

ST8000A FSK MODEM

CHAPTER 5

ALIGNMENT AND TEST

5.1 GENERAL

This chapter describes alignment and test procedures for the ST8000A. Section 5.2 is devoted to alignment procedures and section 5.3 is devoted to test procedures for all ST8000A parameters. Section 5.4 describes the BIT (Built-In-Test feature and how to use it.

NOTE: The ST8000A does not require "routine" maintenance or alignment. It is not necessary to do field alignment or test unless a malfunction has occurred. The best indicator of a malfunction is to use the BIT feature as described in Section 5.4.

5.1.1 Internal Access

Before alignment, it is necessary to remove the top cover of the ST8000A and place one circuit board in "alignment position". The following steps should be followed to prepare for alignment (Section 5.2) or test (Section 5.3). It is not necessary to open the ST8000A cabinet to use the BIT feature.

W A R N I N G

The AC input circuits of this unit use voltages which may be hazardous to life. Exercise extreme caution while working inside the modem when the protective covers are removed.

5.1.2 Removing Top Cover

Only the top cover of the ST8000A need be removed for alignment or test. Please follow these instructions.

1. Turn ST8000A AC power OFF and disconnect all rear-panel connectors.
___ Disconnect four (4) rear-panel connectors, J1 through J4.
2. Remove the ST8000A cabinet from the rack cabinet.
___ Remove four (4) 10-32 rack-mounting screws.
___ Set these screws aside for later re-installation.
3. Set the ST8000A cabinet down, right-side-up on a clean work surface.
 4. Remove the ST8000A top cover.
- ___ Remove all sixteen (16) 4-40 flat screws from the top cover. NOTE:

Use a #1 Phillips Screw-driver. A smaller or larger Phillips screw-driver will damage the screw heads.

___ Set these 16 screws aside for later re-installation.

___ Remove the top cover and set it aside for later re-installation.

5.1.3 Control Board Service Position.

Most ST8000A circuits are contained on two large circuit boards, the MODEM Board (Assembly A1), and the CONTROL board (Assembly A2). The CONTROL Board (A2) mounts on top of the Modem board (A1). The top board (CONTROL) hinges vertically to provide access to the lower board (MODEM). The condition in which the CONTROL board is hinged vertically will be called the Service Position of the CONTROL board. All cable connections are maintained and the ST8000A may be operated with the CONTROL board in the Service Position. Alignment or test requires placing the CONTROL board in the Service Position. Follow these procedures:

1. Place the ST8000A so that the front panel is towards you. The CONTROL board is the large top circuit board on the left half of the cabinet. Note that it is mounted with five (5) screws, three along the front edge, two along the sides approximately 2/3 the distance towards the rear panel, and two screws along the rear edge of the board. The front three screws are the hinges and should not be removed. The other four screws must be removed before hinging the CONTROL board.

NOTE: Use a #2 Phillips Screw-driver to remove these screws. A smaller or larger Phillips screw-driver will damage the screw heads.

___ Remove two (2) 6-32 x 5/16 Phillips-head screws from the rear corners of the CONTROL circuit board.

___ Remove two (2) 6-32 x 5/16 Phillips-head screws from the mid-left and mid-right sides of the CONTROL circuit board.

___ Set these four (4) screws aside for later re-installation.

2. The rear edge of the CONTROL board hinges up-wards (toward the front panel). A retaining latch is provided inside the ST8000A cabinet to lock the CONTROL board in Service Position.

___ Swing the CONTROL board vertically and latch it in place.

W A R N I N G

During the time that the CONTROL board (A2) is in Service Position (tilted up), the bottom surface of the CONTROL Board is accessible. While there are NO dangerous voltage exposed, the sharp ends of component leads are exposed. Exercise care to avoid personal scratches or injuries from these sharp component leads.

___ Lift the rear edge of the CONTROL board upwards.

___ Place the retaining latch so that one end mates with the rear mounting hole on the CONTROL board and one end mates with the left rear metal spacer on the MODEM board (lower board, Assembly A1).

The ST8000A may now be operated with the CONTROL board in Service Position.

___ Reconnect the power cable to the rear panel (J3).

The Service Position of the CONTROL circuit board is shown in Figure 5.1.

5.2 ST8000A ALIGNMENT

All internal alignment adjustments are located on the MODEM circuit board (Assembly A1). These alignment controls are all screw-driver adjustments of circuit board mounted potentiometers. ST8000A circuits are stable and do not require re-alignment unless major repairs have been made to the ST8000A (IC replacement, for example). Routine re-alignment is not required and is not recommended.

5.2.1 Alignment Tools and Instruments

1. A small metal flat-blade screw-driver is adequate for all alignment adjustments (Xcelite No. R3322 or R184, for example). A special, insulated blade alignment tool is not required for ST8000A alignment.
2. Audio Voltmeter. The Hewlett-Packard HP411FL AC Voltmeter or equivalent is recommend for all AC voltage measurements.
3. DC Voltmeter. The Fluke Model 77 Digital Multimeter or equivalent is recommended for all DC voltage measurements.
4. The ST8000A internal BIT loop-back feature will be used as the signal generator source.
 - 4a. An external signal generator may be used in place of the ST8000A BIT feature if desired. If so, the generator should be equivalent to the Hewlett-Packard 3311A Function Generator. Set the generator for sine-wave output and connect a frequency counter to the output when setting the frequencies required. Use the AC Voltmeter to set the noted levels at the generator output terminals. The external generator should be connected to pins 10 and 12 of rear panel connector J2 (AUDIO I/O). Either pin may be grounded if required.
5. A remote control ASCII terminal will be used to set ST8000A parameters as noted. Connect the remote terminal as described in INSTALLATION, Section 2.xx. Be sure that the terminal data rate matches settings of switch SWxx on the CONTROL board.
 - 5a. Parameters may also be set using ST8000A front panel keypads if desired. Section 5.2.3 requires use of a BIT test feature.
6. An Oscilloscope is used to balance the high-speed detector circuit. This is a visual adjustment and does not require precise claibration of the oscilloscope vertical (voltage) or horizontal axis (time). A Tektronix Model 465 or equivalent unit is recommended, set as described in Section 5.2.10 (2).

Test points and control adjustments used in the following sections are shown in Figure 5.2.

5.2.2 Preliminary Test

First, confirm that the ST8000A is correctly operating by running the Built-In-Test (BIT) routine. If you have any doubts about the outcome of any BIT step, please refer to Section 5.4 for a complete discussion of the BIT feature. Normally, the BIT routine will run without any error indication.

___ Turn the ST8000A AC Power switch to ON.

___ Run BIT from the front panel by pressing the "2nd" and then the "BIT" keypads.

___ If BIT fails, discontinue alignment and refer to Chapter 6.

5.2.3 Confirm DC Power Supply Voltages

5.2.3.1 POWER SUPPLY (A4) Voltages

Refer to Figure 5.2 and locate connectors A4J2, A4J3, and A4J4 on the POWER SUPPLY circuit board (Assembly A4). Confirm the presence of the following voltages on these connectors:

TABLE 5.1
DC VOLTAGES AT POWER SUPPLY

CONN	PIN	VOLTAGE	TOLERANCE
A4J2	1	+5 VDC	+0.25 VDC
A4J2	2	+5 VDC	+0.25 VDC
A4J2	3	+8 VDC	+0.25 VDC
A4J2	4	-8 VDC	+0.25 VDC
A4J2	5	0 VDC	+0.05 VDC
A4J2	6	0 VDC	+0.05 VDC
A4J3	1	+5 VDC	+0.25 VDC
A4J3	2	+5 VDC	+0.25 VDC
A4J3	3	+8 VDC	+0.25 VDC
A4J3	4	-8 VDC	+0.25 VDC
A4J3	5	0 VDC	+0.05 VDC
A4J3	6	0 VDC	+0.05 VDC
A4J4	6	0 VDC	+0.05 VDC
A4J4	1	+5 VDC	+0.25 VDC
A4J4	2	+5 VDC	+0.25 VDC
A4J4	3	+8 VDC	+0.25 VDC
A4J4	4	-8 VDC	+0.25 VDC
A4J4	5	0 VDC	+0.05 VDC
A4J4	6	0 VDC	+0.05 VDC

If any of these voltage are out of tolerance or not found, discontinue alignment and refer to Chapter 6, MAINTENANCE.

5.2.3.1 MODEM (A1) Voltages

Locate power connector A1J17 on the MODEM circuit board (Assembly A1). Confirm the presence of the following power supply voltages on this connector.

TABLE 5.2
DC VOLTAGES AT MODEM

CONN	PIN	VOLTAGE	TOLERANCE
A1J17	1	+5 VDC	± 0.25 VDC
A1J17	2	+5 VDC	± 0.25 VDC
A1J17	3	+8 VDC	± 0.25 VDC
A1J17	4	-8 VDC	± 0.25 VDC
A1J17	5	0 VDC	± 0.10 VDC
A1J17	6	0 VDC	± 0.10 VDC

If any of these voltage are out of tolerance or not found, discontinue alignment and refer to Chapter 6, MAINTENANCE.

5.2.3.3 CONTROL (A2) Voltages

Locate power connector A2J6 on the CONTROL circuit board (Assembly A2, in "Service Position"). Confirm the presence of the following power supply voltages on this connector.

TABLE 5.3
DC VOLTAGES AT CONTROL

CONN	PIN	VOLTAGE	TOLERANCE
A2J6	1	+5 VDC	± 0.50 VDC
A2J6	2	+5 VDC	± 0.50 VDC
A2J6	3	+8 VDC	± 0.25 VDC
A2J6	4	-8 VDC	± 0.25 VDC
A2J6	5	0 VDC	± 0.15 VDC
A2J6	6	0 VDC	± 0.15 VDC

If any of these voltage are out of tolerance or not found, discontinue alignment and refer to Chapter 6, MAINTENANCE.

5.2.3.4 FRONT PANEL (A3) Voltages

Locate power connector A3J3 on the FRONT PANEL circuit board (Assembly A3, vertical, behind cabinet front panel). Confirm the presence of the following power supply voltages on this connector.

TABLE 5.4
DC VOLTAGES AT FRONT PANEL

CONN	PIN	VOLTAGE	TOLERANCE
A3J3	1	+5 VDC	± 0.50 VDC
A3J3	2	+5 VDC	± 0.50 VDC
A3J3	3	+8 VDC	± 0.25 VDC
A3J3	4	-8 VDC	± 0.25 VDC
A3J3	5	0 VDC	± 0.15 VDC
A3J3	6	0 VDC	± 0.15 VDC

If any of these voltage are out of tolerance or not found, discontinue alignment and refer to Chapter 6, MAINTENANCE.

5.2.4 BIT Calibration [Schematic A1787]

1. Set-up ST8000A and BIT parameters.

 Connect a terminal to the ST8000A REMOTE port (rear panel connector J4).

 Set the following parameters:

```
CHANNEL      = 1
MARK         = 2000 Hz
SPACE        = 3000 Hz
BAUD         = 50
POLARITY     = NORMAL

CHANNEL      = 2
MARK         = 2000 Hz
SPACE        = 3000 Hz
BAUD         = 0 (Continuous MARK output tone)
POLARITY     = NORMAL
BIT          = -20 dBm LOOPBACK
```

The above commands connect the modulator output to the demodulator input, set the modulator and demodulator frequencies to 2000 Hz (Mark) and 3000 Hz (Space), and set the modulator output for a continuous Mark signal. The Mark demodulator filter is set to minimum bandwidth ("Q" = 33.6).

2. Calibrate BIT Output level.

 Connect the AC Voltmeter to TP1 (near U1). Adjust control R1 (near U1) for a voltmeter reading of -20.0 dBm \pm 0.1 dB.

Use these settings for the following Mark filter alignment.

5.2.5 MARK Filter Alignment [Schematics A1788 & A1789]

1. Confirm operation of stages U2b and U2a.

___ Connect the AC Voltmeter to TP2 (near U2) and measure -10.5 dBm ± 0.5 dB (232 mV ± 10 mV).

2. Align stage U10a.

___ Connect the AC Voltmeter to TP11 (near U19). Adjust control R52 (near U10) for a maximum AC Voltmeter reading. The AC voltage at maximum should be -11.0 dBm ± 0.5 dB (210 mV ± 10 mV).

3. Align stage U10b.

___ Connect the AC Voltmeter to TP13 (near U19). Adjust control R63 (near U10) for a maximum AC Voltmeter reading. The AC voltage at maximum should be +6 dBm ± 0.5 dB (1.62 V ± 0.1 V).

5.2.6 SPACE Filter Alignment [Schematics A1790 & A1791]

1. Set-up BIT and ST8000A parameters.

___ Change the ST8000A parameters to:

```

CHANNEL      = 1
MARK         = 3000 Hz
SPACE       = 2000 Hz
BAUD        = 50
POLARITY    = NORMAL
CHANNEL     = 2
MARK         = 3000 Hz
SPACE       = 2000 Hz
BAUD        = 0 (Continuous MARK output tone)
POLARITY    = REVERSE
BIT         = -20 dBm LOOPBACK

```

The above commands connect the modulator output to the demodulator input, set the modulator and demodulator frequencies to 2000 Hz (Space) and 3000 Hz (Mark), and set the modulator output for a continuous Space signal. The Space demodulator filter is set to minimum bandwidth ("Q" = 33.6).

2. Align stage U3a.

___ Connect the AC Voltmeter to TP8 (near U13). Adjust control R69 (near U3) for a maximum AC Voltmeter reading. The AC voltage at maximum should be -11.0 dBm ± 0.5 dB (210 mV ± 10 mV).

2. Align stage U3b.

___ Connect the AC Voltmeter to TP7 (near U13). Adjust control R82 (near U3) for a maximum AC Voltmeter reading. The AC voltage at maximum should be +6 dBm ± 0.5 dB (1.62 V ± 0.1 V).

5.2.7 Bar Graph Alignment [Schematic A1801]

1. Set-up BIT and ST8000A parameters.

___ Change the ST8000A parameters to:

```
CHANNEL      = 1
MARK         = 1500 Hz
SPACE       = 2500 Hz
BAUD        = 50
POLARITY    = NORMAL
CHANNEL     = 2
MARK        = 1500 Hz
SPACE       = 2500 Hz
BAUD        = 50
POLARITY    = NORMAL
BIT         = -40 dBm M/S (MARK/SPACE pulses)
FRONT PANEL = CH1
```

The above commands connect the modulator output to the demodulator input, set the modulator and demodulator frequencies to 1500 Hz (Mark) and 2500 Hz (Space), and set the modulator output for alternate Mark/Space data output.

2. Set MARK Bar Graph low level calibration.

___ Viewing front panel bar graphs, adjust control R210 (near U45) so that the MARK bar to the right of the -42 dBm marking is fully lit. The -42 dBm bar should not be ON.

3. Set SPACE Bar Graph low level calibration.

___ Viewing front panel bar graphs, adjust control R215 (near U45) so that the SPACE bar to the right of the -42 dBm marking is fully lit. The -42 dBm bar should not be ON.

5.2.8 AMH and Gain Control Alignment [Schematics A1792 & A1793]

1. Set-up BIT and ST8000A parameters.

___ Change the ST8000A parameters to:

BIT = 0 dBm, M/S
AMH = ON

The settings of controls R156 and R159 interact and it may be necessary to repeat steps (1) and (2) several times to obtain correct alignment.

2. Set AMH 0 dBm level.

___ Set AMH Threshold (SW1) to "0 dBm" (Section 1 = ON).

___ Set AMH Delay (SW2) to 1.0 second (Section 8 = ON).

___ Locate control R159 (near U27). Rotate this control to its full CCW (counter clock-wise) position. Do this step only on the first adjustment of AMH calibration. Do not repeat this step on subsequent repeat adjustments.

___ Watching the front panel "AMH" LED, slowly rotate R159 CW (clock-wise) until the AMH LED turns ON. There is a 1 second delay due to the setting of SW2, so adjust R159 carefully and set it so that the AMH LED just turns ON.

3. Set AMH -40 dBm level.

___ Change the ST8000A parameters to BIT = -40 dBm M/S.

___ Change SW1 so that Section 7 = ON (all other sections = OFF).

___ Watching the front panel "AMH" LED, adjust control R156 (near U27) so that the AMH LED just turns OFF. As noted in step (1), there is a 1 second delay between signal change and AMH operation; adjust slowly and carefully.

4. Confirm AMH calibration.

___ The AMH low and high level adjustment interact slightly. It is necessary to repeat steps (1) and (2) until both controls are set correctly. Two or three repeats are all that is required. When repeating step (1), be sure to also change the BIT output to "BIT = 0 dBm, M/S". Change to "BIT = -40 dBm, M/S" for each step (2) test.

___ Cease adjustments when neither R156 or R159 require changing.

5.2.9 MARK and SPACE Offset Adjustment [Schematics A1794, A1795, A1796]

1. Change ST8000A parameters so that there is no signal input.

___ Set BIT = OFF and disconnect all connections to rear panel connector J2.

2. Adjust MARK LP Offset.

___ Connect a DC Voltmeter to TP19.

___ Adjust control R199 (near U38) for a minimum or zero volts DC reading. The zero-signal offset voltage at TP19 should be less than ± 25 mV.

3. Adjust SPACE LP Offset.

___ Connect a DC Voltmeter to TP20.

___ Adjust control R118 (near U31) for a minimum or zero volts DC reading. The zero-signal offset voltage at TP20 should be less than ± 25 mV.

5.2.10 High Speed Demodulator Filter Alignment [Schematic A1799]

The following instructions require stage-by-stage alignment of the High Speed demodulator bandpass filter. The BIT loop-back feature will be used for this alignment.

1. Set-up BIT and ST8000A parameters.

___ Change the ST8000A parameters to:

CHANNEL	=	1
MARK	=	1000 Hz
SPACE	=	2000 Hz
BAUD	=	1200
POLARITY	=	NORMAL
CHANNEL	=	2
MARK	=	1372 Hz
SPACE	=	3000 Hz
BAUD	=	0 (Continuous MARK output tone)
POLARITY	=	NORMAL
BIT	=	-20 dBm LOOPBACK

2. Set-up for bandpass filter alignment.

___ Remove circuit board jumper plugs at J12, J9, and J8.

___ Set these jumper plugs aside for later re-installation.

3. Align 1st BP Filter Stage (U32).

___ Be sure that jumper plug is installed at J11.

___ Connect AC Voltmeter to J12, pin 1.

___ Adjust control R133 (near U32) for a maximum reading. The voltage at maximum should be -20 dBm ± 1.0 dB (78 mV ± 10 mV).

___ Remove jumper plug from J11.

4. Align 2nd BP Filter Stage (U33).

___ Connect test jumper between J11, pin 1, and J12, pin 2.

___ Connect AC Voltmeter to J9, pin 1

___ Change modulator output frequency to 2140 Hz.

CHANNEL = 2
MARK = 2140

___ Adjust control R138 (near U33) for a maximum reading. The voltage at maximum should be -20 dBm ± 1.0 dB (78 mV ± 10 mV).

___ Remove jumper wire.

5. Align 3rd BP Filter Stage (U24).

___ Connect test jumper between J11, pin 1, and J9, pin 2.

___ Connect AC Voltmeter to J8, pin 1

___ Change modulator output frequency to 862 Hz.

CHANNEL = 2
MARK = 862

___ Adjust control R143 (near U24) for a maximum reading. The voltage at maximum should be -20 dBm ± 1.0 dB (78 mV ± 10 mV).

___ Remove jumper wire.

6. Align 4th BP Filter Stage (U15).

___ Connect test jumper between J11, pin 1, and J8, pin 2.

___ Connect AC Voltmeter to TP10.

___ Change modulator output frequency to 2711 Hz.

```
CHANNEL = 2
MARK    = 2711
```

___ Adjust control R95 (near U15) for a maximum reading. The voltage at maximum should be -20 dBm \pm 1.0 dB (78 mV \pm 10 mV).

___ Remove jumper wire.

7. Restore Bandpass Filter to Normal Configuration.

___ Re-install jumper plugs at J11, J12, J9, and J8.

5.2.11 High Speed Detector Alignment [Schematic A1800]

1. Set-up BIT and ST8000A parameters.

___ Change the ST8000A parameters to:

```
CHANNEL = 1
MARK    = 1000 Hz
SPACE   = 3000 Hz
BAUD    = 1200
POLARITY = NORMAL

CHANNEL = 2
MARK    = 1000 Hz
SPACE   = 3000 Hz
BAUD    = 1200 M/S (MARK/SPACE pulses)
POLARITY = NORMAL
BIT     = -40 dBm LOOPBACK
```

2. Adjust H.S. Detector.

___ Connect the oscilloscope vertical input to TP14.

___ Set the oscilloscope controls as follows:

CHANNEL	=	No. 1 (or A)
VERT GAIN	=	0.5 V / div
COUPLING	=	DC
SWEEP RATE	=	1ms / div
TRIGGER	=	Internal, Channel 1

___ View the oscilloscope and adjust controls so that a 0 to +5V square-wave is shown. Note trace levels for "0" and "+5V". Note the mid-voltage level (+2.5 V).

___ Adjust control R150 (near U25) for a symmetrical square wave at TP14 - equal width positive and negative pulses.

___ Increase loop-back level to 0 dBm and check that square wave is still symmetrical (BIT = 0 dBm M/S).

This completes ALL ST8000A internal alignment adjustments. The Modulator Output Level may also be adjusted from the front panel as discussed in Chapter 3, OPERATION. This is a front panel adjustment that may be made at any time and does not require removing the ST8000A from the equipment rack or access to the cabinet interior.

5.2.12 Restore to Operation

___ Turn ST8000A AC Power Switch OFF.

___ Remove all rear panel cable connections from the ST8000A.

___ Visually inspect to be sure that:

- a. SW1 (AMH Threshold) is restored to its pre-alignment setting.
- b. SW2 (AMH Delay) is restored to its pre-alignment setting.
- c. Jumper plugs are installed at J11, J12, J9, and J8.
- d. No tools or jumper wires remain inside the cabinet.

___ Remove the "Service Position" board latch and hinge the CONTROL board back down on top of the MODEM board.

___ Locate and install four (4) 6-32 x 5/16 Phillips head screws to attach the CONTROL board to the MODEM board. Be sure to use a No. 2 Phillips screw-driver and do not over-tighten.

___ Place the top cover back on the cabinet. Note that the ventilation

holes should be along both sides and the front of the ST8000A (not towards the rear).

___ Locate and install sixteen (16) 4-40 x 1/4" flat-head Phillips screws along the perimeter of the top cover. Be sure to use a No. 1 Phillips screw-driver and do not over-tighten.

___ Re-install the ST8000A in its proper rack position, using four (4) 10-32 rack-mounting screws.

___ Re-connect all cables to the ST8000A rear panel connectors. Note labels and be sure that each cable is connected to the correct ST8000A connector. ST8000A connectors are keyed to prevent incorrect connections. Do not force a connector.

___ Turn ST8000A AC Power switch to ON.

___ Press the "2nd" and "BIT" front panel keypads to run BIT. BIT should run without faults.

5.3 ST8000A TEST PROCEDURES

5.4 BUILT-IN-TEST (BIT)