Mastr III P25 Base Station Transmitter Tune-up Procedure

1. Overview

The Mastr III Base Station transmitter alignment is performed in several steps. First, the Transmit Synthesizer module is aligned to the customer frequency. Next, the Base Station is aligned (via electronic potentiometers on the System Module) to set the limiting levels and peak analog frequency deviation. Finally, the digital mode deviation is set on the SitePro (high-speed data) and/or DSP Modem Module (C4FM). No tuning is required on the Power Amplifier, because it is a broadband design with a single low-pass filter covering the entire 136-174 MHz frequency range.

2. Transmit Synthesizer Module Alignment

The Transmit Synthesizer module alignment is performed at the required transmit frequency during installation of the Base Station. Once aligned, no user tune-up is required during normal operation, unless a component is replaced.

2.1. RECOMMENDED TEST EQUIPMENT

The following test equipment is required to test the synthesizer Module:

1. RF signal source for 12.8 MHz, 0 dBm reference (included with item 10)
2. AF Generator or Function Generator
3. Modulation Analyzer; HP 8901A, or equivalent, or a VHF receiver
4. Oscilloscope; 20 MHz
5. DC Meter; 10 meg ohm (for troubleshooting)
6. Power Supply; 13.8 Vdc @ 350 mA 12.0 Vdc @ 25 mA
7. Spectrum Analyzer; 0 - 1 GHz
8. Frequency Counter; 10 MHz - 250 MHz
9. Personal Computer (IBM PC compatible) to load frequency data
10. Service Parts Kit, (TQ0650), (includes software for loading frequency data)

2.2. ALIGNMENT PROCEDURE

1. Set all sections of SW1 to the open position.
2. Apply +13.8 Vdc and -12 Vdc. Verify the current drain on the 13.8 volt supply is <300 mA and the current drain on the -12 volt supply is <20 mA.

   NOTE: Perform step 3 only if any VCO parts or switch SW1 has been replaced. Otherwise go directly to step 4.
3. Program the synthesizer at 175 MHz. Set SW1E and SW1F (4 possible Combinations = both closed, both open, E open and F closed, or E closed and F open) to set Vtest (measured on pin 23A of 96 pin connector) as close to 6.0 volts as possible, but always between 5.5 and 6.5 volts.
4. Set SW1A through SW1D to the appropriate frequency range per Table 1 for the required transmit frequency.
5. Program synthesizer at required transmit frequency for the following three adjustments:
6. Set VR602 for 4.5 kHz peak deviation with a standard modulating signal applied to the audio input.
7. Set VR601 for 4.4 kHz peak deviation with 1.0 Vrms, 10 Hz sine wave audio applied to module AF input.
8. Apply a 10 Hz, 1.4 Volt peak (2.83 volts peak-to-peak) square wave (same peak value as 1.0 Vrms (sine wave) to module AF input. Adjust VR601 slightly for the flattest demodulated

square wave using a modulation analyzer or receiver (no de-emphasis) and an oscilloscope. The maximum net variation in voltage over ½ cycle is 10%.

Table 1 – Transmit Synthesizer Frequency Range Switch Settings

FREQUENCY RANGE (MHz)	SW1A (SW# 1)	SW1B (SW# 2)	SW1C (SW# 3)	SW1D (SW# 4)
160-174	**OPEN**	**OPEN**	**OPEN**	**OPEN**
150-162	**CLOSED**	**OPEN**	**CLOSED**	**OPEN**
142-152	**OPEN**	**CLOSED**	**OPEN**	**CLOSED**
136-143	**CLOSED**	**CLOSED**	**CLOSED**	**CLOSED**

3. Base Station Alignment

3.1. GENERAL

- After the tested modules have been placed in the MASTR III station, make connections to the unit per Figure 1. This procedure assumes the receiver and transmitter modules have been previously tuned and aligned to customer requirements.
- On stations that are assembled less MASTR III power supplies, supply adequate DC power to the station from an external power supply. Adjust the input voltage to the PA to 13.4 VDC ± 0.3 VDC (26.0 ± 0.3 for 800 MHz PAs).
- The signal generator should be connected to the antenna system jack in all but repeater combinations or duplex stations. In repeater stations & EDACS, a separate receive antenna jack is provided.
- For multi-frequency stations, activate the TX Disable switch on the System Module and select the desired receive frequency using the PC.
- The rated system deviations are as follows:
  5.0 kHz Standard (25 kHz IF)
  4.0 kHz NPSPAC
  2.5 kHz Narrow (12.5 kHz narrowband)
- The SQUELCH and VOLUME adjustments should be made for proper operation. Unsquelch the receiver by turning the SQUELCH adjustment counter-clockwise. Verify that unsquelched noise is going to the speaker. Adjust the volume if needed (clockwise to increase level). Set the SQUELCH adjustment for critical squelch as defined in the 344A3700 document. Disable channel guard decode if present.

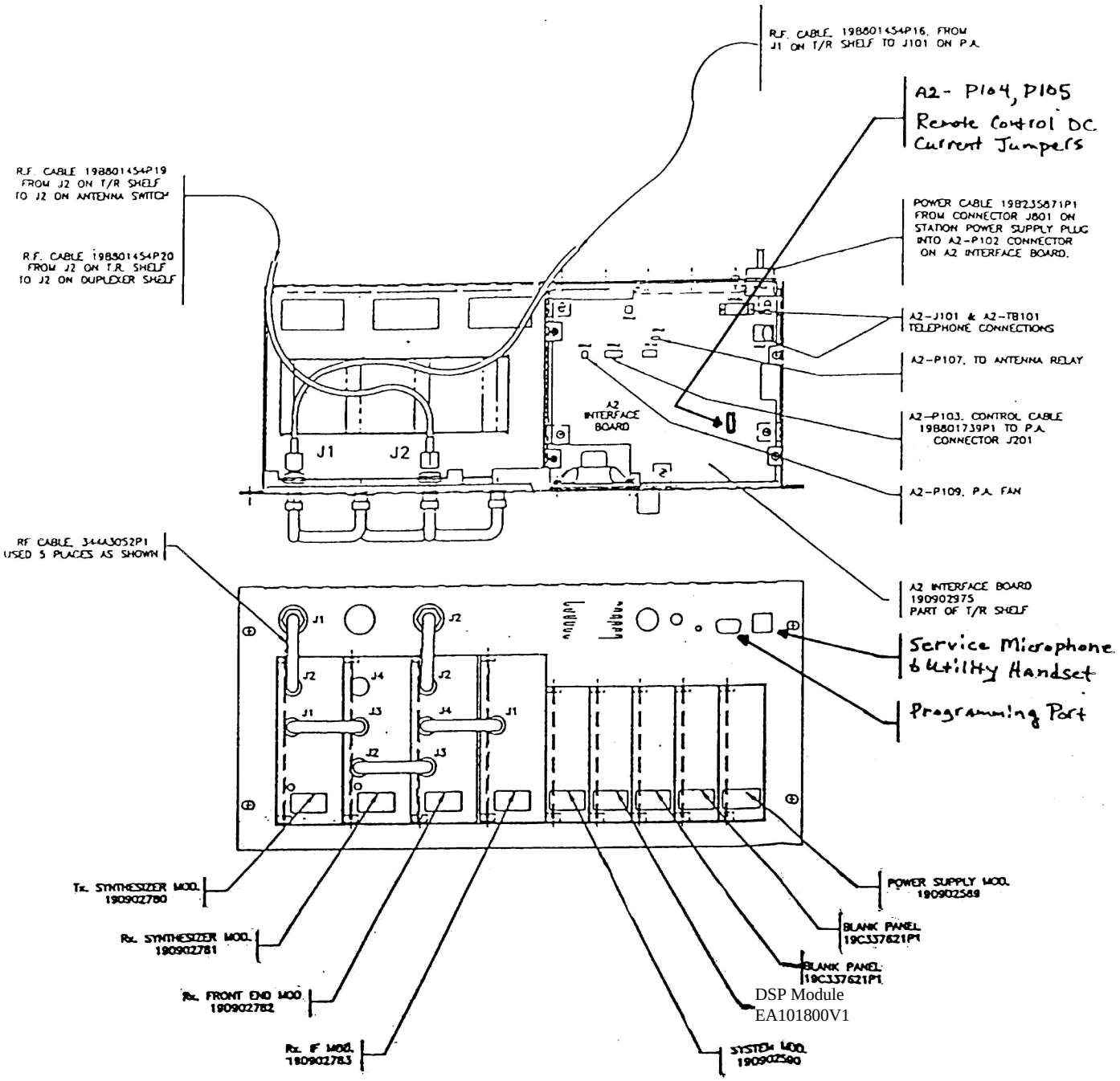

Figure 1 - Base Station Test Setup

3.2. ALIGNMENT PROCEDURE

Terminate Line Input (TB101-3,4), and Line Output (TB101-2,5), with 600 ohms.

3.2.1. Line Input (LI) POT:

Set LI pot to zero (0).

3.2.2. Channel Guard (CG) POT:

If the station is not programmed for channel guard, set the CG pot to zero (0). If the station is programmed with channel guard encode, assert a REMOTE PTT on the System Module. Adjust the CG pot for 750 Hz if a 25 kHz system, 600 Hz if NPSPAC or 500 Hz if a 12.5 kHz system; of channel guard TX deviation. Remove the REMOTE PTT. Repeat this step for each frequency with channel guard.

3.2.3. Transmit Limiter (TX) POT:

Preset the following pots as indicated;

RG (Repeater Gain)	- 1023
CT (Compressor Threshold)	- 5000
CP (Compressor gain Pot)	- 1023
DLI (Dsp Line Input)	- 100.

Place a 0 dBm (775 mVrms), 1000 Hz tone on the line input. Key the station by executing a REMOTE PTT. Adjust the TX pot to a value which results in 4500 Hz (for 25 kHz systems) or 3600 Hz for NPSPAC or 2250 Hz (for 12.5 kHz systems),of TX deviation at the transmitter. Remove the tone from the line input and the REMOTE PTT. Repeat this step for each channel.

3.2.4. Repeater Gain (RG) POT:

If not a repeater station, leave the RG pot at 1023.
If a repeater station, apply a RF signal to the receiver modulated at 60% of rated system deviation by a 1 kHz tone. Adjust the RG pot for 3000 Hz for Standard, 2400 Hz for NPSPAC or 1500 Hz for 12.5 kHz channels, of TX deviation. Set to 3750 Hz for standard, 3000 Hz for NPSPAC or 2000 Hz for 12.5 kHz systems, of TX deviation if channel guard is enabled. Remove the signal from the receiver.

3.2.5. DSP Line Input (DLI) POT:

If not a remote station, set the DLI pot to zero (0).
If a remote station, place a -10 dBm (245 mVrms), 1000 Hz tone on the line input. Key the station by executing a REMOTE PTT. Adjust the DLI pot for 2800 Hz TX deviation if standard or 2250 Hz if NPSPAC or 1400 HZ if Narrowband. If channel guard is enabled, set to 3550 Hz for standard, 2850 if NPSPAC or 1900 Hz if 12.5 kHz system, of TX deviation if channel guard is enabled. Remove the signal from the line input and the REMOTE PTT.

3.2.6. Compressor Gain (CP) POT:

If not a remote station, set the CP pot to zero (0).
If a remote station, place a -10 dBm (245 mVrms), 1000 Hz tone on the line input. Key the station by executing a REMOTE PTT. Adjust the CP pot for 3000 Hz for standard systems or 2400 HZ if NPSPAC or 1500 Hz for 12.5 kHz systems, of TX deviation. Set to 3750 Hz if standard or 3000 Hz if NPSPAC or 2000 Hz for 12.5 kHz systems of TX deviation if channel guard is enabled. Remove the signal from the line input and the REMOTE PTT.

3.2.7. Compressor Threshold (CT) POT:

If not a remote station, set the CT pot to zero (0).
If a remote station, place a 0 dBm (775 mVrms), 1000 Hz tone on the line input. Key the station by executing a REMOTE PTT. Decrease the CT pot for 4000 Hz for standard systems or 3200 Hz if NPSPAC or 2000 Hz for 12.5 kHz

systems, of TX deviation. Remove the signal from the line input and the REMOTE PTT.

3.2.8. DSP Cancellation (DC) POT:

If a 2 wire, tone remote station, set the DC pot to 75.
In all other configurations, set the DC pot to zero (0).

3.2.9. Line Output (LO) POT:

If not a remote station, set the LO pot to zero (0).
To perform receiver tests on a remote station, the LO level may be set to 0 dBm into a 600 ohm load. After these tests are completed, return the LO pot to zero.
If a remote station, apply a RF signal to the receiver modulated at 60% of rated system deviation by a 1 kHz tone. Set the LO pot for a 0 dBm (775 mVrms) line output level as measured into a 600 ohm load. Remove the signal from the receiver.
If a channel guard station, re-enable Channel Guard Decode.

Note: 1) the line input is terminated to prevent line audio deviation while adjusting channel guard deviation.

4. SitePro Alignment

This section applies when a SitePro is used for controlling the Base Station.

4.1. POWER UP SEQUENCE

Verify connections as shown in the test hook-up diagram, Figure 2.
Connect AC power to the rack under test. Turn on DC power to the MIII Station and Sitepro channels under test. Verify that the Fault indicators on the Mastr III station are off. At this point LED's and the display have very little meaning.

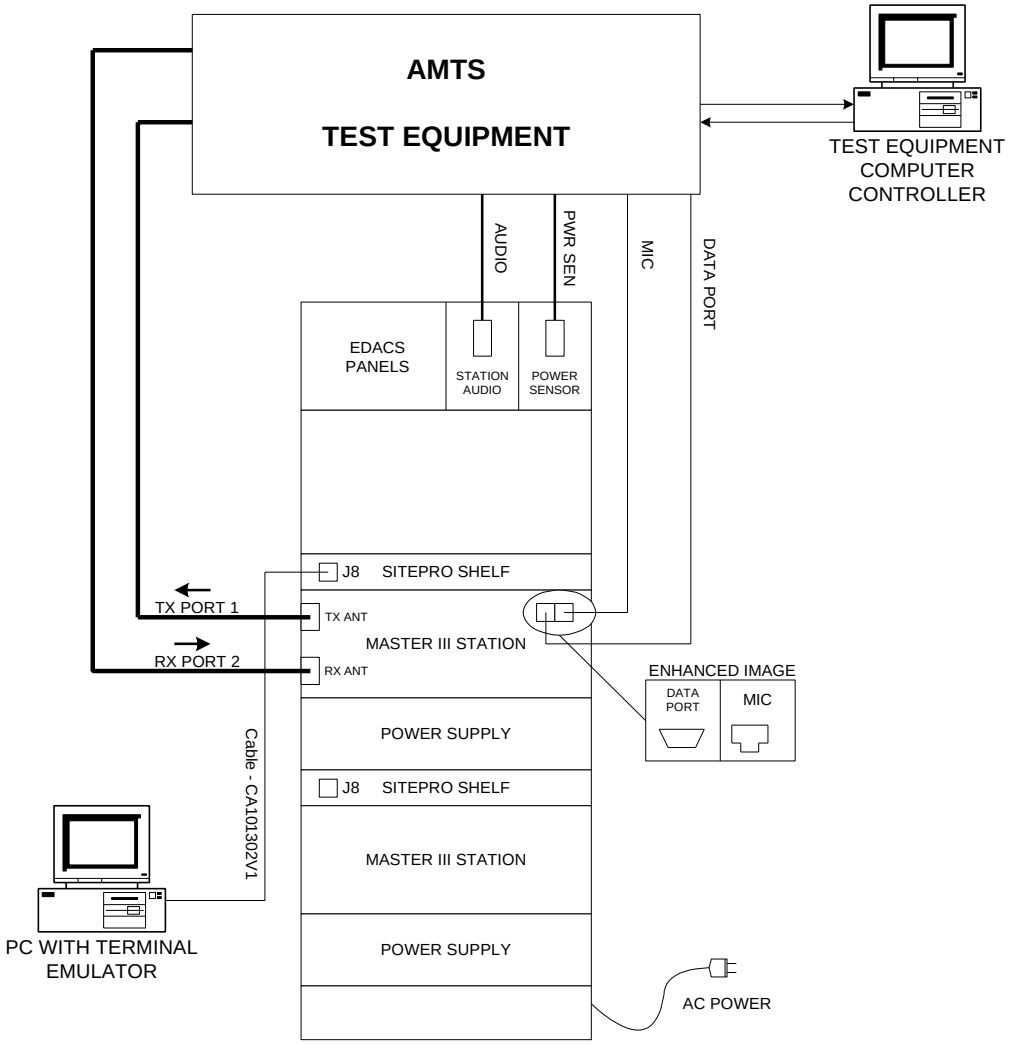

Figure 2 – Site Pro Alignment Setup

4.2. START SITEPRO TEST

If the station is for Simulcast (option MDIG), the "bypass" lead, J13-20 on the rear of the SitePro shelf, must be connected to ground before beginning tests.

4.3. POT ALIGNMENT FOR EDACS

A Standard Test tone is defined as 245mV rms or -10 dBm across 600 ohm. The maximum test tone is defined as 775mV rms or 0 dBm into 600 ohm.

Rated system deviation is: 5.0 kHz Standard 25 or 30 kHz spaced systems
4.0 kHz NPSPAC systems
2.5 kHz Narrow (12.5 kHz) systems

4.4. PRE-SET STATION

4.4.1. Terminations

Terminate the Line Input (TB101-3,4) with a 600 ohm load. Terminate the Line Output (TB101-2,5) when it is not being used for measurement. Terminate the output of the transmitter with a 150 Watt, 50 ohm load.

4.4.2. Pots

Function	AMTS Default Value
Repeater Gain (RG)	- 1023
Compressor Threshold (CT)	- 5000 (32767 if Simulcast)
Compressor Gain (CP)	- 1023
DSP Line Input (DLI)	- 100

4.4.3. Station Test Mode

The SITEPRO is placed in the test mode of operation by connecting an ASCII terminal to the Controller front panel debug port (J8) and typing the command 'TEST' followed by return. Successful entry into Test Mode is indicated by the serial port prompt '>' and the message "TESTMODE" displayed on the front LED display (if present). The Test Mode provides a primitive set of commands used for controlling High Speed Data, Low Speed Data and Conventional operation. Most commands are terminated with the 'STP' command.

4.4.4. Switch Definition

In a Simulcast Control Point, where the SitePro Controller is installed in a VME shelf, the Controller DIP switch is used to define the channel address.

In a Basic or Simulcast Transmit station, where the SitePro Controller is installed in a horizontal shelf, the Controller DIP switch is used to define the initial channel address. During the station alignment procedure, the channel (along with other parameters) will be stored in non-volatile memory on the analog board. Thereafter, the dipswitch setting is ignored. This allows the Controller board to be swapped without altering previously programmed parameters.

No other parameters are defined through the DIP switch.

4.4.5. Terminal Hook-Up

An ASCII terminal is used to communicate with the SITEPRO to enable it to perform testing and alignment of the EDACS base station. Use interface cable CA101302V1.

The SITEPRO serial communication parameters are as follows:

Hardware protocol RS-232C via debug port J8

Terminal settings 38.4 Kbaud, 8 data bits, 1 stop bit, no parity, upper case

4.5. RECEIVER LINE OUTPUT POT ALIGNMENT (LO)

While in Test Mode, type the command 'CON' to invoke the conventional repeater mode of operation.

Apply an "on channel" RF signal to the receiver at a steady signal level of -47 dBm or 1mV, with a 1 kHz tone at 60% of the rated system deviation.

Adjust the LO pot for -10 dBm across 600 ohm or 775mV at the line output (TB101-3,4 on the interface board).

Type 'STP' to exit conventional repeater mode.

Table 2 - Transmitter Pot Alignment

Transmitter Pot Alignments					
		System Bandwidth			
Test Number	Pot Name	25/30 kHz 5 kHz sys dev	20 kHz (NPSPAC) 4 kHz sys dev	12.5 kHz (4800 baud) 2.5 kHz sys dev	12.5 kHz (9600 baud) 2.5 kHz sys dev
12.1	CG	750 ± 25 Hz	600 ± 25 Hz	500 ± 15 Hz	500 ± 15 Hz
12.2	TX	4500 ± 100 Hz	3600 ± 100 Hz	2250 ± 50 Hz	2250 ± 50 Hz
12.3	RG	3000 ± 100 Hz	2400 ± 100 Hz	1500 ± 50 Hz	1500 ± 50 Hz
12.4	DLI	3000 ± 100 Hz	2400 ± 100 Hz	1500 ± 50 Hz	1500 ± 50 Hz
12.5A	SITEPRO	3000 ± 200 Hz	2400 ± 200 Hz	1800 ± 100 Hz	2350 ± 100 Hz
12.5B	SITEPRO	3000 ± 200 Hz	2400 ± 200 Hz	1800 ± 100 Hz	2350 ± 100 Hz
12.5C	SITEPRO	2700 ± 200 Hz	2200 ± 200 Hz	1600 ± 100 Hz	2150 ± 100 Hz
12.6	DLI	3000 ± 100 Hz	2400 ± 100 Hz	1500 ± 50 Hz	1500 ± 50 Hz
12.7.1A	DLI	2800 ± 100 Hz	2200 ± 100 Hz	1400 ± 100 Hz	1400 ± 100 Hz
12.7.1B	CP	3000 ± 100 Hz	2400 ± 100 Hz	1500 ± 100 Hz	1500 ± 100 Hz
12.7.2	CT	4000 ± 100 Hz	3200 ± 100 Hz	2000 ± 50 Hz	2000 ± 50 Hz
14.2	SITEPRO	2700 Hz	2200 Hz	1850 ± 100 Hz	2150 ± 100 Hz
14.3	CG	750 Hz	600 Hz	500 Hz	500 Hz
14.4	TX Deviation	3000 Hz	2400 Hz	1500 Hz	1500 Hz

4.6. Transmitter Pot Alignment:

Use Table 2 for deviation limits.

4.6.1. LOW SPEED DATA - CHANNEL GUARD (CG)

While in Test Mode, type the command ‘LSD 4’ and ‘RFT 1’ to generate Low Speed Data and key up the transmitter.

Ensure the receiver is squelched during this alignment else receiver audio will be routed to the transmitter.

Adjust the CG pot for the transmitter deviation limit specified in test 12.1 in Table 2

Note: Leave the low speed data on while setting the transmit limiter because the two deviations are independent of each other and are summed together for total output deviation.

Type the command ‘STP’ to terminate test.

4.6.2. TRANSMIT LIMITER - TRANSMIT POT (TX)

While in Test Mode, type the command ‘LSD 4’ and ‘CON’ to generate Low Speed Data and invoke Conventional Repeat mode.

The Transmit (TX) pot adjusts the limit of the deviation level for all audio into the transmitter except CG/LSD. Apply a 1000 Hz tone at 0 dBm or 775mV rms to the line input (TB101-2, 5 on the interface board).

Adjust the transmit deviation limit (TX) pot for desired system deviation maximum or the limit specified in test 12.2 in Table 2.

4.6.3. REPEATER GAIN (RG)

While in Test Mode, type the command ‘LSD 4’ and ‘CON’ to generate Low Speed Data and invoke Conventional Repeat mode.

The Repeater Gain pot sets the gain from the receiver audio to the modulation input to the transmitter. This pot is normally set for unity gain. Apply an "on channel" RF signal to the receiver at a steady signal level of -47 dBm or 1mV, with a 1 kHz tone at 60% of rated system deviation (Omit this test for Simulcast Transmit Site)

Measure the transmitter deviation and adjust the Repeater Gain (RG) pot in the Mastr III System Module for the limit specified in test 12.3 in Table 2.

4.6.4. LINE INPUT SENSITIVITY - DSP LINE INPUT (DLI)

The DSP Line Input (DLI) pot adjusts the transmitter deviation sensitivity to audio on the line input. Apply a 1000 Hz tone at -10 dBm or 245mV rms to the line input (TB101-2,5 on the interface board).

Adjust the DSP Line Input (DLI) pot for the limit specified in test 12.4 in Table 2.

4.6.5. HIGH SPEED DATA DEVIATION

While in test mode, type the command ‘HSF dd’ to choose the correct high speed filter for the system under test.

dd	Filter
0	9600 baud WB
1	4800 baud NB
2	9600 baud WB ETSI
3	4800 baud NB ETSI
4	9600 baud NB

While in Test Mode, type the command ‘RFT 1’ and ‘HSD FF’ to key up the transmitter and generate High Speed Data random data at 9600 baud (4800 baud for some systems).

The High Speed Data Deviation is set using the command ‘HSL xx’, where xx is a hexadecimal value from 00 to FF (ie 0 to 255). Refer to Fig. 2 for waveform. In this test, no other signals (receiver, line in) are transmitted.

Measure the transmitter deviation and execute the HSL command as required for the deviation limit specified in test 12.5A in Table 2 above.

4.6.6. BYPASS DEVIATION (SIMULCAST ONLY)

While in Test Mode, type the command ‘LSD 4’ and ‘CON’ to generate Low Speed Data and invoke Conventional Repeat mode.

Ground the Bypass lead, J13-20 on the rear of the SitePro shelf.

In Bypass mode the receiver audio is routed back from the line output on the SITEPRO Interface card by the Bypass relay to the modulation input to the transmitter. Apply an "on channel" RF signal to the receiver at a steady signal level of -47 dBm or 1mV, with a 1 kHz tone at 60% of rated system deviation.

Measure the transmitter deviation. If necessary adjust the DSP Line Input (DLI) pot. The deviation should be as specified in test 12.6 in Table 2.

4.6.7. COMPRESSOR

Note: The compressor is not necessary for systems with no remote audio into the station through the line input (omit for Simulcast). If compression is not desired, omit this section and leave the compressor gain (CP) and compressor threshold (CT) pots set to their pre-set values.

The compressor in the station is adjusted by applying a standard test tone and reducing the line input sensitivity (DSP Line Input) by an amount that will produce 1 dB compression after the gain and threshold are set. Next the compressor gain is increased to bring the deviation back up to normal. The tone is then increased to the maximum test tone to put the deviation into limiting and the compressor threshold is adjusted down to the desired level.

4.6.7.1. Compressor Gain (CP)

While in Test Mode, type the command 'LSD 0' and 'CON' to kill Low Speed Data and invoke Conventional Repeat mode.

Apply a 1000 Hz tone at -10 dBm or 245mV rms to the line input (TB101-2, 5 on the interface board).

Adjust the DSP Line Input (DLI) pot for the limit specified in test number 12.7.1A of Table 2

Adjust the Compressor Gain (CP) pot for the limit specified in test 12.7.1B of Table 2.

4.6.7.2. Compressor Threshold (CT)

Apply a 1000 Hz tone at 0 dBm or 775mV rms to the line input (TB101-2, 5 on the interface board).

Adjust the Compressor Threshold (CT) pot for the desired compression level or the limit specified in test 12.7.2 of Table 2.

4.6.8. LOW PA POWER ALARM THRESHOLD

Key the station using the REM PTT switch on the front panel. Using the PA power (PA) pot, adjust the output power of the PA to the level that is desired to be the alarm threshold (25W standard). Note the decimal value of the TX Meter. Enter this value for the alarm "ON" threshold (do not use the same number for alarm "OFF", i.e.: On-111, Off-110). Remove the REM PTT.

4.6.9. PA OUTPUT POWER

Key the station using the REM PTT switch on the front panel. Using the PA power (PA) pot, adjust the output power of the PA to the appropriate rated output power level. Remove the REM PTT.

5. DSP Modem Module Alignment

5.1. General

Deviation for C4FM mode is controlled by the DSP Module and programmed using an RS-232 link via the T/R Shelf DSP Port. This alignment must be performed after the Base Station has been aligned.

5.2. Recommended Test Equipment

1. Modulation Analyzer; HP 8901A, or equivalent, or a VHF receiver

2. Personal Computer (IBM PC compatible) to load frequency data
3. DSP Module Programming Software

5.3. Alignment

1) Install the DSP Module Programmer software per its programming requirements.
2) Disconnect the Transmit Synthesizer RF Output from the Power Amplifier, and connect the RF output of the Transmit Synthesizer module to the RF input of the modulation analyzer to monitor the FM deviation.
3) Connect the programming PC to the TR shelf DSP Port with an RS-232 cable.
4) From the DSP Module Programmer menu or tool bar choose DEVICE->PERSONALITY->DOWNLOAD to obtain the current personality saved in the DSP Module or FILE->OPEN to get a personality from the PC hard drive.
5) Set the Transmit Test Mode for High Deviation Dotting Pattern. From the Programmer menu or tool bar choose DEVICE->PERSONALITY->UPLOAD. NOTE: Recycling Power is not required.
6) Observe that the base station is transmitting. Measure the deviation of the P25 High Pattern.
7) If the deviation is not 2826 +/- 25 Hz, then adjust the High Deviation personality parameter. A higher number increases the deviation.
8) From the Programmer menu or tool bar choose DEVICE->PERSONALITY->UPLOAD. NOTE: Recycling Power is not required.
9) Repeat steps 6 – 8 until the deviation meets the specification in Step 7.
10) Set the Transmit Test Mode for Disabled (Normal Operation). From the Programmer menu or tool bar choose DEVICE->PERSONALITY->UPLOAD.
11) Verify that the Station is no longer in transmit mode.
12) Disconnect the Modulation Analyzer and reconnect the Transmit Synthesizer RF output to the Power Amplifier.