detail in section 3.3. The controls and indicators on the front panel of the ST-8000A are shown in Figure 3.1 and described in later portions of this chapter. Some of the keys and the OUTPUT LEVEL control affect only the modulator or the demodulator no matter which channel of the ST-8000A is selected. Others affect the state of only the channel selected. The keys and the channels they affect are listed in table 3.1.

Table 3-1 Keypad Keys Application

KEY	MODULATOR	DEMODULATOR
MUTE	X	
AMH		X
* MARK ONLY		X
* SPACE ONLY		X
SYNCH		X
* REGEN		X
FSK		X
* HOLD	X	X
CHAN	X	X
MARK	X	X
SPACE	X	X
BAUD RATE	X	X
CLEAR	X	X
NORM	X	X
* REV	X	X
M/S	X	X
* CENT	X	X
NUMBER KEYS	X	X
ENTER	X	X
BIT	X	X

NOTE: The "2ND" key selects the second function of keys. The function selected determines the effect. 2ND functions are indicated by an "*" next to the function name in table 3-1.

3.8.3 Standby Mode

Enter AMH HOLD without the 2ND key to select the AUTO MARK HOLD mode. AMH sets the demodulator output to a steady MARK condition after a Delay when the input signal drops below the Threshold. Section 2.5.2 details the settings of the Delay and Threshold for AMH.

3.8.4 Emergency Operation

The ST-8000A may be operated with certain failures in an emergency. However, operation of the ST-8000A with a known failure is not recommended. Failure conditions with emergency operation requirements are:

1. A Front panel failure may not affect operation of the ST-8000A through the REMOTE port. The failure may be the indicators or keypad. In these cases, the BIT may indicate correct operation when executed from the REMOTE terminal. The modem may be temporarily operated using remote control. The front panel OUTPUT LEVEL control will not be affected by failure of the keypad.

2. The REMOTE port may fail without causing a failure in LOCAL operation. In this case the BIT will show no error if executed from the front panel but control from the REMOTE terminal may not work. The ST-8000A may be operated in LOCAL mode under these conditions.

3. The ST-8000A memory feature ensures retention of operational setup through power down and up. If the an error in the applicable memory is detected, the ST-8000A will default to a factory preset setup state. The MODEM may be operated under these conditions in an emergency.

4. The REGENeration circuits can have a failure without affecting other modes of operation.

5. Either the MIL-188C or RS-232 outputs may fail without affecting the other.

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CHAPTER 4
REMOTE CONTROL

4.1 ST8000A REMOTE CONTROL SET-UP

Use of the ST-8000A remote control feature requires that the ST-8000A and the remote control terminal first be set-up so that parameters match. Set-up requirements are detailed in sections 2.5.5 (Data Rate), 2.5.6 (Address), 2.5.8 (RS-232/MIL-188), 2.5.9 (Terminations), and 2.6.3 (Cable Connections). Data rate and address are also discussed in the following sections.

4.1.1 Remote Control Data Rate

The REMOTE port on the ST-8000A can be used to control the ST-8000A with any ASCII terminal running the data rate set by Control Board DIP switch SW3. The character format for this port is 1 start bit, 7 data bits, one space parity bit, and 2 stop bits (11 bits total). The remote control terminal can send characters with any parity and 1 or 2 stop bits; the parity bit is ignored. Commands may be entered in upper or lower case; the echo is in the same case sent by the remote control terminal. Data rate set-up is shown in Table 4.1.

TABLE 4.1
REMOTE CONTROL DATA RATE SET-UP

Switch SW3 1 2 3 4 5 6 7 8	Remote Port Rate
O O O O O O O O	38,400 BPS
X O O O O O O O	19,200 BPS
O X O O O O O O	9,600 BPS
O O X O O O O O	4,800 BPS
O O O X O O O O	2,400 BPS
O O O O X O O O	1,200 BPS
O O O O O X O O	600 BPS
O O O O O O X O	300 BPS
O O O O O O O X	110 BPS

NOTE: X = CLOSED or ON
O = OPEN or OFF

4.1.2 Unit Addressing

A single remote control terminal may control up to 9 ST-8000A modems using a special multi-connect cable. To address one modem, the channel select command, "Cxx", is sent. Subsequent commands will be processed only by the addressed modem for the selected channel until the next "Cxx" command is sent. The channel address for each ST-8000A is set with Control Board DIP switch SW4 as shown in Table 4.2.

TABLE 4.2
REMOTE CONTROL ADDRESS SET-UP

Switch SW4 1 2 3 4 5 6 7 8	Channel Select [Cxx]	Unit: Channel
X O O O O O O O	C01 / C02	Unit 1: DEMOD / MOD
O X O O O O O O	C03 / C04	Unit 2: DEMOD / MOD
O O X O O O O O	C05 / C06	Unit 3: DEMOD / MOD
O O O X O O O O	C07 / C08	Unit 4: DEMOD / MOD
O O O O X O O O	C09 / C10	Unit 5: DEMOD / MOD
O O O O O X O O	C11 / C12	Unit 6: DEMOD / MOD
O O O O O O X O	C13 / C14	Unit 7: DEMOD / MOD
O O O O O O O X	C15 / C16	Unit 8: DEMOD / MOD
O O O O O O O O	C17 / C18	Unit 9: DEMOD / MOD

NOTE: X = CLOSED or ON
O = OPEN or OFF

4.2 REMOTE CONTROL PROTOCOL

Remote control commands have the following limitations:

1. One or more commands may be included on a single line of up to 80 characters terminated with a CR (Carriage Return). All spaces and commas in the string are ignored, but count toward the 80 character limit. MARK and SPACE frequencies and BAUD rates may be entered as 1 to 4 numbers (e.g. M1234) or as 1 to 5 numbers with a decimal point (e.g. M1234.5) for one-half Hz entries. Leading zeros are not required since they are ignored.

2. Commands may be corrected using the BACKSPACE (BS) or DELETE (DEL) key before CR is entered to terminate the command string. If ECHO is enabled, the BS and DEL will be echoed as BS-SPACE-BS. If any command error is detected, an error message is sent to the remote terminal and the command parser continues to process the input command line after the error.

3. A status request command "G" is treated as a pseudo string terminator in that all commands up to the "G" are processed so that the status summary is correct. After the status display, any remaining commands are processed up to the terminating CR. Note that the status could change based on these remaining commands.

4. When the ST8000A is turned ON, it returns to the state of operation when the power was last turned OFF. This state includes REMOTE ON and OFF.

5. If the REMOTE CONTROL BUSY IN control signal is turned OFF or pulled to -6VDC, the ST8000A completes any character being sent to the remote control terminal then stops sending characters. Character transmission resumes when the BUSY IN control signal is turned ON or pulled to +6VDC.

6. The UNIT BUSY OUT is ON or pulled to +6VDC when the ST8000A is ready to receive commands. This signal turns OFF or is pulled to -6VDC when the unit is busy. Characters sent to the ST8000A when UNIT BUSY is OFF may be lost.

7. The ST8000A will terminate all status and error responses with a CR character only when operating in echo OFF (X0) and short format (F0) mode. When echo is enabled (X1) the ST8000A terminates all status and error messages with a CR/LF pair.

4.3 CONTROL COMMANDS

Table 4.3 lists all of the available ST-8000A Remote Control commands. Note that the rules listed in section 4.2 must be followed and all commands must be entered exactly as described.

TABLE 4.3
ST-8000A REMOTE CONTROL COMMANDS

COMMAND	DESCRIPTION
A0	Disable receive AMH
A1	Enable receive AMH
Bxxxx	Set BAUD rate
Cxx	Select channel (Optional: Cx. Leading 0 is ignored.)
D0	Disable DIVERSITY
D1	Enable DIVERSITY
E0	Disable 0.5 Hz increment
E1	Enable 0.5 Hz increment
F0	Enable short format response
F1	Enable long format response
G	Show Channel status
G1	Show Channel 1 status
G2	Show Channel 2 status
G3	Show Jumper and Switch settings
G4	Show Modem Status
G5	Show System Information
H0	Disable channel HOLD
H1	Enable channel HOLD

TABLE 4.3 (Continued)
ST-8000A REMOTE CONTROL COMMANDS

COMMAND	DESCRIPTION
J0	Select FSK mode
J1	Select MARK ONLY receive mode (DEMOD ONLY)
J2	Select SPACE ONLY receive mode (DEMOD ONLY)
J3	Select FSK mode
Kxxxx	Set CENTER frequency [Optional: Kxxxx.0 / Kxxxx.5]
L/?	Show HELP page 1
L2	Show HELP page 2
L3	Show HELP page 3
Mxxxx	Set MARK frequency [Optional: Mxxxx.0 / Mxxxx.5]
N0	NORMAL channel polarity
N1	REVERSE channel polarity
P0	Setchannel 1 and 2 to factory defaults
P1	COPY channel 1 parameters into channel 2
P2	COPY channel 2 parameters into channel 1
Q0	Select MARK/SPACE display mode
Q1	Select CENTER/SHIFT display mode
R0	LOCAL mode
R1	REMOTE mode
Sxxxx	Set SPACE frequency [Optional: Sxxxx.0 / Sxxxx.5]
T	Show TEST status
T0	Stop all BIT tests
T1	Activate automatic BIT
T2	Transmit constant MARK tone
T3	Transmit constant SPACE tone
T4	Transmit alternating MARK/SPACE at BAUD RATE
T5	Enable analog loopback at 0 dBm
T6	Enable analog loopback at -20 dBm
T7	Enable analog loopback at -45 dBm
T9	Activate the BIT Menu
U0	Disable transmit tone MUTE
U1	Enable transmit tone MUTE
Vxxxx	Set SHIFT
W0	Select SYNCHRONOUS mode
W5	Select ASYNCHRONOUS mode, 5 bit chars
W6	Select ASYNCHRONOUS mode, 6 bit chars
W7	Select ASYNCHRONOUS mode, 7 bit chars
W8	Select ASYNCHRONOUS mode, 8 bit chars
X0	Disable remote port ECHO
X1	Enable remote port ECHO
Y0	Disable receive REGENERATION
Y1	Enable receive REGENERATION

4.4 STATUS RESPONSES

The response to a status request command "G" is in one of two forms: Short Format (F0) or Long Format (F1).

4.4.1 Long Format

In the long format, the status of the selected channel is displayed as shown in Table 4.4.

TABLE 4.4
LONG COMMAND FORMAT

Demodulator (C01, C03, C05, C07, C09, C11, C13, C15)

Unit Type	HAL ST-8000A HF MODEM
Channel	DEMODULATOR STATUS
Unit # and Channel #	UNIT-x CHANNEL-1 (Cxx)
MARK Frequency	xxxx Hz / xxxx.5 Hz
SPACE Frequency	xxxx Hz / xxxx.5 Hz
CENTER Frequency	xxxx Hz / xxxx.5 Hz
SHIFT Frequency	xxxx Hz
BAUD Rate	xxxx Baud
MODE	FSK / MARK ONLY / SPACE ONLY
POLARITY	NORMAL / REVERSE
HOLD	ON / OFF
CODE	SYNC / ASYNC + x LEVEL
REGENERATION	ON / OFF
DIVERSITY	ON / OFF
AUTO MARK HOLD	ENABLED / DISABLED
CONTROL	LOCAL / REMOTE

Modulator (C02, C04, C06, C08, C10, C12, C14, C16)

Unit Type	HAL ST-8000A HF MODEM
Channel	MODULATOR STATUS
Unit # and Channel #	UNIT-x CHANNEL-2 (Cxx)
MARK Frequency	xxxx Hz / xxxx.5 Hz
SPACE Frequency	xxxx Hz / xxxx.5 Hz
CENTER Frequency	xxxx Hz / xxxx.5 Hz
SHIFT Frequency	xxxx Hz
BAUD Rate	xxxx Baud
MODE	FSK
POLARITY	NORMAL / REVERSE
HOLD	ON / OFF
MUTE	ON / OFF
CONTROL	LOCAL / REMOTE

4.4.2 Long Format Examples

In the following examples, the command to the ST8000A is underlined.

C01G<CR>

```
 HAL ST-8000A HF MODEM
 DEMODULATOR STATUS
 UNIT - 1   CHANNEL - 1  (C01)
--------------------------------
 MARK        =  1575 Hz
 SPACE       =  2425 Hz
 CENTER      =  2000 Hz
 SHIFT       =   850 Hz
 RATE        =    50 Baud
 MODE        =  FSK
 POLARITY    =  NORMAL
 HOLD        =  OFF
 CODE        =  ASYNC - 5 LEVEL
 REGEN       =  OFF
 DIVERSITY   =  OFF
 AMH         =  ENABLED
 CONTROL     =  REMOTE
```

C02G<CR>

```
 HAL ST-8000A HF MODEM
 MODULATOR STATUS
 UNIT - 1   CHANNEL - 2  (C02)
--------------------------------
 MARK        =  1575 Hz
 SPACE       =  2425 Hz
 CENTER      =  2000 Hz
 SHIFT       =   850 Hz
 RATE        =    50 Baud
 MODE        =  FSK
 POLARITY    =  NORMAL
 HOLD        =  OFF
 MUTE        =  OFF
 CONTROL     =  LOCAL
```

4.4.3 Short Format

The short format is available for computer control applications where complete text responses are not required. The status returned is in the same form as the commands listed in Section 4.3. The short format is shown in Table 4.5.

TABLE 4.5
SHORT COMMAND FORMAT

Demodulator (C01, C03, C05, C07, C09, C11, C13, C15)

CxxMxxxxSxxxxBxxxxJxNxHxYxDxAxRx<CR>

Modulator (C02, C04, C06, C08, C10, C12, C14, C16)

CxxMxxxxSxxxxBssssJxNxHxUxRx<CR>

4.4.4 Short Format Examples

In the following examples, the command to the ST8000A is underlined.

C01G<CR>
C01M1575S2425B0050J0N0H0W5Y0D0A1R1

C02G<CR>
C02M1575S2425B0050J0N0H0U0R1

4.4.5 Other Status Responses

The ST-8000A provides additional status information with other G commands. The responses to these commands are the same in long and short format. G command responses are shown in Table 4.6 and in the following examples.

TABLE 4.6
G COMMAND RESPONSES

COMMAND	RESPONSE
G	- send selected channel status
G1	- show channel 1 status (DEMODULATOR)
G2	- show channel 2 status (MODULATOR)
G3	- show switch and jumper settings
G4	- show modem status
G5	- show firmware version

G Command Examples:

G3<CR>

```
 HAL ST-8000A HF MODEM
 CONTROL OPTIONS
 PORT JUMPER SETTINGS
-----------------------------------------
 DATA I/O PORT INPUT    [J2]   =  RS-232
 REMOTE CONTROL PORT    [J7]   =  RS-232

 CONTROL BOARD SWITCH SETTINGS
-----------------------------------------
 KEYLINE DELAY     [SW1-SW2]   =  0250 ms
 REMOTE CONTROL RATE  [SW3]    =  9,600 Baud
 UNIT NUMBER          [SW4]    =  1
 DEMODULATOR CHANNEL (CH 1)    =  C01
 MODULATOR CHANNEL   (CH 2)    =  C02
```

Note: if an error is detected in the setup of any switch, an error message is included on the line. Errors include closing more than 1 switch position in SW3 or SW4. The error message is illustrated in the following example.

G3<CR>

```
 HAL ST-8000A HF MODEM
 CONTROL OPTIONS
 PORT JUMPER SETTINGS
-------------------------------------------
 DATA I/O PORT INPUT    [J2]  =  RS-232
 REMOTE CONTROL PORT    [J7]  =  RS-232

 CONTROL BOARD SWITCH SETTINGS
-------------------------------------------
 KEYLINE DELAY     [SW1-SW2]  =  02_0 ms  <<-- ERROR:INVALID SETTING
 REMOTE CONTROL RATE  [SW3]   =  9,600 Baud
 UNIT NUMBER          [SW4]   =  1
 DEMODULATOR CHANNEL (CH 1)   =  C01
 MODULATOR CHANNEL   (CH 2)   =  C02
```

G4<CR>

```
 HAL ST-8000A HF MODEM
 SIGNAL STATUS
-----------------------------------------
 DATA I/O TXD INPUT     =  MARK
 DEMOD RXD OUTPUT       =  SPACE
 DATA I/O RTS INPUT     =  OFF
 REMOTE PORT BUSY IN    =  OFF

 RECEIVE SIGNAL LEVEL   =  -39 dBm
 LOSS OF SIGNAL (LOS)   =  ON

 BIT: No Test Active.
```

G5<CR>

```
 HAL ST-8000A HF MODEM
 SYSTEM INFORMATION
-----------------------------------------
 FIRMWARE VERSION  =  1.7
 VERSION DATE      =
 VERSION CHECKSUM  =

 RTS-CTS DELAY     =  200 ms

 DIVERSITY OPTION  =  NOT INSTALLED
```

4.4.6 HELP Page 1

The L or ? command will show the following HELP page, illustrated in Table 4.7.

Enter: L<CR> or L1<CR> or ?<CR>

TABLE 4.7
HELP PAGE 1

```
HAL ST-8000A COMMAND SUMMARY                    Page 1 of 3
-----------------------------------------------------------
CHANNEL          =  Cxx              [01 - 16]
MARK / CENTER    =  Mxxxx / Kxxxx    [300 - 3000]
SPACE            =  Sxxxx            [300 - 3000]
SHIFT            =  Vxxxx            [01 - 2700]
+.5 Hz           =  Ex               [E0=OFF / E1=ON]
BAUD RATE        =  Bxxxx            [30 - 1200]

FSK              =  J0   (DEMODULATOR MODES)
MARK / SPACE     =  Jx   [J1=MARK ONLY / J2=SPACE ONLY]
SYNCHRONOUS      =  W0
ASYNCHRONOUS     =  Wx   [LENGTH = 5, 6, 7, or 8]

AUTO MARK HOLD   =  Ax   [A0=DISABLE / A1=ENABLE]
COPY CHANNEL     =  Px   [P1=CH1 / P2=CH2 / P0=DEFAULT]
DIVERSITY        =  Dx   [D0=OFF / D1=ON]
HOLD             =  Hx   [H0=OFF / H1=ON]
MUTE             =  Ux   [U0=OFF / U1=ON]
POLARITY         =  Nx   [N0=NORMAL / N1=REVERSE]
REGENERATION     =  Yx   [R0=OFF / R1=ON]

NOTE: Enter L2<CR> or L3<CR> for more HELP.
```

4.4.7 HELP Page 2

The L2 command will show HELP page 2, Table 4.8.

Enter: L2<CR>

TABLE 4.8
HELP PAGE 2

```
 HAL ST-8000A COMMAND SUMMARY              Page 2 of 3
-------------------------------------------------------
 CHANNEL STATUS     =  G    [CURRENT CHANNEL]
 CHANNEL 1 STATUS   =  G1
 CHANNEL 2 STATUS   =  G2
 CONTROL OPTIONS    =  G3
 SIGNAL STATUS      =  G4
 SYSTEM INFO        =  G5

 STOP ALL TESTS     =  T0
 AUTOMATIC BIT      =  T1
 SEND MARK TONE     =  T2
 SEND SPACE TONE    =  T3
 ALTERNATING M/S    =  T4   [AT CH 2 BAUD RATE]
 ANALOG LOOPBACK    =  Tx   [T5=0 T6=-20 T7=-45 dBm]
 BIT MENU           =  T9

 REMOTE DISPLAY     =  Qx   [Q0=M/S / Q1=CENT]
 REMOTE ECHO        =  Xx   [X0=OFF / X1=ON]
 REMOTE FORMAT      =  Fx   [F0=SHORT / F1=LONG]
 REMOTE / LOCAL     =  Rx   [R0=LOCAL / R1=REMOTE]

NOTE: Enter L<CR> or L3<CR> for more HELP.
```

4.4.8 HELP Page 3

The L3 command will show HELP page 3, TABLE 4.9.

Enter: L3<CR>

TABLE 4.9
HELP PAGE 3

HAL ST-8000A KEYPAD TESTS Page 3 of 3

TEST	KEYPAD SEQUENCE	PROMPT
AUTOMATIC BIT	2nd-BIT-ENTER	--
AUTOMATIC BIT	2nd-BIT-1-ENTER	--
SEND MARK TONE	2nd-BIT-2-ENTER	"/~~~"
SEND SPACE TONE	2nd-BIT-3-ENTER	"/___"
SEND MARK/SPACE	2nd-BIT-4-ENTER	"Alt "
LOOPBACK 0 dBm	2nd-BIT-5-ENTER	"LP 1"
LOOPBACK -20 dBm	2nd-BIT-6-ENTER	"LP 2"
LOOPBACK -45 dBm	2nd-BIT-7-ENTER	"LP 3"
REMOTE PORT ECHO	2nd-BIT-0.5-ENTER	"Echo"
REMOTE PORT QBF	2nd-BIT-REMOTE-ENTER	"Port"
CONTROL OPTIONS	2nd-BIT-CHAN-ENTER	--

NOTE: Enter L<CR> or L2<CR> for more HELP.

4.5 INTERNAL BIT

Internal Built-In-Test (BIT) options may be activated from the Remote Control port. When activated using the proper Tx command, a message is sent to the Remote Control terminal to confirm that the test is active. BIT is terminated with the T0 command.

A summary of the test confirmation messages follow for each Tx command: A typical T1 response is shown in Table 4.10.

Enter: T1<CR>

TABLE 4.10
BIT T1 RESPONSE

```
HAL ST-8000A HF MODEM
BUILT-IN-TEST (BIT) SUMMARY
-----------------------------------
1 .. Timer Frequency Test.... PASSED
2 .. EPROM Memory Test....... PASSED
3 .. RAM Memory Test......... PASSED
4 .. EEPROM Memory Test...... PASSED
5 .. Display Test............ PASSED
6 .. Loopback Test #1........ PASSED
7 .. Loopback Test #2........ PASSED
8 .. Loopback Test #3........ PASSED
9 .. Loopback Test #4........ PASSED
A .. Loopback Test #5........ PASSED
B .. Remote Port Test........
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG'S BACK 0123456789
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG'S BACK 0123456789
B .. Remote Port Test........ PASSED
C .. Deadman Timer Test...... PASSED

ST-8000A PASSED ALL TESTS.
```

Further Examples:

T2<CR>

```
BIT T2: Sending Constant MARK.
Enter T0<CR> to End Test.
```

T0<CR>

T3<CR>

```
BIT T3: Sending Constant SPACE.
Enter T0<CR> to End Test.
```

T0<CR>

T4<CR>

BIT T4: Sending Alternating MARK/SPACE.
Enter T0<CR> to End Test.

T0<CR>

T5<CR>

BIT T5: Analog Loopback, 0 dBm.
Enter T0<CR> to End Test.

T0<CR>

T6<CR>

BIT T6: Analog Loopback, -20 dBm.
Enter T0<CR> to End Test.

T0<CR>

T7<CR>

BIT T7: Analog Loopback, -45 dBm.
Enter T0<CR> to End Test.

T0<CR>

Two commands show the remote port user whether an internal test is presently active. The T command without a valid option number and G4 shows the current test status.

T<CR>

BIT T6: Analog Loopback, -20 dBm.

G4<CR>

```
HAL ST-8000A HF MODEM
SIGNAL STATUS
-----------------------------------------
DATA I/O TXD INPUT     =  SPACE
DEMOD RXD OUTPUT       =  SPACE
DATA I/O RTS INPUT     =  OFF
REMOTE PORT BUSY IN    =  OFF

RECEIVE SIGNAL LEVEL   =    0 dBm
LOSS OF SIGNAL (LOS)   =  OFF

BIT T6: Analog Loopback, -20 dBm.
```

4.6 ERROR MESSAGES

Error messages are displayed in either long or short format, depending on the current setup selection. When long format (F1) is selected, the text message shown below is reported followed by a CR or CR/LF pair. If short format (F0) is selected, the error response is the letter "E" followed by the error number and a CR or CR/LF pair. Long format errors responses are shown in Table 4.11.

TABLE 4.11
REMOTE COMMAND ERROR RESPONSES

---

* ERROR 0 - SYNTAX ERROR. *
  Valid command letter is not followed by correct number, command ignored.

* ERROR 1 - COMMAND / BOARD-TYPE MISMATCH. *
  Command not suitable for selected channel, command ignored.

* ERROR 2 - UNKNOWN COMMAND. *
  Unknown command letter, command ignored.

* ERROR 4 - UNIT IS NOT IN REMOTE MODE. *
  Remote mode must be enabled, command ignored.

* ERROR 5 - BAUD RATE IS TOO LOW. (30 BAUD MIN.) *
  Baud rate is set to 30.

* ERROR 6 - BAUD RATE IS TOO HIGH. (1200 BAUD MAX.) *
  Baud rate is set to 1200.

* ERROR 7 - FREQUENCY IS TOO LOW. (300 Hz MIN.) *
  Frequency is set to 300.

* ERROR 8 - FREQUENCY IS TOO HIGH. (3000 Hz MAX.) *
  Frequency is set to 3000.

* ERROR 9 - INPUT LINE TOO LONG. (80 CHARACTERS MAX.) *
  Line is too long, entire line is ignored.

* ERROR H - SHIFT FREQUENCY IS TOO HIGH. (2700 Hz MAX.) *
  Command ignored.

4.7 OPERATING PROCEDURES

The ST8000A is controlled either from the Front Panel or the remote control terminal.

4.7.1 Local Operation

The front panel keypad is used for local operation. The commands may be entered in any sequence and saved by pressing the ENTER key. Each channel is selected by pressing the CHAN key until the desired channel is displayed. To clear an error in an entry, press the CLEAR key instead of the ENTER key.

4.7.1.1 Standby Operation

The following function can place a channel in standby:

Enter AMH to select AUTO MARK HOLD for the selected channel. AMH sets the output to a steady MARK when the input signal level drops below the preset level.

4.7.1.2 Shut-Down

The ST8000A does not require any special procedure to turn OFF power. The current operating parameters are stored in memory when power is removed.

4.7.2 Remote Operation

4.7.2.1 Start-up

When the ST8000A is turned ON, remote operation can be accessed by the local or remote command. Entering REMOTE from the keypad places the unit into remote operation and disables the keypad. Command "R1" from a remote terminal places the unit into remote operation when the unit is address. Any keypad entry, except for REMOTE, is ignored when the remote operation is enabled.

4.7.2.2 Standby Operation

The following functions can place a channel in standby:

Enter "A1" on the remote terminal to select AUTO MARK HOLD for the selected channel. AMH sets the output to a steady MARK when the input signal level drops below the preset level.

CHAPTER 5
THEORY OF OPERATION

5.1 GENERAL

This chapter describes the theory of operation of the ST-8000A. It includes descriptions of the demodulator, modulator, control, front panel, and power supply. The ST-8000A is an audio Frequency Shift Keyed (FSK) MODEM (MOdulator-DEModulator).

5.2 FSK SYSTEM APPLICATION

The ST-8000A is used to convert RS-232 or MIL-188 serial digital data into FSK audio tones. These tones are sent to distant stations using radio or wire lines. Digital data is used to FSK an audio tone. The FSK audio tone drives a radio transmitter or is connected to wire lines. The FSK modem at the receiving station detects these tones and converts the signal to digital data.

5.2.1 Radio FSK Data System

Figure 2.14 shows a typical radio FSK data system using the ST-8000A. Each radio system includes three to five major electronic components:

1. Data Terminal
2. Encryption Device (Optional)
3. ST-8000A Modem
4. Radio Transceiver
5. Remote Control System (Optional)

The Data Terminal device may be as simple as a keyboard and a printer. Or, it may be as complicated as a computer system. Data to and from the Data Terminal is digital. RS-232 or MIL-188 interface levels may be used.

The Encryption Device is optional. When used, it is installed between the Data Terminal and ST-8000A. Data into and out of the Encryption Device is digital RS-232 or MIL-188. Only the Data Terminal and Encryption Device need to be "secure units". The ST-8000A and radio process only encrypted "black" data.

The FSK Modem serves as a data format converter. It converts RS-232 or MIL-188 digital data to and from FSK audio tones. The ST-8000A's operation is similiar to that of a common telephone modem. The ST-8000A includes additional signal processing to make up for distortion by radio propagation.

The radio may be separate receive and transmit devices, connected for transmit/receive control. The radio system may operate at any radio frequency (RF). Data to and from the radio equipment is audio FSK tones in the range of 300 to 3000 Hz. Radio characteristics determine data rate and tone frequencies used. The Push To Talk (PTT) control of the radio may be controlled by the ST-8000A keyline output.

The Remote Control System is optional. It sets and controls all ST-8000A operational parameters. A typical remote control system is a data terminal (VT-100, for example) or a computer system. Between one and nine ST-8000A modems may be controlled by one remote control system. Some systems include remote computer control of the radio.

5.2.2 Wire Line FSK Data System

Figure 2.16 shows a typical Wire Line FSK Data System. A wire line system is very similar to a radio data system. Except, in the wire line system, a wire connection replaces the radio link. A wire line system includes two to four major equipment items:

1. Data Terminal
2. Encryption Device (Optional)
3. ST-8000A Modem
4. Remote Control System (Optional)

The functions of these items are as described in section 5.2.1.

5.3 FUNCTIONAL DESCRIPTION

Figure 5.1 shows the major sections of the ST-8000A Modem. The ST-8000A includes a:

1. Demodulator circuit
2. Modulator circuit
3. Microprocessor Control circuit
4. Front Panel Display and Keypad Entry circuits
5. Power Supply.

One shielded aluminum cabinet contains the ST8000A. It is 19" wide (48.3 cm) by 3.5" high (8.9 cm) by 18" deep (45.7 cm). The ST-8000A is designed to be mounted in a standard "19 Inch Rack Cabinet". All external connections to the ST-8000A are made via 4 rear panel connectors. The ST-8000A front panel includes displays and LED indicators. These show modem tone frequencies, data rate, and selected parameter settings. A 27-key keypad allows manual entry of data to set operational parameters. ST-8000A parameters may also be set and read via the rear panel REMOTE port (J4). The following sections will discuss these circuits in greater detail.

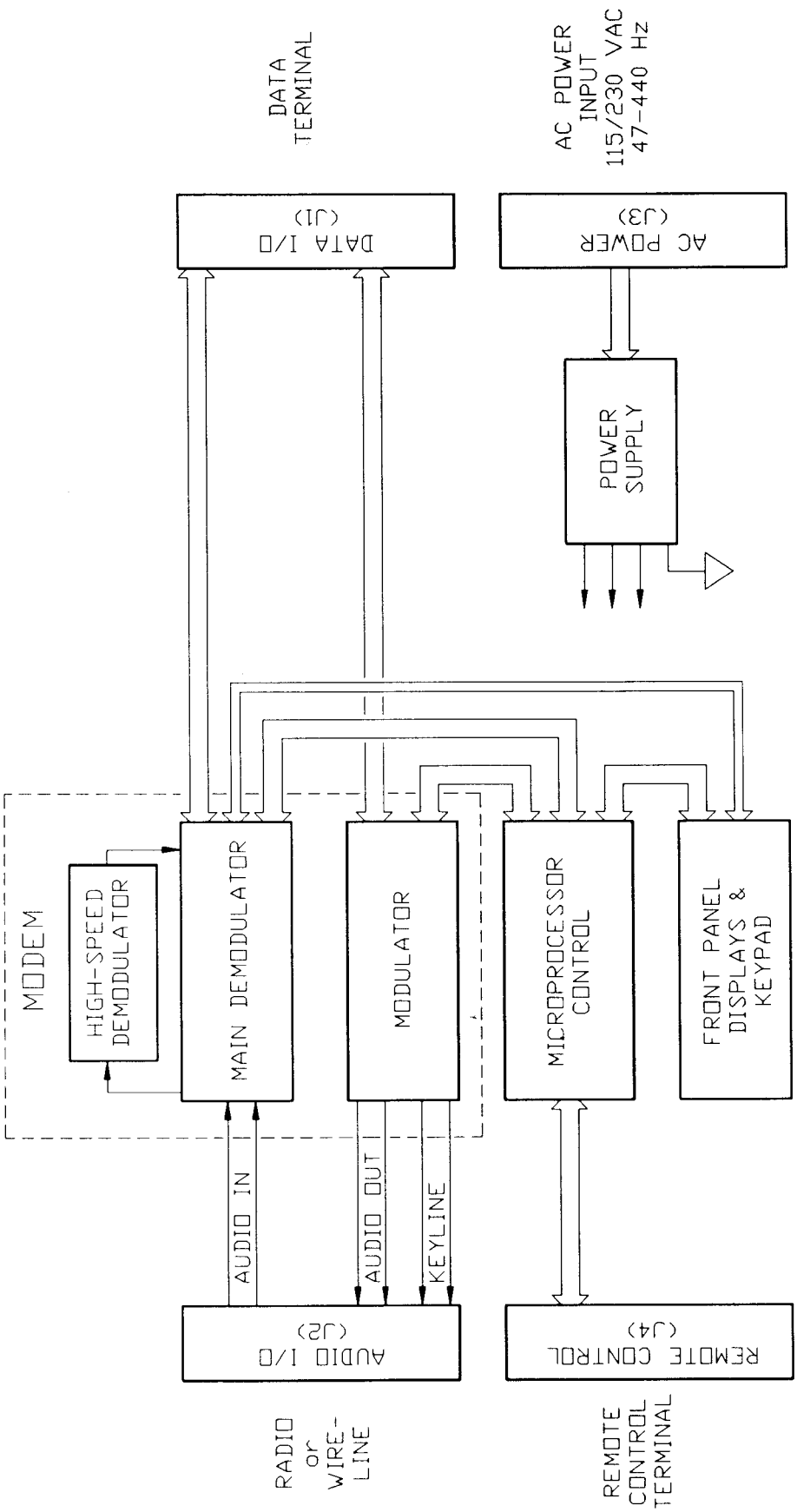

FIGURE 5.1 ST-8000A INTERNAL ASSEMBLIES

5.3.1 Demodulator Circuits

Figure 5.2 shows a block diagram of the ST-8000A demodulator section. Demodulator circuits accept FSK signals and convert the signals to base band digital pulses (MARK or SPACE). The major functional requirements are:

1. Accept and filter the input FSK signal.
2. Discriminate and separate MARK and SPACE signals
3. Adjust for input signal amplitude variations.
4. Provide for varying FSK frequencies and data rates.
5. Detect and combine MARK and SPACE data signals.
7. Provide data outputs (RS-232 and MIL-188).
8. Provide control of signal processing.

FSK input signals from rear panel connector J2 (AUDIO I/O) pass through an impedance matching, balanced to unbalanced, isolating transformer. The input impedance is set by jumper A1J6 for 600 ohms or 10,000 ohms. Setting jumper A1J6 is described in section 2.5.1. Input signals pass through input filters and separate MARK and SPACE filters. The microprocessor control system sets the center frequency and bandwidth of the MARK and SPACE filters. The filtered MARK and SPACE signals are peak detected to provide outputs to the:

1. Front panel bar-graphs.
2. AMH (Automatic MARK Hold) circuit.
3. AGC (Automatic Gain Control) circuit.

The AMH Threshold and Delay are set by option switches A1SW1 (Threshold) and A1SW2 (Delay). The Threshold is adjustable in 6 dB increments over a range of -42 dBm to 0 dBm (600 ohm input). The Delay adjustment range is 1.0 to 5.0 seconds in 0.5 second increments. The AMH feature is turned ON or OFF under microprocessor control. Section 2.5.2 describes AMH settings.

The AMH circuit provides the Carrier Detect (CD) or Loss Of Signal (LOS) output signal. The CD/LOS polarity is set by jumper A1J9 as described in section 2.5.3. The CD/LOS signal is output to rear panel connector J1 (DATA I/O).

The AGC circuit adjusts the filtered MARK and SPACE signals for input signal amplitude variations. The signals then pass to separate tone detectors. Programmable low pass filters follow the tone detectors to remove noise and other undesired signals. The cut off frequency of each low pass filter is set by microprocessor control (LP CLOCK). The pre-detection signals are output as the UNDETECTED MARK and SPACE signals on connector J1 (DATA I/O).

The detected and filtered MARK and SPACE pulses pass through MARK ONLY, SPACE ONLY and M/S (MARK/SPACE) pulse discriminators. The DETC MODE output of the microprocessor controller selects which discriminator output is sent to rear panel connector J1 (DATA I/O).

Signals with data rates higher than 600 baud (601 to 1200 baud) use a "High Speed" demodulator circuit. The output of the input filter stage drives a heterodyne mixer. This converts the signal to an Intermediate Frequency (IF) of approximately 12 kHz. The microprocessor control (HS LOCAL OSC) provides the Local Oscillator for this mixer. The IF signal passes through multiple section IF filters and amplitude limiter stages. A Phase Locked Loop detector detects the "High Speed" data signal.

Microprocessor control selects "High Speed" (601 - 1200 baud) or "Low Speed" (30 - 600 baud) detector outputs. The microprocessor provides polarity control (NORMAL/REVERSE) and Regeneration (REGEN) of the received data signal. Separate amplifiers provide RS-232 (MARK = -V) and MIL-188 (MARK = +V) output signals to rear panel connector J1 (DATA I/O). Microprocessor control detects received data pulses and generates a mid-bit clock output signal to J1.

The ST-8000A Built In Test (BIT) feature includes FSK audio loopback between the modulator and demodulator circuits. The audio input to the demodulator is disconnected from connector J2 (AUDIO IN) during BIT loopback tests. For these tests the demodulator input is connected to the modulator FSK audio output. This provides internal testing of all demodulator and modulator signal processing circuits. Three amplitude levels of BIT tests are included, 0 dBm, -20 dBm, and -45 dBm. BIT functions are set by microprocessor control (BIT CONTROL). When the Diversity Option is installed (Option -01), microprocessor control sets this feature.

The demodulator provides MARK and SPACE output signals that drive the front panel MARK and SPACE bar-graphs (MARK BAR OUT, SPACE BAR OUT). These signals provide calibrated front panel indications for the amplitude (in dBm) of the input FSK MARK and SPACE signals.

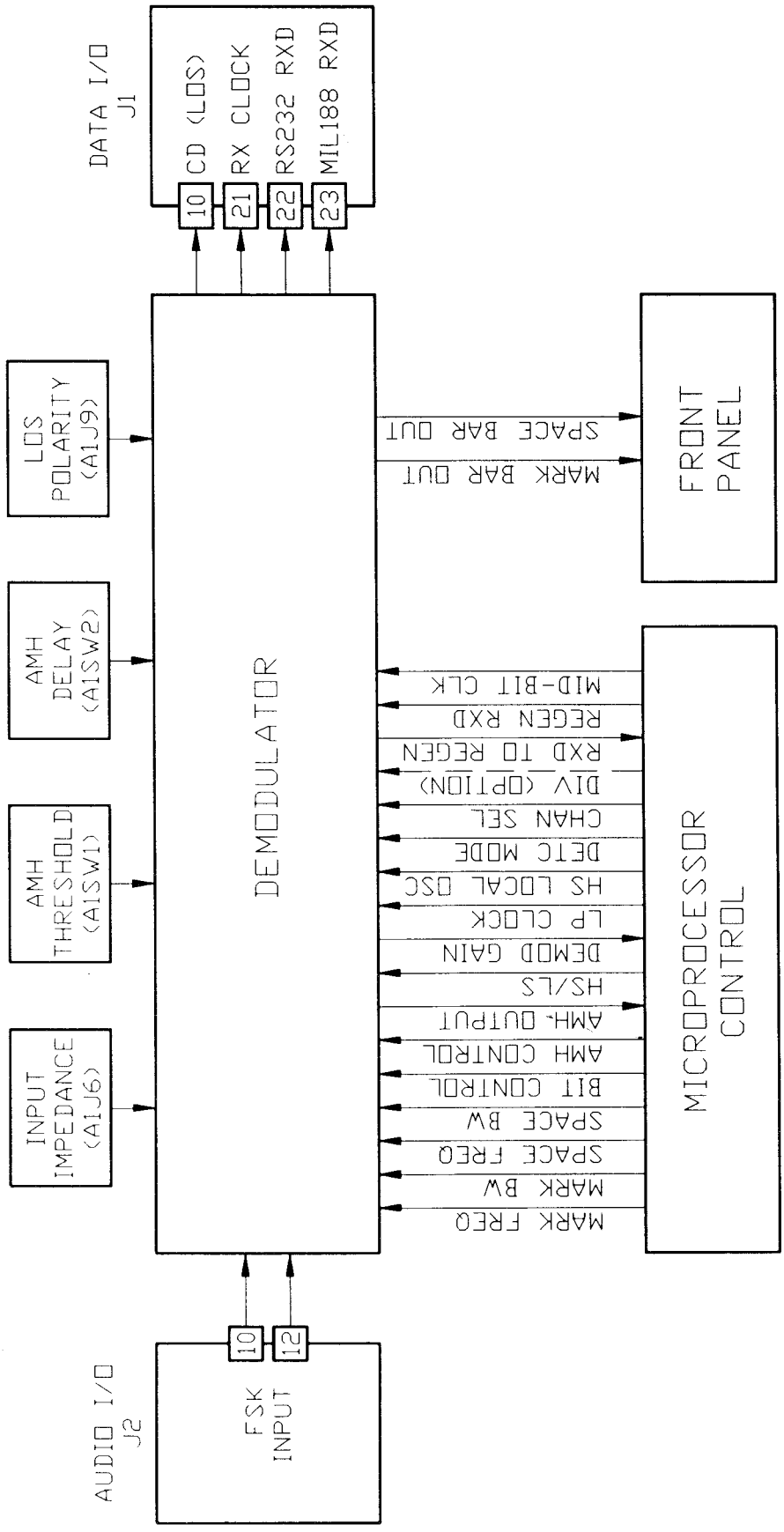

FIGURE 5.2 DEMODULATOR CIRCUIT

5.3.2 Modulator and Keyline Circuits

The ST-8000A Modulator circuit accepts Transmit Data (TXD) input from rear panel connector J1 (DATA I/O). Either RS-232 (MARK = -V) or MIL-188 (MARK = +V) format may be set by jumper A2J2 as explained in section 2.5.8. The microprocessor control sets the desired transmit data polarity (NORMAL/REVERSE).

A crystal controlled digital synthesizer generates the FSK modulator audio signals. The TXD input signal switches the modulator synthesizer between MARK and SPACE frequencies. The MARK and SPACE frequencies are set by microprocessor control. FSK modulator signals are generated at 100 times the desired output frequencies. An EPROM look-up table and D/A (Digital to Analog) converter generate a 100 step digital approximation of a sinewave. The D/A output is then low pass filtered to smooth the steps and eliminate harmonic distortion. The modulator output signal has more than 40 dB of harmonic suppression. All other spurious (undesired) signals are suppressed by more than 60 dB.

The modulator output signal passes through the front panel OUTPUT LEVEL control. The output level may be adjusted over a range of 0 dBm (maximum) to less than -35 dBm (600 ohm reference). The front panel bar-graphs indicate the actual output in dBm (600 ohm) when CH displays "2". The output FSK signal then passes through amplifiers and an isolating 600 ohm transformer to rear panel connector J2 (AUDIO I/O).

The input transmit data signal from J1 (DATA I/O) also drives the AUTO MUTE and Keyline circuits. TXD activity (MARK/SPACE transitions) is detected by the microprocessor control circuit. When an active transmit data (TXD) signal is present, the Keyline output terminals to J2 (AUDIO I/O) and J1 (DATA I/O) are shorted together. The isolated relay contact output is often used to turn the transmitter ON and OFF as explained in section 2.6.1.1.2.

When TXD activity ceases, the keyline relay opens after a delay set by switches A2SW1 and A2SW2. Setting the MUTE DELAY is explained in section 2.5.7. This delay may be set from 1.0 ms (milliseconds) to 9.999 Seconds in 1.0 ms increments. Jumper A1J8 allows ON/OFF control of the modulator FSK tone output by the AUTO MUTE feature (see section 2.5.4). A MUTE from the front panel or remote command turns the output tones OFF.

The ST-8000A DRTS (Data Request To Send) input on J1 allows immediate ON/OFF control of the keyline (and modulator output). A logical "high" (+V) signal to DRTS results in immediate closure of the keyline relay. This occurs regardless of activity on TXD. About 200 ms after DRTS is set to +V, the DCTS (Data Clear To Send) output signal to J1 activates. The DCTS signal may be used to "hold off" TXD until the transmitter's circuitry has stabilized. The microprocessor control provides a transmit data clock (TX CLOCK) output to rear panel connector J1 (DATA I/O). This may be used to synchronize external transmit data sources to the ST-8000A.

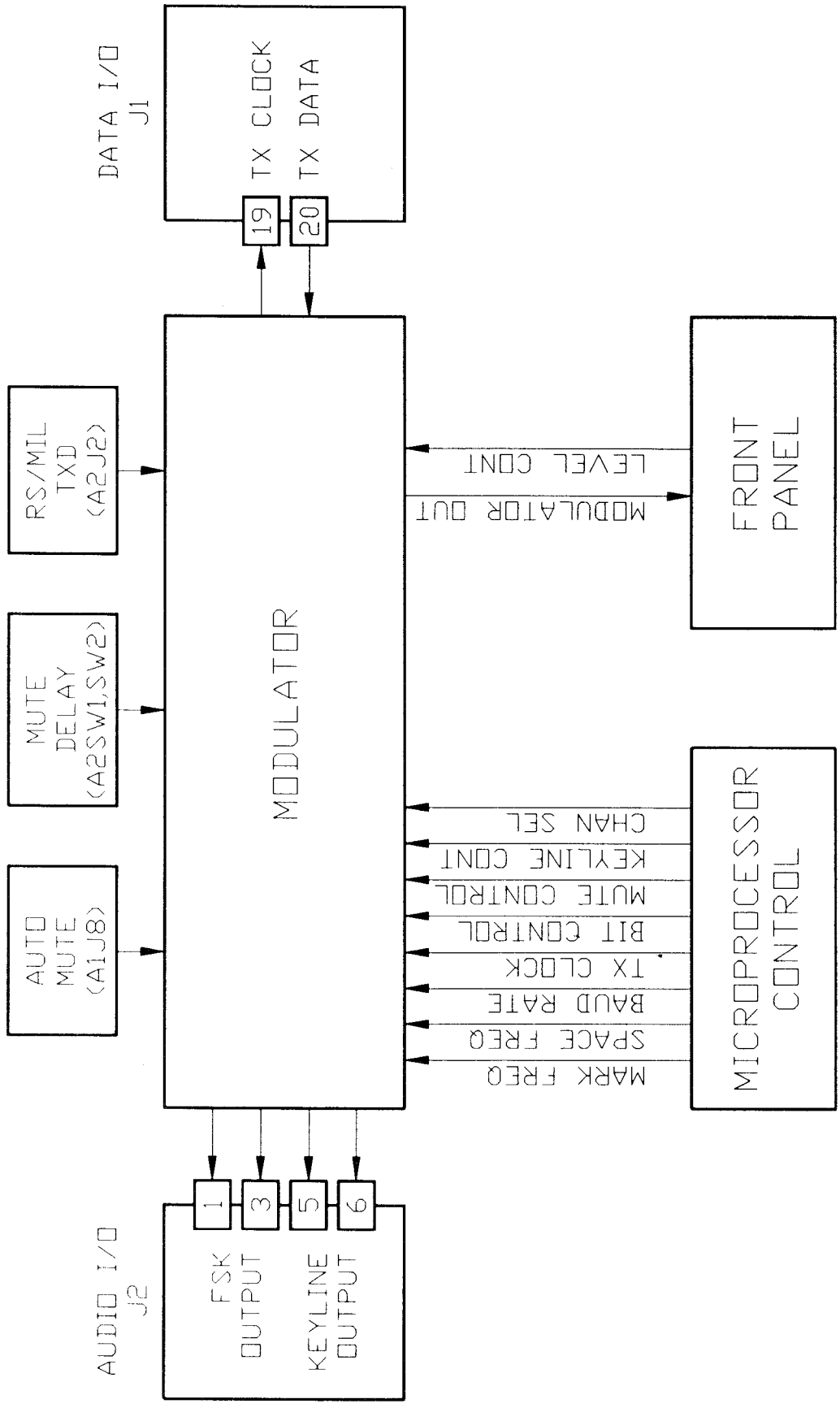

FIGURE 5.3 MODULATOR CIRCUIT

5.3.3 Microprocessor Control Circuits

The ST-8000A Microprocessor Control circuits perform the following tasks:

1. Controls all demodulator operating parameters.
2. Synthesizes filter clock signals to the demodulator.
3. Computes and sets demodulator filter bandwidths.
4. Provides receive data regeneration (REGEN).
5. Recovers mid-bit receive data clock.
6. Synthesizes MARK and SPACE modulator signals.
7. Sets modulator baud rate.
8. Generates transmit data clock.
9. Controls AUTO-MUTE feature and Keyline.
10. Controls the BIT feature.
11. Interprets and sets parameters from the keypad.
12. Sets all front panel displays and indicator LEDs.
13. Interfaces with and interprets all remote control input.
14. Performs all other required control and computation.

The ST-8000A Microprocessor Control circuit uses an 8-bit microprocessor (Z-80A). Three types of memory devices are used: (1) RAM (Random Access Memory), (2) PROM (Programmable Read Only Memory), and (3) EEPROM (Electrically Erasable ROM). All program "firmware" for the ST-8000A is contained in the PROM. Program execution and temporary storage use RAM. The EEPROM provides non-volatile storage of the currently set parameters. The previous parameters are restored from the EEPROM device each time AC power is turned ON.

The control system includes a "Dead-Man" timer circuit that senses microprocessor activity. If activity ceases (non-functioning processor), the "Dead-Man" circuit resets the microprocessor. This circuit guards against incorrect operation that might be caused by AC power "brown-outs" or transients. If the EEPROM contents are valid, the previous parameters are restored upon reset. If the EEPROM contents were disturbed by the fault, default parameters are restored upon reset. See section 2.7 for a list of the default parameters.

Microprocessor Control includes four direct digital frequency synthesizers and three programmable clock dividers. The synthesizers provide clock outputs to the MARK and SPACE demodulator filters, Modulator FSK output, and the Local Oscillator to the "High Speed" demodulator mixer stage. Programmable dividers provide the Low Pass filter clock, 1.0 ms timing pulses for AUTO MUTE delay timing, and the data rate clock for the Remote control port. The microprocessor, synthesizers, and two clock dividers are timed from one 4.9152 MHz crystal controlled oscillator. A 6.144 MHz crystal controlled oscillator provides timing for the AUTO MUTE Delay circuit.

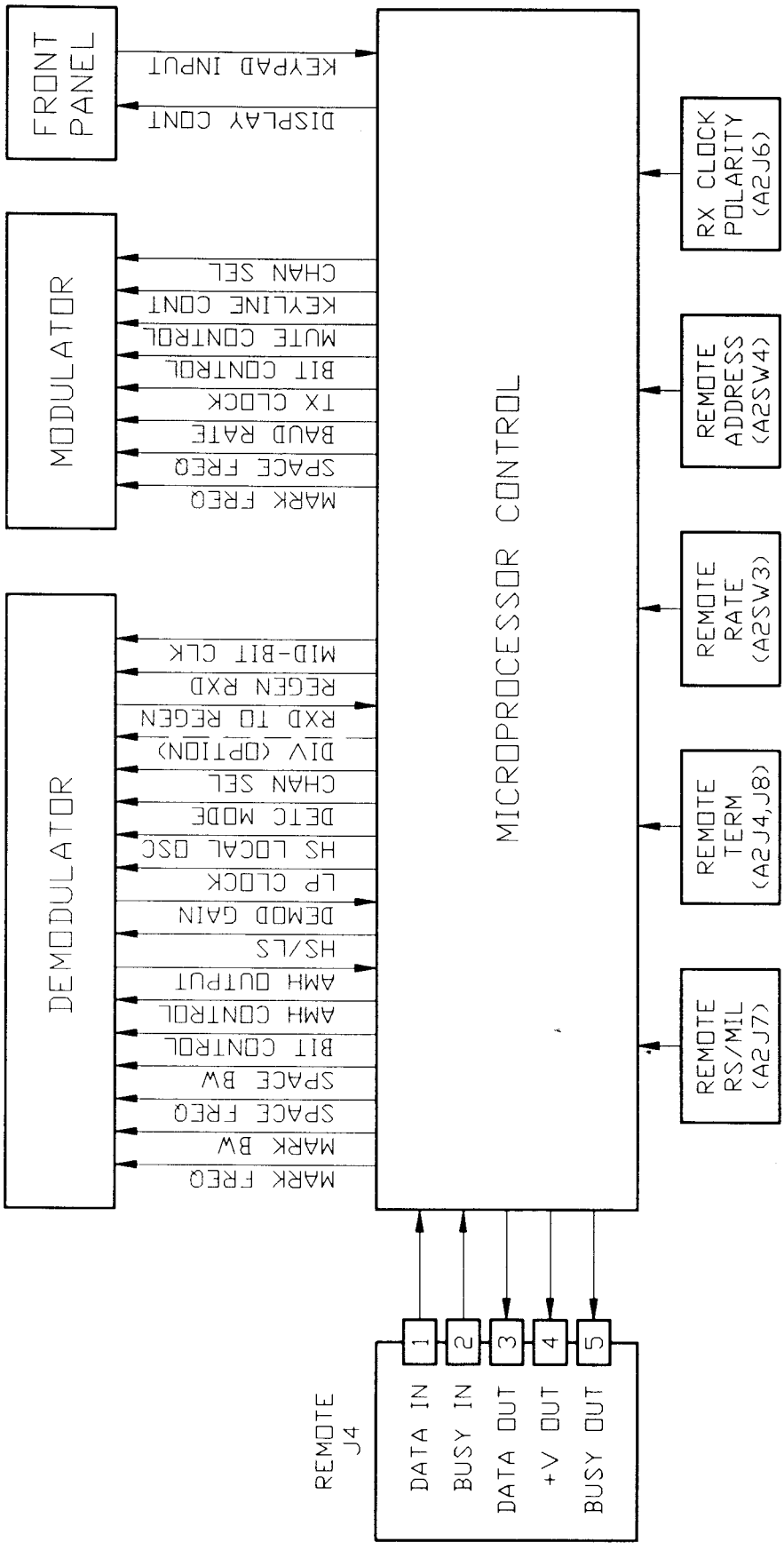

FIGURE 5.4 MICROPROCESSOR CONTROL

A serial I/O UART (Universal Asynchronous Receiver/Transmitter) provides interface between the remote control terminal and the microprocessor. Rear panel connector J4 (REMOTE) links the remote control terminal to the ST-8000A. Jumper A2J7 (see section 2.5.8) may be set for use of an RS-232 or MIL-188 remote control data format. The remote control data rate is set by option switch A2SW3. Setting this switch is explained in section 2.5.5. The microprocessor controller interprets and executes all remote control commands.

When the ST-8000A is used in a multiple unit "daisy-chain" connection for remote control, each ST-8000A must be set to a different unit address. Option switch A2SW4 sets this address, explained in section 2.5.6. In a multiple unit system, only one unit should use terminations on the remote control data signals. See section 2.5.9 for details on setting termination jumpers A2J4 and A2J8. Up to nine ST-8000A Modems may be controlled by one terminal or computer.

The microprocessor provides receive data regeneration (REGEN) and mid-bit clock recovery (MID-BIT CLK). Clock polarity is set by jumper A2J6. This jumper is discussed in section 2.5.8.

The microprocessor interfaces with the front panel displays and keypad. It interprets and executes all keypad entries. These entries are processed under firmware control. The demodulator and modulator parameters are then adjusted as required. The controller sets front panel displays and indicators to reflect current operating parameters.

5.3.4 Front Panel Circuits

The ST-8000A Front Panel includes all switches, displays, and indicators to manually operate the modem. The displays and indicators show all current parameters when remote control is used. Figure 5.5 shows the front panel interface. Figure 3.1 shows the front panel.

Operation of each key of the 27-key keypad is discussed in section 3.3. These keys are used to enter parameters and change operating modes of the ST-8000A. Figure 3.2 shows an expanded view of the keypad.

The Front Panel displays include 2 five-digit indicators to show MARK and SPACE frequencies. A four-digit display shows the BAUD RATE. A single digit shows the selected display and control CHANNEL. These displays show demodulator (CH 1) or modulator (CH 2) parameters. Eighteen LED (Light Emitting Diode) indicators show the current modes of the selected channel. The controller sets all displays and LED's.

The OUTPUT LEVEL front panel control allows direct adjustment of the modulator output amplitude, as discussed in section 5.3.2. The POWER switch controls all power to the ST-8000A.

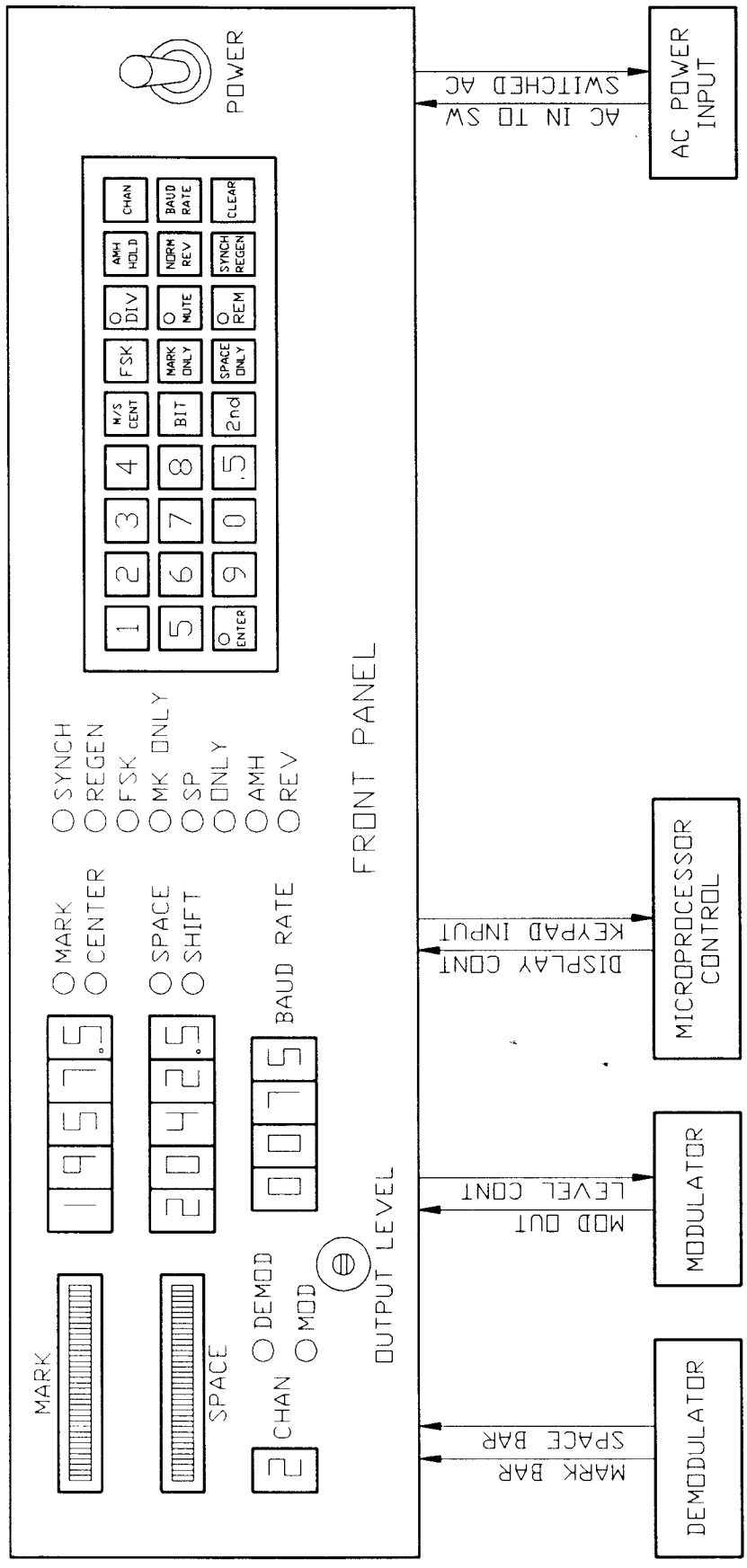

FIGURE 5.5 FRONT PANEL

5.3.5 Power Supply

All circuits of the ST-8000A are powered by a regulated DC power supply. The voltages are regulated to produce operating voltages of +5.0 VDC, +8 VDC, and -8 VDC. All DC outputs are current limited and short-circuit protected. The +5 VDC regulator integrated circuit is mounted to a rear panel heat sink. Internal cables link the power supply to other circuit assemblies.

5.3.6 Cabinet

The cabinet houses all assemblies of the ST-8000A. It includes cables, AC power circuitry, the low-voltage power transformer, and rear-panel I/O connections.

All AC power components are chosen to meet safety requirements of UL-1950 and "Host Nation" (EC, or European Community) EN-60950. This includes the rear panel AC power connector, RFI filter, AC power switch, AC voltage and frequency selector switches, fuse and fuse holder, connectors, power transformer, and wire used. AC power voltages of 115 or 230 VAC (±10%) may be used at frequencies from 47 to 440 Hz.

Rear panel connectors J1 (DATA I/O), J2 (AUDIO I/O), and J4 (REMOTE CONTROL) are military MS27508-series round connectors. An additional rear panel hole is provided for the optional Diversity connector (J5). A hole cover is included on all modems without this option.

The ST-8000A cabinet is constructed of extruded aluminum front, rear, and side panels. Top and bottom covers are aluminum sheet. All exterior aluminum surfaces have a conductive iridite finish. The combination of the heavy extrusions and iridite finish produces a durable cabinet that is strong and RFI "tight".

All rear panel I/O connections are by-passed and filtered. Key internal circuit boards use four layer construction with internal layers devoted to power and ground busses to minimize RFI generation. The recessed lips of the cabinet extrusions produce a "choke-flange" seal between the cabinet and the top and bottom covers. This minimizes RFI radiation and susceptibility. The ST-8000A exceeds FCC Part 15 and VDE RFI requirements.

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CHAPTER 6
MAINTENANCE

6.1 GENERAL

The ST-8000A includes internal test features that greatly simplify diagnostic testing of the modem. The tests are the Power-On Self Test (POST), and Built-In-Test (BIT procedures). POST is automatically run each time AC power is applied to the ST-8000A. As explained in sections 3.3.4 and 4.5, multiple BIT routines may be run at any time, accessed either from the front panel keypad or via remote control commands.

This chapter describes POST, BIT, and additional bench-top tests which the user may distinguish between ST-8000A and other system failures.

6.2 DEPOT MAINTENANCE

The recommended maintenance plan for the ST-8000A MODEM is depot maintenance. This plan is:

1. The user should stock spare ST-8000A MODEMS to be used as maintenance replacements.

2. The user should periodically exercise POST and BIT on each ST-8000A in use.

3. Should any ST-8000A fail POST or BIT tests, it should be immediately replaced by a functioning spare unit.

4. The user may optionally choose to conduct further tests to be sure that the failure was not in other portions of the system (cables, for example).

5. A "failed" ST-8000A should be immediately returned to the HAL factory in Urbana, Illinois for repair.

6. User maintenance beyond the "complete unit" level is not recommended. The user should not attempt field diagnostics or replacement of internal parts or assemblies of the ST-8000A.

6.3 ROUTINE MAINTENANCE

As noted above, it is recommended that the user periodically observe the POST results and periodically exercise the BIT routines. The full BIT routine requires from 38 to 63 seconds to run. A daily review of POST and exercise of BIT is suggested.

The POST and BIT are the only routine maintenance procedures required, with the exception of the AC power fuse. Fuse elements are stressed each time AC power is turned ON. It is recommended that the rear panel fuse be replaced each 6 to 12 months of operation as part of routine maintenance.

A routine dusting and inspection of system blowers and filters (if used) is highly recommended. The ST-8000A includes no blowers and cooling is via convection through ventilation holes in the bottom and top covers of the cabinet. These ventilation holes should be kept clean and clear of obstructions.

It may also be desirable to periodically wipe the front panel with a damp, dust and lint-free cloth (gently). Avoid scratching the RED display "windows" and do not spray cleaning fluids directly onto the front panel surface.

6.4 POWER-ON SELF TEST (POST)

Each time the ST-8000A AC power is turned ON, a Power-On Self Test (POST) is performed. POST results are viewed on the front panel display. Correct operation is indicated by:

1. ALL DISPLAY SEGMENTS AND LED INDICATORS TURN ON (1 Second):

   The front panel indicators show:

```
8888.8   (MARK)
8888.8   (SPACE)
8888     (BAUD)
8        (CHAN)
All LED indicators turn ON.
```

This tests the front panel indicators and their driving circuits.

2. THE FOLLOWING MESSAGE APPEARS (1 Second):

```
HAL      (MARK)
8000A    (SPACE)
1.7      (BAUD) [Firmware Version No; may vary]
All LED indicators turn OFF.
```

This test confirms that the microprocessor is operating correctly and that the firmware EPROM has passed an internal sum-check. If an error is detected, the ST-8000A displays "FAIL" in the BAUD display and runs POST again.

6.5 BUILT-IN-TESTS (BIT)

6.5.1 Purpose

The ST-8000A includes a "Built-In-Test" (BIT) feature that may be used at any time to rapidly test key circuits of the FSK Modem. The intended use of the BIT feature is for in-field confirmation of ST-8000A operability. Field operators may invoke BIT at any time. If all steps of BIT pass, the operator may proceed with operation with a high confidence that the ST-8000A is fully operational. If any Built-In-Test step fails, the ST-8000A should be replaced and returned to HAL Communications for repair.

6.5.2 BIT Activation

The ST-8000A BIT feature is not automatically invoked. BIT use requires active operator entry of either a series of front panel keypad keys or transmission of unique commands from a Remote Control terminal connected to the ST-8000A rear panel REMOTE Port (connector J4). The BIT feature can not be accidentally invoked by any received data combination, data obtained via either the Audio I/O Port (connector J2), or Data I/O Port (connector J1). BIT is not automatically invoked upon ST-8000A AC power ON.

During the time that BIT sequences are running, the ST-8000A is not available for coding or decoding of Radio or Wire-Line data (data via connector J2). BIT activation causes the following changes inside the ST-8000A:

1. Demodulator audio input is disconnected from J2 (pins 10 & 12) and connected to the modulator output, forming an internal audio loopback. The internal audio loopback connection includes three calibrated attenuator settings to test demodulator operation. The loopback test levels used are 0 dBm, -20 dBm, and -45 dBm.

2. The modulator data input signal (TXD) is disconnected from Data I/O connector J1 (pin 20). This signal is used internally by BIT to confirm modulator and demodulator operation.

The ST-8000A operator may start the BIT sequence in two different ways: (1) via front panel keypad key entry; and (2) via Remote Control port command entry. These two entry techniques are detailed in the following sections.

6.5.2.1 BIT Entry via Front Panel Keypad:

To start BIT from the front panel, perform the following steps:

1. Turn ST-8000A AC Power ON.

2. Wait until normal MARK, SPACE, BAUD, and CHANNEL numbers are displayed on the front panel.

3. In sequence, press and release first the 2nd, then the BIT, and finally the ENTER keypads. A three-key sequence is required to prevent accidental BIT activation.

Built-In-Tests will now be run in the sequence described in Section 6.5.4. Once the BIT sequence has started, the operator has two additional options:

4. To RESTART BIT at Step #0, press BIT.

5. To cancel BIT and return the ST-8000A to normal operation, press CLEAR. BIT steps are immediately disabled and the ST-8000A is returned to the operational parameters in use prior to activating BIT.

6.5.2.2 BIT Entry via Remote Control Commands:

To start BIT using Remote Control commands, perform the following steps:

1. Turn ST-8000A AC Power ON.

2. Wait until normal MARK, SPACE, BAUD, and CHANNEL numbers are displayed on the front panel.

3. Select the unit using the "Cxx" ("xx" = Channel No.) and R1 commands.

4. Enter the Remote Control command T1.

Built-In-Tests will now be run in the sequence described in Section 6.5.4. Once the BIT sequence has started, the operator has two additional options:

5. To RESTART BIT at Step #0, re-enter the T1 Remote Control command.

6. To cancel BIT and return the ST-8000A to normal operation, enter the T0 (DISABLE) Remote Control command. BIT steps are immediately disabled and the ST-8000A is returned to the operational parameters in use prior to activating BIT.

6.5.3 BIT Test Result Indications

During the time that the Built-In-Test feature is running, the front panel "CH" (Channel), "BAUD", "SPACE", and "MARK" indicators are used to show the BIT status and results.

Immediately upon activation of BIT, the MARK display will show "8000A" and the SPACE display will show "-bit-". These characters remain on the MARK and SPACE displays throughout the duration of BIT.

The "CH" (Channel) display indicates the number of the BIT sequence in process. There are a total of thirteen (13) BIT sequences, indicated by "0" through "9" and "A", "B", and "C".

The "BAUD" display shows "FAIL" and flashes if any step fails and "PASS" after all 13 BIT steps pass. The "BAUD" display is normally blank during the operation of BIT if no failures occur.

If BIT has been activated by Remote Control command, descriptive text for each step is printed on the remote control terminal, followed by "PASSED" or "FAILED" as each test step is completed.

6.5.3.1 BIT Step Successful:

As each BIT step is run, the number of that step is shown on the "CH" display. Successful completion of that BIT step is indicated by changing of the "CH" display to the next step number (or letter). The BAUD display remains blank during each successful step, but shows "PASS" when all 13 steps have been successfully completed.

If BIT has been activated via the Remote Control port, the characters "PASSED" are printed following the description of the test conducted. Successful completion of all 13 steps of the BIT are indicated by printing "ST-8000A PASSED ALL TESTS" on the Remote Control terminal. Except for BIT "Test B" (see 4.12), messages are output to the Remote Control terminal only when BIT has been activated via Remote Control.

6.5.3.2 BIT Step Failure:

If any test should fail, the following sequence is observed:

1. The word "FAIL" appears on the BAUD display.
2. The failed BIT step number appears on the CH display.
3. The ST-8000A halts at this BIT step and will not proceed further.

Procedure after BIT step failure differs slightly between front panel activation and Remote Control activation of BIT.

If BIT has been activated via the front panel keypad and a step fails:

4a. Upon failure of a step, the ST-8000A remains locked in that BIT step. Pressing the front panel "BIT" or "CLEAR" keypads will not restart BIT or reset to normal operation. Cycling the AC Power switch OFF and back ON will restore the ST-8000A to normal operation. The parameters set before activation of BIT are restored.

If BIT has been started with Remote Control command T1 and a step fails:

4b. The ST-8000A remains locked in the failed BIT step. It will respond to a T0 command. This restores the ST-8000A to normal operations at the parameters set before activation of BIT. This feature allows operator access to the Remote Control command menus (T9). As in the case of front panel BIT access, cycling of the AC power switch OFF and back ON will restore normal ST-8000A operation.

5. The phrase "FAILED" is continuously sent to the remote control terminal. "FAILED" is repeated until ST-8000A AC Power is turned OFF or until the remote control command T0 is entered.

Although a BIT step failure may be by-passed, a failure has nonetheless occurred. Continued operation of a failed ST-8000A is not recommended. However, should a failure occur, BIT activation should be repeated to confirm the failure mode.

6.5.4 ST-8000A BIT Steps

A total of 13 BIT steps are conducted, "0" through "9" and "A" though "C". The following is a description of each of these steps.

6.5.4.1 Microprocessor Alive Test (Test 0):

When BIT is invoked, the letters "8000A" appear in the MARK numerical display, "-bit-" appears in the SPACE numerical display, the BAUD display is cleared and CHANNEL is set to "0". Also, the MARK and SPACE level indicators and all LED's are cleared.

If BIT is activated via remote control, the following message is sent to the remote control terminal:

```
HAL  ST-8000A HF MODEM
BUILT-IN-TEST (BIT) SUMMARY
-----------------------------------
```

When this step passes, BIT automatically proceeds to "Test 1". "Test 0" requires approximately 0.5 seconds to complete.

6.5.4.2 Internal Clock Test (Test 1):

BIT "Test 1" tests the Programmable Interval Timer (8254) and its generated clocks. This step verifies the internal timing clock, the Low-pass filter clock and the Transmit Sync clock. Operation of other clocks are confirmed during "loop-back" steps ("Test 6" through "Test A").

If BIT is activated via remote control, the following message is sent to the remote control terminal:

```
1.. Timer Frequency Test ....  PASSED   (or repeated FAILED)
```

When this step passes, BIT automatically proceeds to "Test 2". "Test 1" requires approximately 0.5 seconds to complete.

6.5.4.3 ROM Checksum Test (Test 2):

BIT "Test 2" checks the firmware ROM (A2U4) for errors by calculating a sum-check of the entire ROM contents. "Test 2" fails if the sum-check value does not agree with the factory calculated correct value.

If BIT is activated via remote control, the following message is sent to the remote control terminal:

```
2.. EPROM Memory Test ....... PASSED    (or repeated FAILED)
```

When this step passes, BIT automatically proceeds to "Test 3". "Test 2" requires approximately 0.5 seconds to complete.

6.5.4.4 Random Access Memory (RAM) Test (Test 3):

BIT "Test 3" checks the Random Access Memory (RAM, A2U3). Test patterns are written to the RAM and verified. "Test 3" fails if any single read value does not match the value written. Front panel displays will flicker when the RAM configuration is restored.

If BIT is activated via remote control, the following message is sent to the remote control terminal:

3.. RAM Memory Test ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to "Test 4". "Test 3" requires approximately 1.0 seconds to complete.

6.5.4.5 EEPROM Test (Test 4):

BIT "Test 4" verifies EEPROM (A2U2) operations. EEPROM sections used by the main program are tested. Previous EEPROM data is saved in RAM and replaced after the test is completed. "Test 4" fails if the read operation does not match the write operation.

If BIT is activated via remote control, the following message is sent to the remote control terminal:

4.. EEPROM Memory Test ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to "Test 5". "Test 4" requires approximately 1.5 seconds to complete.

6.5.4.6 Front Panel Indicator Test (Test 5):

BIT "Test 5" requires operator observation. At the start of "Test 5", all segments and LED's are turned ON for 2.5 seconds. The operator must visually verify that this does occur. All LED indicators and display segments are then turned OFF for 2.0 seconds. The operator must also visually verify that all segments turn OFF.

Pass or failure of "Test 5" must be confirmed by operator observation. Test 5 always concludes with "PASSED" on the front panel display. If the operator should miss this test or be unsure of its result, he should re-invoke BIT by pressing the front panel BIT keypad or by re-entering the T1 Remote Control command. Note, however, that this will also cause repeat of BIT steps "Test 0" through "Test 4".

If BIT is activated via remote control, the following message is sent to the remote control terminal:

5.. Display Test ..... PASSED (no failure indication)

BIT automatically proceeds to "Test 6" upon completion of the ON/OFF display test. "Test 5" requires approximately 4.5 seconds to complete.

6.5.4.7 Loopback Data Test, Parameter Set #1 (Test 6):

BIT "Test 6" is a complete test of all low-speed modulator and demodulator signal processing circuits. To do these tests, the modulator output is internally connected to the demodulator input ("loopback") and a known data stream is sent through the modem. The demodulated data stream is bit-by-bit compared with the test data sent. "Test 6" fails if any single bit comparison fails. The parameters used for this test are:

MARK	= 300 Hz
SPACE	= 3000 Hz
BAUD	= 100
MODULATOR LEVEL	= 0 dBm
TEST DATA	= 511 pseudo-random data elements

If BIT is activated via remote control, the following message is sent to the remote control terminal:

6.. Loopback Test #1 ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to "Test 7". "Test 6" requires approximately 6.0 seconds to complete.

6.5.4.8 Loopback Data Test, Parameter Set #2 (Test 7):

BIT "Test 7" is the second loopback test of the low-speed demodulator. "Test 7" fails if any single bit comparison fails. The test parameters are:

MARK	= 2000 Hz
SPACE	= 2085 Hz
BAUD	= 75
MODULATOR LEVEL	= -20 dBm
TEST DATA	= 511 pseudo-random data elements

If BIT is activated via remote control, the following message is sent to the remote control terminal:

7.. Loopback Test #2 ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to "Test 8". "Test 7" requires approximately 7.0 seconds to complete.

6.5.4.9 Loopback Data Test, Parameter Set #3 (Test 8):

BIT "Test 8" is the third loopback test of the low-speed demodulator. "Test 8" fails if any single bit comparison fails. The test parameters are:

MARK	= 1000 Hz
SPACE	= 2000 Hz
BAUD	= 300
MODULATOR LEVEL	= -45 dBm
TEST DATA	= 511 pseudo-random data elements

If BIT is activated via remote control, the following message is sent to the remote control terminal:

8.. Loopback Test #3 ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to "Test 9". "Test 8" requires approximately 2.5 seconds to complete.

6.5.4.10 Loopback Data Test, Parameter Set #4 (Test 9):

BIT "Test 9" is the first loopback test of the high-speed demodulator circuit. "Test 9" fails if any single bit comparison fails. The test parameters are:

MARK	= 1575 Hz
SPACE	= 2425 Hz
BAUD	= 650
MODULATOR LEVEL	= -20 dBm
TEST DATA	= 511 pseudo-random data elements

If BIT is activated via remote control, the following message is sent to the remote control terminal:

9.. Loopback Test #4 ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to "Test A". "Test 9" requires approximately 2.0 seconds to complete.

6.5.4.11 Loopback Data Test, Parameter Set #5 (Test A):

BIT "Test A" is the final loopback test of the high-speed demodulator. "Test A" fails if any single bit comparison fails. The test parameters are:

MARK	= 1400 Hz
SPACE	= 2600 Hz
BAUD	= 1200
MODULATOR LEVEL	= 0 dBm
TEST DATA	= 511 pseudo-random data elements

If BIT is activated via remote control, the following message is sent to the remote control terminal:

A.. Loopback Test #5 ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to "Test B". "Test A" requires approximately 1.5 seconds to complete.

6.5.4.12 Remote Port Test (Test B):

BIT "Test B" is a test of the Remote Control port of the ST-8000A. This test requires that the operator observe the output of a message sent by the ST-8000A to the remote control terminal. This message is always sent to the Remote Control port, even if BIT is accessed via the front panel keypad. This test requires observation to determine "PASS" or "FAIL". The text sent to the remote control terminal is:

```
B.. Remote Port Test .....
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG'S BACK 0123456789
   [0.5 second delay]
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG'S BACK 0123456789
B.. Remote Port Test ..... PASSED
```

There is no failure message sent to the remote control terminal for Test B.

BIT "Test B" always proceeds to BIT "Test C". The time required to complete "Test B" varies with the data rate chosen for communications with the remote control terminal (via option switch U2SW3). At 300 baud, "Test B" requires approximately 6.0 seconds. At 9600 or 19,200 baud, "Test B" requires approximately 2.5 seconds.

6.5.4.13 Deadman Timer Test (Test C):

BIT "Test C" tests the automatic reset circuitry. The length of time required for the microprocessor system to reset is verified to be within acceptable limits. Note that BIT "Test C" causes a reset and will flicker the display. If "Test C" passes, the ST-8000A returns to BIT test mode without the loss of any modem parameters. "Test C" fails if the time-out period is outside of acceptable limits.

If BIT is activated via remote control, the following message is sent to the remote control terminal:

C.. Deadman Timer Test ..... PASSED (or repeated FAILED)

When this step passes, BIT automatically proceeds to display of the "Final BIT Report". "Test C" requires approximately 2.5 seconds to complete.

6.5.4.14 Final BIT Report:

This concludes the ST-8000A Built-In-Tests. If all tests have been successful, the word "PASS" appears on the BAUD display. If BIT was accessed via remote control, the phrase "ST-8000A PASSED ALL TESTS" is sent to the remote control terminal.

As noted in section 3.2, a failure of any BIT step will result in the display of the word "FAIL" on the BAUD display. If BIT was accessed via the remote control port, the word "FAILED" is also sent continuously to the remote control terminal.

The final report display of "PASS" on the BAUD display remains for approximately 4.0 seconds. After this delay, BIT proceeds to restore operational parameters.

6.5.4.15 Restore Parameters:

At the successful conclusion of all BIT steps, all parameters of the ST-8000A are restored to the same values that were in use prior to entering BIT. All input and output connections are restored and the ST-8000A modem is then "on-line" for normal data modulation and demodulation.

As noted previously, an in-process BIT sequence may be aborted at any time by pressing the CLEAR keypad or entering the DISABLE (T0) command from the remote port. The CLEAR or DISABLE commands immediately restore the ST-8000A to full operation using the previously set parameters.

6.5.5 BIT Execution Times

Wherever necessary, the BIT procedure has included pauses to allow for comfortable viewing of the progression of the individual tests. The following is a list of times for each BIT step. Note that BIT requires a longer time to run when the remote terminal data rate is slow. Table 1 shows approximate BIT step times for front panel BIT activation, and remote control activation at 300 and 9600 baud.

TABLE 6.1
BIT STEP EXECUTION TIMES

TEST	DESCRIPTION	BIT ACCESS METHOD ----- FRONT PANEL	- REMOTE CONTROL -- 300 BD	9600 BD
"Test 0"	Microprocessor Alive:	0.5 sec.	4.0 sec.	0.5 sec.
"Test 1"	Internal Clock Test:	0.5 sec.	3.0 sec.	0.5 sec.
"Test 2"	ROM Checksum Test:	0.5 sec.	3.0 sec.	0.5 sec.
"Test 3"	RAM Test:	1.0 sec.	3.0 sec.	1.0 sec.
"Test 4"	EEPROM Test:	1.5 sec.	3.0 sec.	1.5 sec.
"Test 5"	Indicator Test:	4.5 sec.	6.0 sec.	4.5 sec.
"Test 6"	Loopback Test #1:	6.0 sec.	7.5 sec.	6.0 sec.
"Test 7"	Loopback Test #2:	7.0 sec.	9.5 sec.	7.0 sec.
"Test 8"	Loopback Test #3:	2.5 sec.	3.5 sec.	2.5 sec.
"Test 9"	Loopback Test #4:	2.0 sec.	3.0 sec.	2.0 sec.
"Test A"	Loopback Test #5:	1.5 sec.	2.5 sec.	1.5 sec.
"Test B"	Remote Port Test:	2.5 sec. to 6.0 sec.*	6.0 sec.	2.5 sec.
"Test C"	Deadman Timer Test:	3.0 sec.	4.0 sec.	3.0 sec.
	BIT Final Report:	4.0 sec.	5.5 sec.	4.0 sec.
	Total BIT Time:	38.0 sec. to 41.5 sec.*	63.5 sec.	38.0 sec.

* Time varies with data rate set on remote control port.

6.5.6 Manual Test Selection

The ST-8000A allows manual selection of an individual test included in the BIT. Selection of a single test is accomplished from the REMOTE port with the T9 command. This results in the display of the manual test selection menu. From this menu, any of the BIT steps may be executed.

A front panel keypad test is included in the manual test menu as option "K". When this option is activated, all keys pressed on the keypad are reported on the remote control terminal. While the modem is in this test, no key command operations are performed. This test is provided to isolate suspected keypad problems.

To leave the manual test menu, enter the "X" command on the remote terminal.

6.6 ADDITIONAL FAULT IDENTIFICATION

The ST-8000A BIT tests are extensive and will locate most ST-8000A FSK MODEM failures. However, failures that cannot be tested by the ST-8000A BIT feature include:

1. ST-8000A Demodulator audio input transformer and modulator audio output transformer. The internal BIT audio loopback does not pass through the transformers. "Host Nation" and FCC modem interconnect rules do not permit additional internal connections to the "outside" transformer winding terminals.

2. The system cables that the user may have connected between the ST-8000A and other equipment.

A "suspect" ST-8000A that passes BIT but appears to be malfunctioning may be checked by replacing the unit with another modem with the same internal option settings and the same operational parameters. If the replacement solves the error conditon, the replaced unit has a failure. The failure should be described to include the fact that the BIT did not detect the failure. The failure description should go with the unit when shipped for repair.

If an ST-8000A does not turn ON when the POWER switch is activated, check the fuse. If replacing the fuse does not return the unit to operation, let the unit sit with power OFF for 30 minutes. The ST-8000A power transformer has a thermal circuit breaker on the coil. This safety device opens the transformer primary winding when the temperature exceeds the design limit. Letting the ST-8000A cool for 30 minutes will provide sufficient time for the circuit breaker to reset. The thermal breaker provides fire safety protection required by UL1950 and EN60950. The breaker should not open under normal operating conditions. A unit whose thermal breaker repeatedly trips should be replaced and returned for repair.

The reason for the over heating should be determined before the unit is returned to use. If no environmental causes are identified, the unit should be returned to the factory for servicing.

6.7 RETURN TO FACTORY

If it is necessary to return an ST-8000A FSK MODEM to the HAL factory for repair, please follow these procedures:

1. Write a short description of the failure mode. List any failed tests and test steps (POST or BIT). List any possibly related circumstances (lightning storm, dropped unit, high dust or temperatures, etc.). Include a copy of this note inside the package containing the ST-8000A. Include the serial number of the unit on this note.

2. If possible, Locate the original packing materials and re-pack the ST-8000A as shown in Figure 2.1. The connector covers should be replaced prior to wrapping the modem. If the original packing materials are not available, pack the ST-8000A in a fashion as close as possible to the system shown in Figure 2.1. Avoid foam pellets if at all possible. Foam pellets will shift during shipment, possibly exposing the cabinet to damage. "Bubble-wrap" and double-boxing are recommended.

3. Contact the HAL factory and inform repair personnel that the unit is being returned to the factory. Phone numbers are:

   Voice: (217) 367-7373 (M-F, 0800 - 1700 CST/CDT)
   FAX: (217) 367-1701 (all times)

4. Include in the package the organization, address, and name to be used when returning the repaired unit.

5. If the ST-8000A is "out-of-warranty" include in the package information concerning how the repairs and return shipment will be paid. If the repair is a "warranty repair", HAL will pay for repair and return shipment to a CONUS address.

4. Ship the packaged ST-8000A postpaid and insured to the HAL factory at the following address:

   HAL COMMUNICATIONS CORP.
   1201 WEST KENYON ROAD
   URBANA, ILLINOIS 61801

   ATTN: REPAIR DEPARTMENT

APPENDIX A

FCC PART 15 RFI NOTIFICATION

The ST-8000A has been tested and verified by HAL Communications to be in accordance with Part 15 of FCC Rules concerning RFI emission. The following text is required by that FCC regulation:

> "NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of 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 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."

The user is further cautioned that the ST-8000A cabinet provides RFI shielding. The ST-8000A must be operated with all covers in place and screwed-down.

ST-8000A installation must be in accordance with procedures outlined in Chapter 2. Shielded cables should be used on all connections to J1, J2, and J3 on the rear panel. Unshielded cables or poorly grounded cable shields may cause radio frequency interference. The rear-panel ground terminal is primarily for connection to a safety ground. Use of the ground terminal does NOT replace the need for shielded cables.

The installation should be designed to prevent radio frequency interference to the ST-8000A. Equipment operated near the ST-8000A must also be shielded and grounded. Antennas and antenna feedlines should not be placed close to the ST-8000A. All transmitter control lines should be filtered and shielded. Transmitter AC power connections must be filtered.

APPENDIX B

LIMITED WARRANTY

HAL Communications Corp. of Urbana, Illinois, hereby warrants to the original retail purchaser only that the product herein described and sold shall be free from defects in materials and workmanship for a period of one year from the date of sale to the original retail purchaser.

In the event of a defect in materials or workmanship during the warranty period, HAL Communications Corp. will, at its own expense, repair the defective unit and replace any defective parts. Cost of shipping the unit to HAL Communications Corp. shall be paid by the purchaser, as well as costs of removal and reinstallation of the unit. HAL Communications Corp. will bear the shipping costs incurred in returning the unit to the purchaser (48 contiguous states only). To obtain service under this warranty:

1. Notify, as soon as possible, the Customer Service Department of HAL Communications Corp., Box 365, Urbana, Illinois, 61801, in writing or by telephone, of the existence of a possible defect.
2. At the time of notification, identify the model and serial number, date and place of purchase, and the possible defect.
3. Hold the unit until written return authorization is received.
4. Return the unit, freight prepaid, upon the receipt of the return authorization.

Correct installation, use, maintenance, and repair are essential for proper performance of this product. The purchaser should carefully read the Operator's Manual.

This warranty does not apply to any defect which HAL Communications Corp. determines is due to any of the following:

1. Improper maintenance or repair, including the installation of parts or accessories that do not conform to the quality and specifications of the original parts;
2. Misuse, abuse, neglect, improper installation or operation.
3. Accidental or intentional damage.

All implied warranties, if any, are limited in duration to a period of one year from the date of purchase by the original retail purchaser. (Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.)

HAL Communications Corp. disclaims any liability for incidental or consequential damages arising out of the use of, or inability to use, this product. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.)

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.