MAINTENANCE MANUAL
ALIGNMENT PROCEDURES
FOR
SIMULCAST

TABLE OF CONTENTS

INTRODUCTION

The following **SIMULCAST** equipment alignment procedures are with respect to each RF channel. To align the system properly, the adjustments should be completed in the following order. Read entire procedure before beginning.

1. Tektronix 2430A Digital Storage Oscilloscope **Start-up Procedure**
2. Tektronix 2430A Digital Storage Oscilloscope **Amplitude Measurement** From Test Receiver Start-up Procedure
3. Tektronix 2430A Digital Storage Oscilloscope **Phase Measurement** From Test Receiver Start-up Procedures
4. Exciter Deviation Adjustment
5. Audio Variable Delay/Audio Phase Amplitude Equalizer Pre-Alignment
6. Phase Equalization Adjustment
7. Amplitude Equalization Alignment
8. Analog Delay Check
9. Clock Reference Edge Check
10. 300 Hz Reference Polarity Check
11 Digital Delay Check

ERICSSON

TOOLS AND TEST EQUIPMENT

1. Tektronix 2430A Digital Storage Oscilloscope with option 1R. Configure scope for rack mount. If a plotter is desired, the HP100 - color pin plotter and option 01 - GPIB cable is recommended.

2. Hewlett Packard HP3575A Gain/Phase Meter with options 001 Dual Readout/Dual Outputs and 908 rack flange kit.

3. Hewlett Packard 8116 Pulse/Function Generator with option 001 Burst and Logarithmic Sweep and HP5061-9672 rack mount kit.

4. Delay Line panel.

5. Balun Panel assembly.

6. IFR Systems Inc. - Communications Service Monitor FM/AM 1200S with Spectrum Analyzer.

7. Miscellaneous Test Leads:

Length	Connectors	Quantity
10-inch plus	BNC to BNC	4
13-inch plus	BNC to BNC	1
18-inch plus	BNC to BNC	2
40-inch plus	BNC to jack plug	2
10-inch plus	BNC to Banana	1
18-inch plus	BNC Male to Banana Female	2
40-inch plus	Banana to jack plug	1

TEKTRONIX 2430A DIGITAL STORAGE OSCILLOSCOPE START UP PROCEDURE

Refer to the TEK Operations Manual No. 070-6286-00, Product Group 37. Read Sections 1, 4 and 5 of the Tektronix manual.

NOTE

If this procedure has been performed at any time and the Tektronix 2430A Oscilloscope has "saved," then performing the following steps will not be necessary.

1. Perform all five steps of the Starting Setup procedures as outlined in Checks and Adjustments section of the Tektronix manual.

2. Press the **SETUP PRGM** front panel button.

3. Press the bezel button labeled **SAVE**.

4. Enter the word "**START**" using the menu buttons.

5. Press the bezel button labeled **SAVE**.

6. Press the **SETUP PRGM** front panel button. After the PRGM button is pressed, the **SET STEP ACTIONS** menu will be displayed.

7. Use the arrow labeled bezel buttons and the **Y:N** (yes:no) menu button select **<Y>** for the following labels: **SELF-CAL**, **SELF-TEST**, **BELL** and **PROTECT**. Set all others to **<N>**.

8. Select **SAVE SEQ** menu button.

TEKTRONIX 2430A DIGITAL STORAGE OSCILLOSCOPE AMPLITUDE MEASUREMENT FROM TEST RECEIVER START UP PROCEDURE

NOTE

If this procedure has been performed at any time and the Tektronix 2430A Oscilloscope set-up for amplitude has been "saved," then performing the following steps will not be necessary.

The required settings and adjustments when measuring and saving the amplitude signals from the test receiver are listed in the following pages. For additional information, refer to the TEK Operations Manual No. 070-6286-00, Product Group 37, Section 5, Table 5-2. Perform the start-up procedures if necessary as outlined in previous pages.

1. Set **VERTICAL** mode controls as follows:
   - **CH1 VOLTS/DIV** to 10 mV/div (approx. 1dB/div gain)
   - **CH2 VOLTS/DIV** to 5 V/div COUPLING (both) to DC
   - **50 Ω** to **OFF**
   - **INVERT** (both) to **OFF**
   - **POSITION** to mid screen
   - Display Mode to **YT**
   - Bandwidth to 20 MHz
   - **SMOOTH** to **ON**

2. Set **TRIGGER** controls as follows:
   - **AB TRIG** to **A**
   - **A TRIG MODE** to Normal
   - **SOURCE EXT** 1÷5
   - **COUPLING** (both) to **DC**
   - **SLOPE** (both) to - (minus)
   - **TRIG POSITION** (both) to 1/4
   - **LEVEL** (both) to 1.00V (trigger source = Ch 2)
3. Set **HORIZONTAL** controls as follows:
   - **MODE** to **A**
   - **A SEC/DIV** to 1 second
   - **POSITION REF** mode to trigger paint "**T**" is at the extreme left side of the screen.
4. Set **STORAGE** control as follows:
   - **ACQUIRE** to **ACQUIRE NORMAL**
   - **DISPLAY REF** in **YT** mode to **HORIZ POS REF**, then to **IND:LOCK**
5. Press **SETUP PRGM** button. Select **SAVE** menu button.
6. Use the menu buttons and arrow keys to enter name: **AMP**. Select **SAVE** menu button. Press **SETUP PRGM** button.
7. After the third-level menu appears, set **BELL**, and **PROTECT** to **<Y>** and set all others to **<N>**.
8. Select **SAVE SEQ** menu button.
9. **NOTE**: When recalling the program set-up, the vertical position is not recalled.

TEKTRONIX 2430A DIGITAL STORAGE OSCILLOSCOPE PHASE MEASUREMENT FROM TEST RECEIVER START UP PROCEDURE

NOTE

If this procedure has been performed at any time and/or the programmable Tektronix 2430A Oscilloscope set-up for phase measurement has been "saved," then performing the following steps will not be necessary.

The following steps outline the required settings and adjustments when measuring and saving the phase signals from the test receiver. For additional information, refer to the TEK Operations Manual No. 070-6286-00, Product Group 37. Perform the start-up procedures if necessary as outlined in previous pages.

1. Display the stored **AMP** signal as outlined in previous pages.
2. Change **CH1 VOLTS/DIV** from 10 mV/div to 500 mV/div.
3. Select **SAVE** menu button.
4. Use the menu buttons and arrow keys to enter name: **PHASE**.
5. Select **SAVE** menu button.
6. Press **SETUP PRGM**.
7. After the third-level menu appears, set **BELL** and **PROTECT** to **<Y>** and set all others to <N>.
8. Select **SAVE SEQ** menu button.
9. **NOTE**: When recalling the program set-up, the vertical position is not recalled.

EXCITER LEVEL ADJUSTMENT

Perform the steps in the order presented. A technician is required at both the control point and at the transmit site to perform this task. Establish a communication link between technicians before starting the procedures. Refer to Figure 1. It is important tht the same (or exactly matched) deviation measurement equipment be used at each site.

1. At the control point, perform the following:
   a. On the control panel, set the following switches:
      - Site 1, transmit control switch 1 (PTT) to **ON**.
      - Site 1, voice control switch 1 (A/D) to **ON**.
      - Site 2 switch 1 and site 3 switch 1, under both transmit control and voice control to **OFF**.
   b. On the 150 baud data select circuit card, set the **TEST ENABLE** switch (**SW2**) to **TEST**.

This is the lower switch located on the front of the data selector; down is the **TEST** position.

2. At the transmit site:

   a. Set the communication service monitor to **FM NAR** operation and tune to receive the RF channel under test.

   b. Observe modulation analog meter on service monitor and adjust R50 on the GE exciter for 0.75 kHz deviation (150 baud data), (.600 kHz if **NPSPAC**).

   c. For checking after initial system installation, a 75 Hz, RS-232 level test signal may be injected on the GETC interface card of the station under test. Remove J4 and inject on Pin 1 (Rev. D or later). Key station manually. The test switch on the 150 baud data selector remains in th "**Normal**" position, allowing normal system operation on the other channels.

3. At the control point (for the site being tested):

   a. Set the pulse/function generator for a -10 dBm, 1 kHz tone (system test tone level).

   b. Insert the -10 dBm signal into the A60X jackfield Tx V audio channel 1 (line) circuit.

   c. Return the test enable switch on the 150 baud data selector to the normal operating position.

4. At the transmit site:

   a. Remove the **FSK** modem from sync unit D100 assembly. This removes the low speed data from all channels.

   b. Remove 16 dB (minimum) of attenuation, on the Receiver end Mux card, for the channel under test.

   c. Set communication service monitor to **FM MID** and observe the display while adjusting R52 in the GE exciter for 3.75 kHz deviation (3.0 kHz if **NPSPAC**).

   d. Replace attenuation removed in (**b**.).

   e. Observe the deviation with the communication service monitor; reading should be 3.0 kHz (±.05) (2.4 kHz if **NPSPAC**). Adjust the equalizer level control for this site to achieve 3.0 kHz (**FM NAR**) (2.4 kHz if **NPSPAC**). **Note**: Mux attenuation removed is nominally set to produce -17 dBm for MII with -10 dBm system level. This normally provides the correct deviation.

   f. Replace the FSK modem.

5. At the control point:

   a. On the control panel, set the site 1 transmit (PTT) control and voice control (A/D) switches to **OFF**.

   b. Remove inhibit lead clips to prevent control channel from moving.

   c. At jackfield D601, patch the control channel data into the channel being set.

6. At the transmit site:

   Adjust R31 on the **GETC** circuit card assembly for 3.0 kHz deviation as observed on the communication service monitor display (2.4 kHz if **NPSPAC**).

7. Repeat procedures for each channel and site. After exciter adjustments have been performed, return all switches on the control panel to the system position.

9.6 kHz CLOCK EDGE REFERENCE CHECK

This checks the 9.6 kHz clock polarity relative to the rising edge of the 300 Hz signal and must be checked at each site. This test determines if Universal Sync card jumpers P8, P12, P16 and P20 are in the correct position. These jumpers must be positioned the same on all Universal Resync cards at a given site. It is possible that their position at one site may be different from their position at another site.

Procedure:

1. At the remote site, remove a Resync card and reinstall it on an extender card. There is less disruption to an operating system if it is not the Master Resync card.

2. Using a dual trace scope:

   a. Channel 1 - probe U32, Pin 1 - 300 Hz reference signal

   b. Channel 2 - probe U12, Pin 16 - 9.6 kHz clock out

   c. Trigger on channel 1

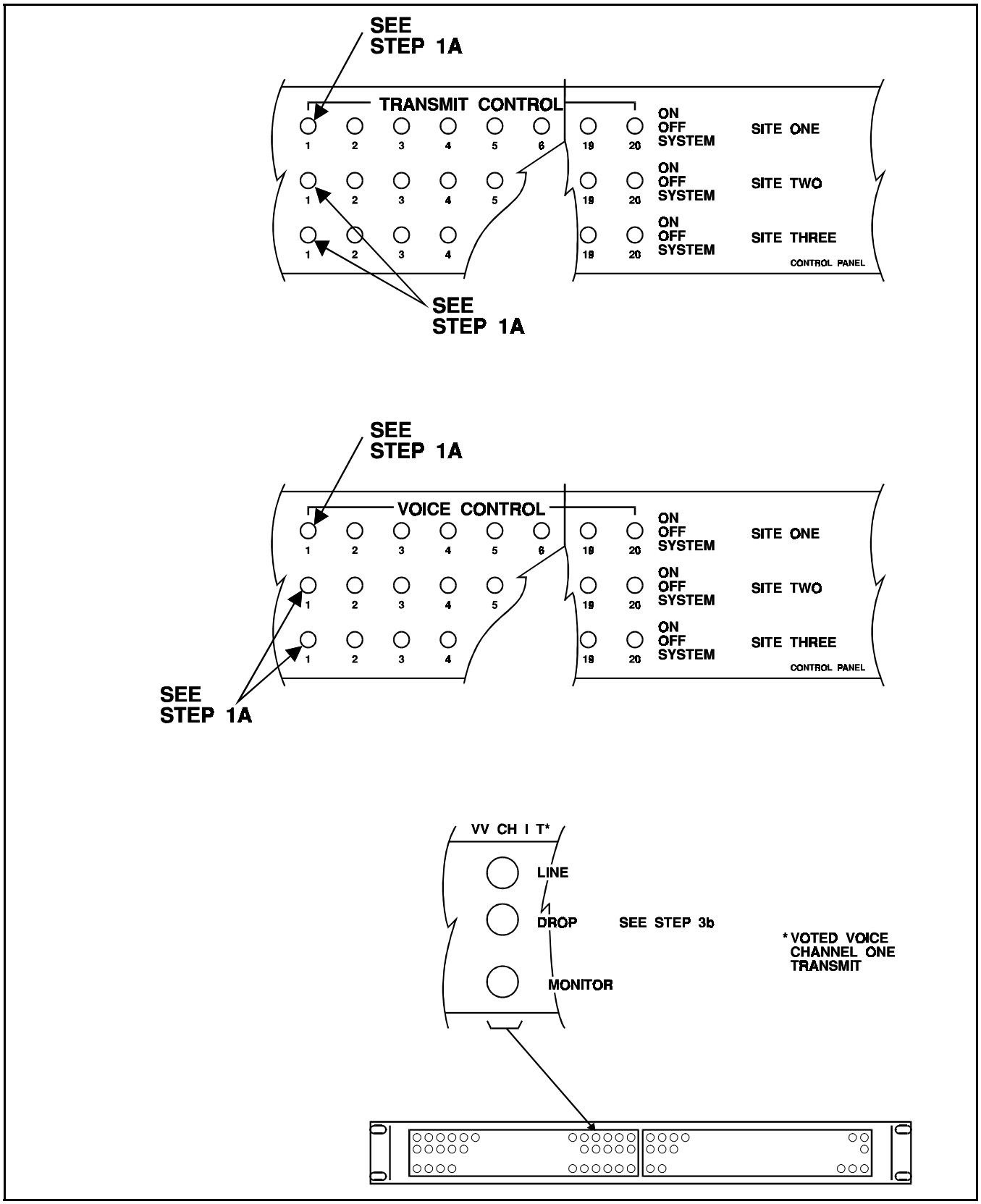

Figure 1 - Exciter Level Adjustment

3. The 9.6 kHz clock out polarity is chosen (using the jumpers) so that the rising edge of the 9.6 kHz clock is as close as possible to the rising edge of the 300 Hz signal. Note that there are only two choices. The four jumpers are one for each channel and all four (P8,P12, P16, & P20) must be installed in the same position on every card at this site.

300 Hz REFERENCE POLARITY CHECK

The polarity of the 300 Hz timing reference must arrive at the transmit site Master Universal Resync Card without an inadvertent inversion in the balanced audio lines. If the following check indicates this reference to a site is inverted from proper polarity, the condition can be corrected by either (1) "flipping" the balanced pair line at either the control end or the transmit end (not both) or (2) moving the position of jumper "J3" on the Tone Interface card at the transmit site in question.

Test Procedure:

1. Connect the Test Delay in series with the Tx modem audio going to the site under test on the Control Channel as shown in Figure 2.

NOTE

The Control Channel data can be patched to a "**Disabled**" channel at the Tx 9.6 data jackfield to minimizes system interruption and the "**Disabled**" channel used for this test.

2. With the test delay at zero (**0**), use delayed sweep on the oscilloscope to display the "**dotting/barker**" region of the Control Channel data (External trigger on **FSL**, discriminator output of the Test Radio set to the proper RF channel). On the test panel only the site under test should have PTT (See Figure 3 for "**dotting/barker**" region and oscilloscope connections. The scope setup may be stored under "DIGTME").

3. Set one cursor at the reference edge, the other cursor 3.3 milliseconds later (allow sufficient time for Resync (up to 56 seconds)).

4. Add one (1) millisecond of delay on the test delay; the edge will reappear after the modem retrains at some random point. Wait for Resync. The reference edge should come back to the first cursor.

5. Increase the delay to 2.5 milliseconds. After retraining and Resync, the reference edge should be at the second cursor. If the reference edge "**Resyncs**" to the first cursor the 300 Hz polarity is inverted going to the site and must be changed.

6. Repeat this test for all sites.

DIGITAL DELAY ADJUSTMENT

Perform the steps in the order presented. Refer to the Figure 3 and Delay Unit Shelf Assembly Maintenance Manual LBI-38941.

1. Connect the test equipment as shown in Figure 3. Patch data from Control Channel to the Test Channel.

2. Starting with the transmit site furthest from the Control Point, on the Control Panel, set the following switches.
   - Furthest site transmit control **ON**.
   - Furthest site voice control **OFF**.
   - All other sites transmit control **OFF**.
   - All other sites voice control **ON**.

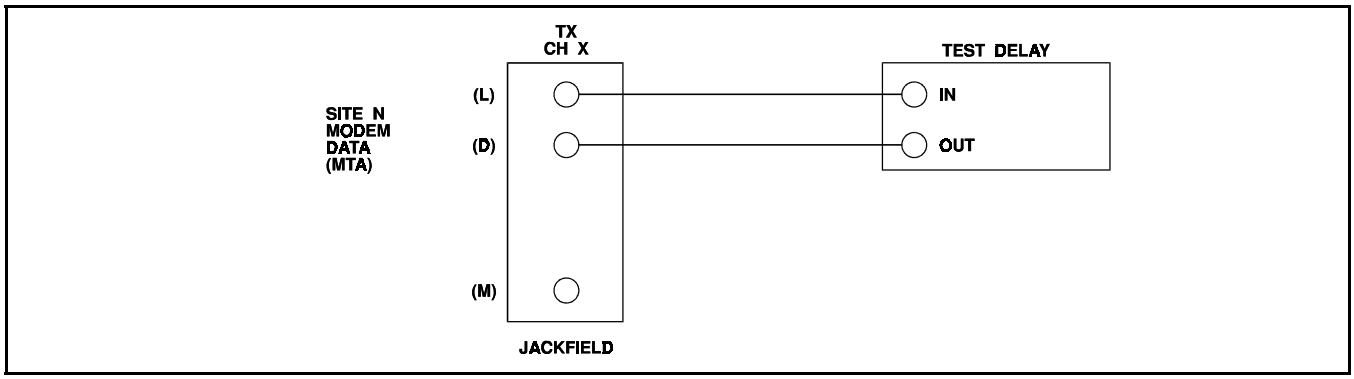

Figure 2 - Test Hook-Up

NOTE

The different equiment delays may cause the geographically most distant site NOT to be electronically the farthest. It is acceptable to start with any site; it is the relative time between sites that must be correct once finished.

3. Set the oscilloscope to view the first "dotting/ barker" region of data after the scope triggers using delayed sweep. Record the time from trigger to a uniquely identifiable zero crossing of data.
4. Set the switches at the control point control Panel as follows:
   - Next site transmit control **ON**.
   - Next site voice control **OFF**.
   - All other sites voice control **ON**, transmit control **OFF**.
5. Observe the oscilloscope display. This site should arrive "**earlier**" than the prior site. Adjust digital delay for this site to move the identified data point out to the time recorded for the prior site.
6. Continue with the remaining sites per procedure.
7. Digital delays are set/adjusted on the Digital Delay Cards. Two sites are on each card. The setting is on a binary weighted dip switch (1.0 µS/bit). Refer to Digital Delay Card adjustment document.
8. These settings must be offset to compensate for the geographic difference in location of the overlap regions and the monitor receiver.
9. It is advisable to patch the Control Channel data to each channel for the site and verify that each "**Resyncs**" to the same place in time.

NOTE

Convex equalizers are factory pre-adjusted for a FLAT response. Do Not pre-adjust. The following pre-adjustment procedures are applicable to Tellabs equalizers only.

AUDIO PHASE AMPLITUDE EQUALIZER PRE-ALIGNMENT

Perform the steps in the order presented. Refer to delay/amplitude equalizer document.

1. At the control point, perform the following:
   a. Preset all controls per manufacturer's instructions.
   b. Mechanically preadjust all 13 Amplitude and all 13 Delay Pots as follows:
      1. Rotate Pot counterclockwise 15 turns.
      2. Rotate Pot clockwise 4 turns.

      This mechanical adjustment "presets" all cards alike and gives a starting point to work from.
2. Repeat for each site on channel 1.
3. Repeat for each channel.

AMPLITUDE EQUALIZATION ALIGNMENT

Perform the steps in the order presented. Refer to the Figure 4. For each site, the amplitude and phase must be iterated until no further adjustment is required. It may be desirable to sweep at a 5 second rate and decrease vertical sensitivity by one position for initial iterations.

1. Perform the digital oscilloscope start-up and amplitude measurement procedures as outlined on previous pages or recall **AMP** (refer to the **Table Of Contents** for the correct page number).
2. Turn off the compressor for the channel being tested (Bypass Gain and Compression).
3. Pulse/Function Generator:
   a. Set the pulse/function generator marker output signal to sweep from 300 Hz and 3.0 kHz (10 sec. sweep time marker at 1 kHz).
   b. Set the pulse/function generator output signal for approximately -20 dBm. Set Gain Phase meter to amplitude.
4. On the control panel, set the following switches:
   - Site 1, transmit control switch 1 to **ON**.
   - Site 1, voice control switch 1 to **ON**.
   - Remaining sites switch 1, both transmit and voice control to **OFF**.
5. Sweep Set Up:
   a. Insert this signal into the jackfield for site 1, channel 1 transmit audio drop circuit. Adjust amplitude to provide 2 to 2.5 kHz deviation, at

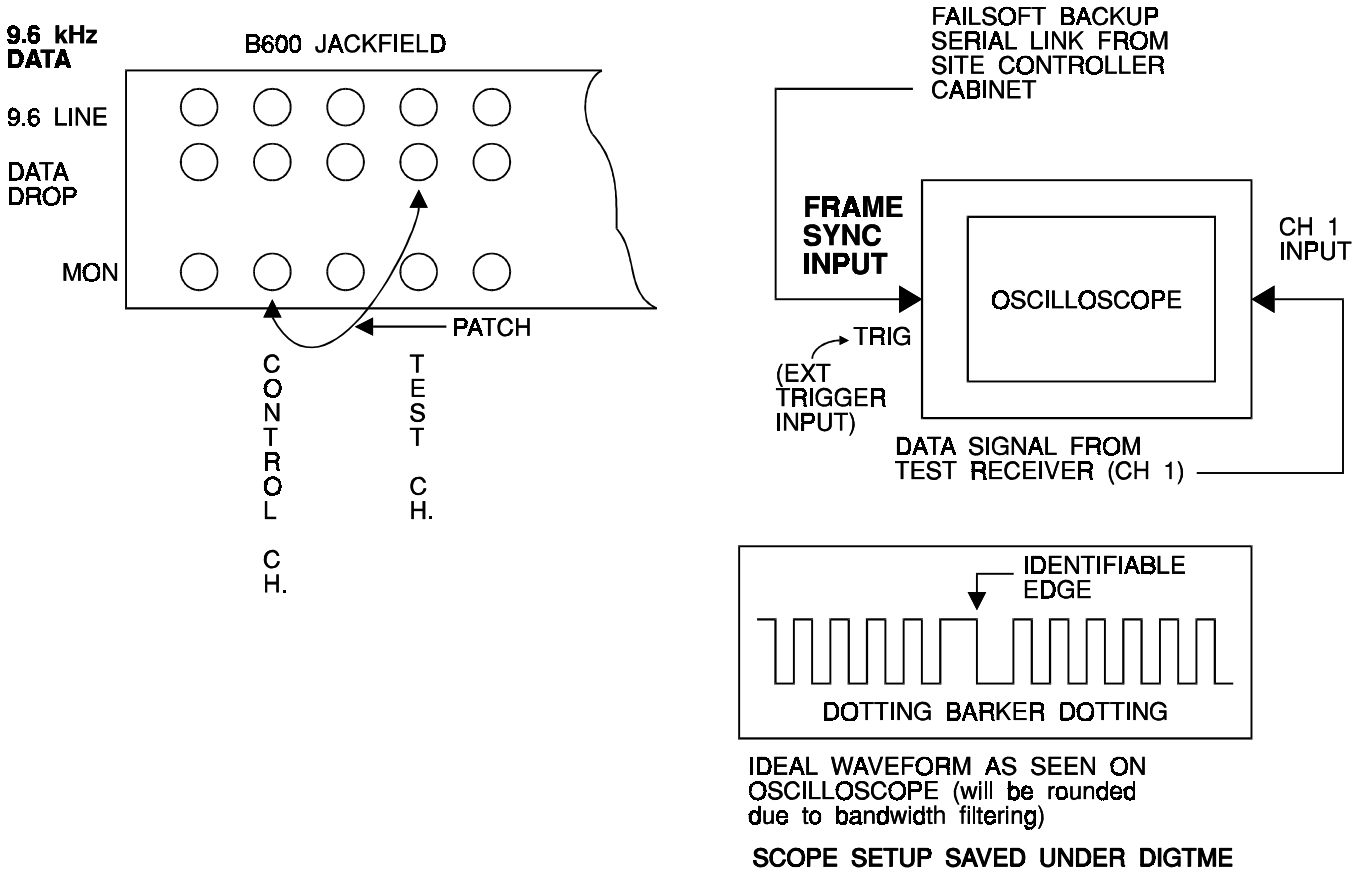

Figure 3 - Digital Delay Adjustment

1 kHz, from the station. Establish a reference based on a single exciter's characteristic without equalization. The test Rx output may need to be adjusted (R2 on the Bridge card in the Alignment Receiver unit) to approximately match the reference level (can precisely match at 1 kHz as gain set procedure).

b. Save the exciter only waveform in the oscilloscope as **CH1** memory location **REF1**.

6. a. Remove the signal from Site 1, channel 1 and insert into Jackfield Voted Audio Channel 1 drop circuit.

b. Turn on transmit for each site, one at a time and note weakest RF site (Test Rx meter). Close attention is necessary to pad each site down to the weakest site signal using the RF attenuator on the alignment receiver.

7. Sweep site 1, channel 1 and adjust the amplitude pots on the equalizer to within ± 0.1 dB of the reference signal as saved in step 5b. . Repeat as necessary to obtain results.

8. On the control panel, set the following switches:

- Site 2, transmit control switch 1 to **ON**.
- Site 2, voice control switch 1 to **ON**.
- Site 1 switch 1 and sites 3 - 8 both transmit and voice control to **OFF**.

9. Sweep site 2 channel 1 and adjust the amplitude pots on the equalizer to ± 0.1 dB of the reference signal as saved in step **5b**. Save the final adjusted waveform in the oscilloscope as **CH1** memory location **REF2**.

10. Remaining Sites:

a. Continue the method for these sites, i.e., site being tested has transmit and voice control switches on; all other sites have transmit and voice control switches off.

b. Sweep remaining sites and adjust corresponding amplitude pots on equalizer for the site and channel being tested to ±0.1 dB of the reference signal as saved in step **5b**.

c. It may be necessary for some sites to use a remote test receiver to receive a distant site. Use a previously adjusted site that is strong enough

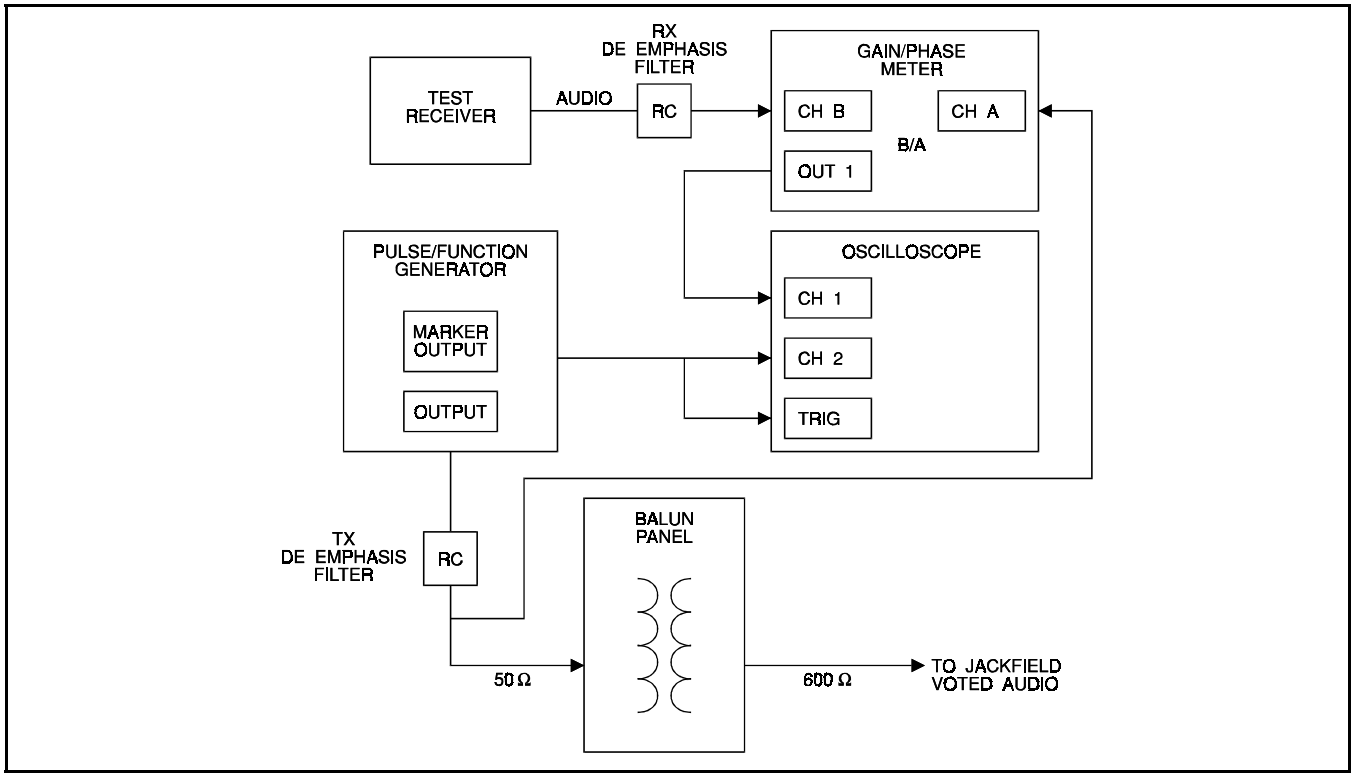

Figure 4 - Amplitude Equalization Alignment

for the remote test receiver to use as a reference. Store this new reference signal from the remote test receiver.

11. Compare all waveforms for each test receiver. The waveforms should remain within ±0.20 dB to assure proper long term operation.

12. When finished sweeping a channel, restore the compressor switches to normal.

PHASE EQUALIZATION ALIGNMENT

Perform the steps in the order presented. Refer to figure 5 to set up the equipment and to the waveforms of figures 6 and 7.

1. Perform the digital oscilloscope start-up and phase measurement procedures as outlined on previous pages or recall phase.

2. Starting with the site that is the greatest distance from the control point, on the control panel, set the following switches:
   - Transmit control switch 1 to **ON**.
   - Voice control switch 1 to **ON**.
   - All other sites switch 1 transmit control and voice control to **OFF**.

3. Pulse/Function Generator:
   a. Set the pulse/function generator output to provide 2 to 2.5 kHz deviation at 1 kHz (as for amplitude equalization).
   b. Set the pulse/function generator to sweep between 300 Hz and 3.0 kHz, and sweep the signal for channel 1.

4. a. Set the gain/phase meter to measure phase. If required to move the Ch1 oscilloscope cable to "**OUT 2**" on the gain/phase meter.
   b. Observe the waveforms on the oscilloscope. The waveforms may show insufficient, excessive or optimum reference delay (see Figure 8).
   c. Adjust the delay controls on the delay line panel to obtain an optimum reference delay.
   d. Save the adjusted waveform in the oscilloscope as **REF3** memory location **CH1**.

NOTE

To obtain optimum delay, the following method may help send a band of tones (sweep) through the system to the site: Feed the monitor receiver output to the oscilloscope. Route the same tone through test delay and also to the scope. Using dual trace, adjust time delay to get both "in phase" at "all" frequencies. "In phase" will have some flutter because delays have not been equalized.

5. On the control panel, set the following switches for the next site:
   - Transmit control switch 1 to **ON**.
   - Voice control switch 1 to **ON**.
   - All other sites switch 1 transmit and voice control to **OFF**.

6. Adjust the delay line panel for site reference setting.
   a. Sweep site, channel 1 and observe the phase difference between the previous site channel 1 (channel reference) and this sweep.
   b. Adjust the delay pots on the equalizer until the site 2 channel 1 waveform is within ±10 degrees between a frequency range of 600 Hz and 2800 Hz.

NOTE

The delay pots of the equalizer change the time delay in a band centered at the corresponding frequency. Since phase, which is a function of both time and frequency, is displayed, the major effect of adjustment is to "**rotate**" the phase curve and change the slope rather than simply raise or lower the curve. Experiment with one of the controls to get a feel for the effect.

7. Continue the method for sites 6 - 1, i.e., site being tested has transmit and voice control switches **ON**; all other sites have transmit and voice control switches **OFF**.

NOTE

The sequence in which sites are aligned is not critical; any convent sequence is acceptable.

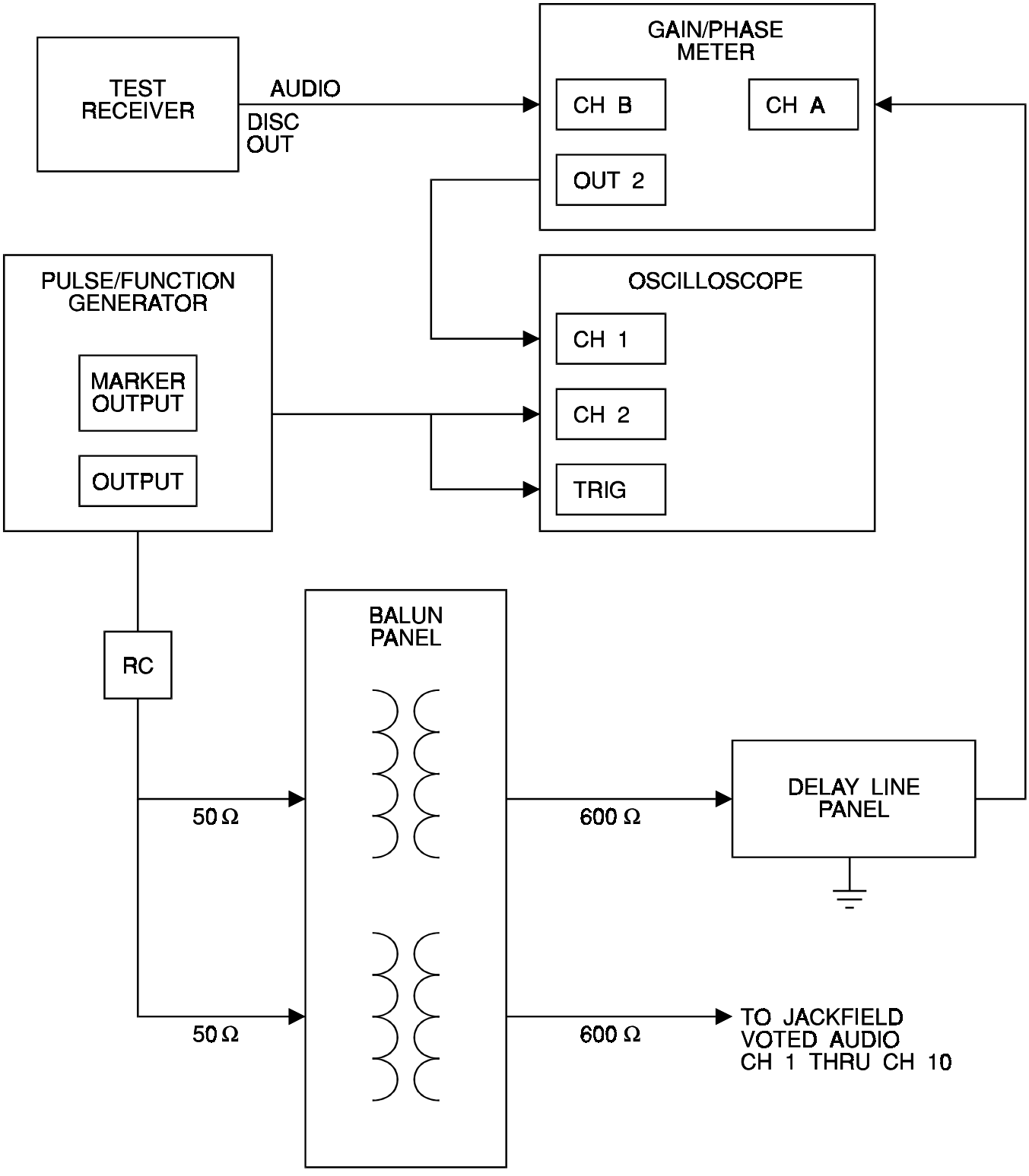

Figure 5 - Phase Equalization Alignment
(Amplitude and Phase Alignment is repeated for all channels.)

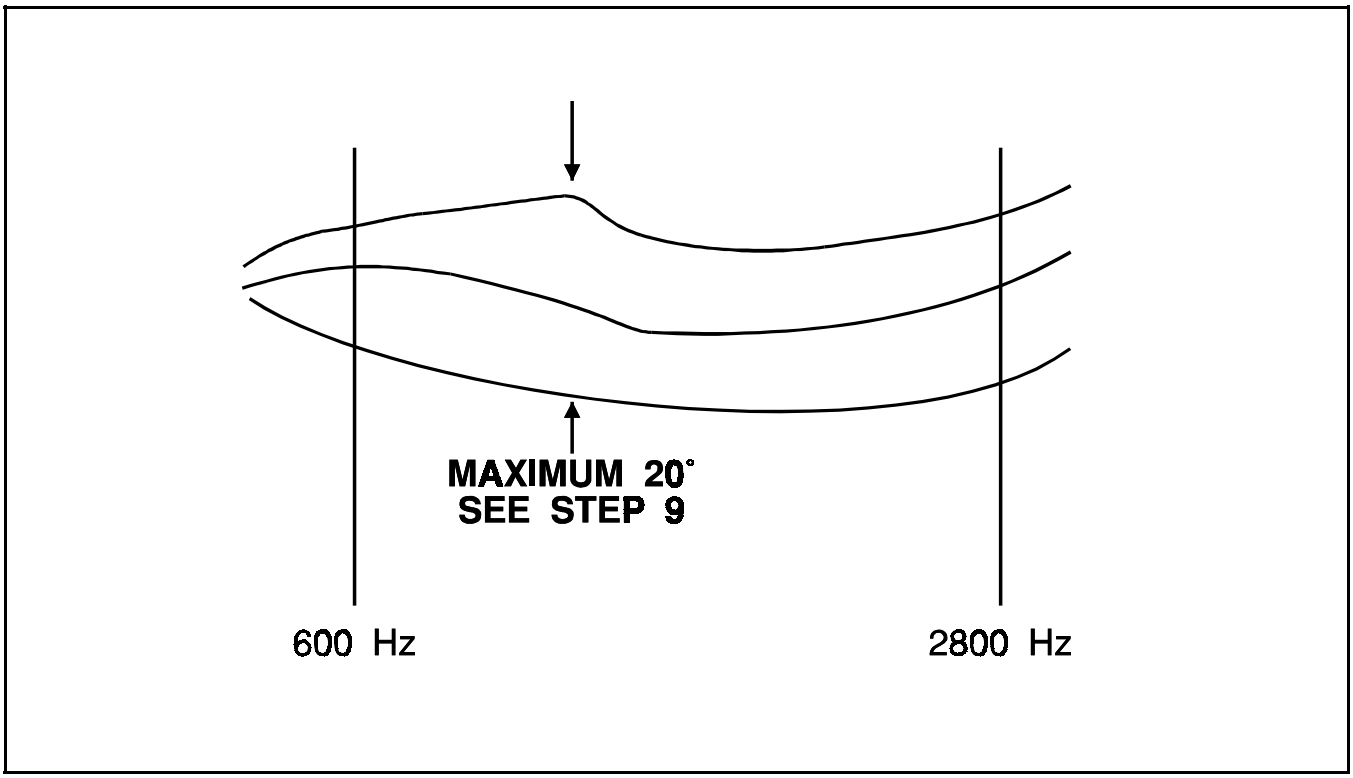

Figure 6 - Phase Equalization Alignment Waveforms

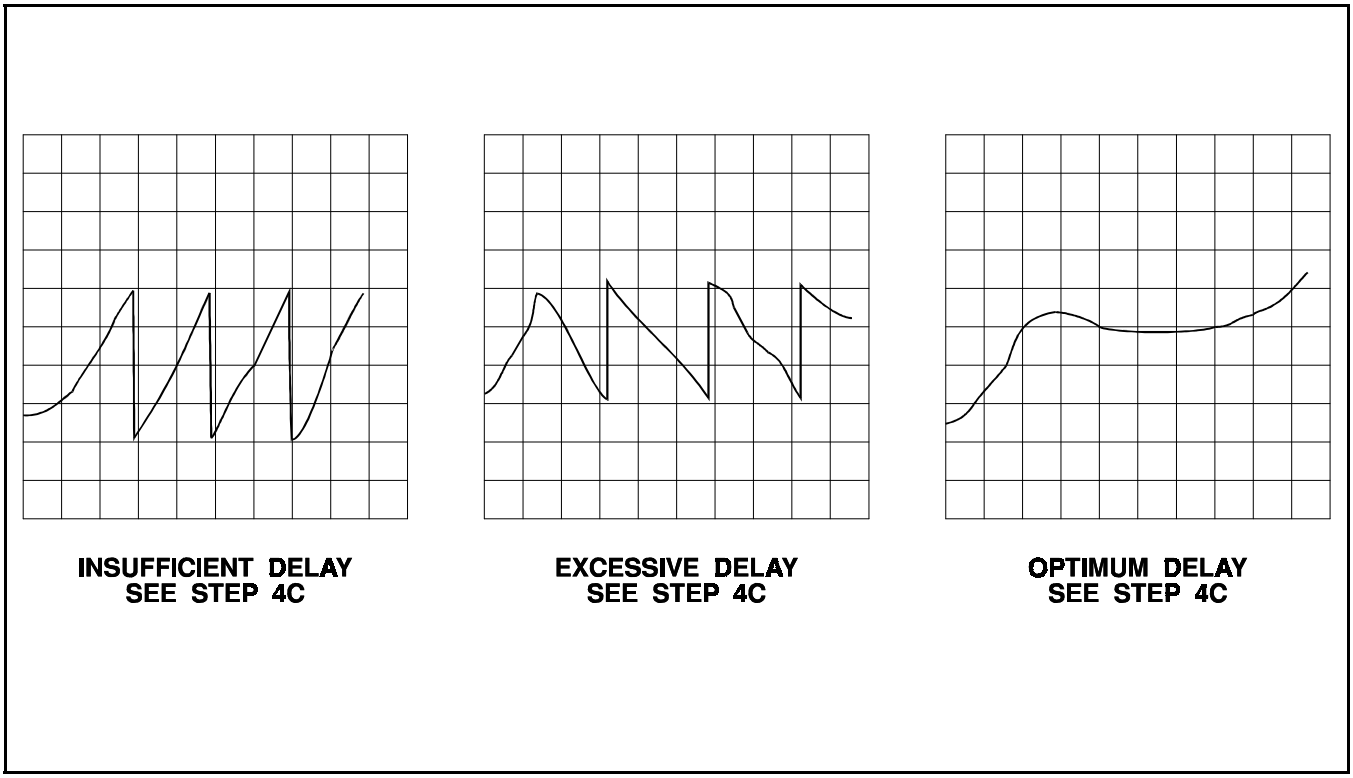

Figure 7 - Delay Waveforms

8. Sweep remaining sites and adjust corresponding phase delay pots on equalizer for the site and channel being tested to ±10 degrees over a frequency range of 600 Hz and 2800 Hz.

   It may be necessary for some sites to use a remote test receiver to receive a distant site. Use a previously adjusted site that is strong enough for the remote test receiver to use as a reference. Adjust delay line panel to obtain a similar pattern as originally displayed for the reference. Store this new reference signal from the remote test receiver.

9. Compare all waveforms from each test receiver. The waveforms should be within ±30 degrees or less.

ANALOG DELAY ADJUSTMENT

Perform the steps in the order presented. Refer to Figure 6 and Analog Delay Assembly Maintenance Manual LBI-38477.

1. Send a swept tone over a channel to all sites.

2. As was done in delay equalizing, route this signal through the test delay and adjust so that this matches the signal monitored from the farthest site (use dual trace on oscilloscopes.) This will become the "**farthest site**" time reference.

3. Adjust the Analog Delay for each site to match (in phase) this reference using the same procedure (If the **A/-A** Phase reference must be moved, the audio pairs polarity to this site must be reversed).

4. Offset these delays to compensate for the difference in location of the overlap region and the monitor receiver.

5. These differences can be included in the test delay, creating a differnt test delay for each site. This is preferable for future alignment checking and should be recorded.

COMPRESSION SETTING PROCEDURE

Compression will be set with 5 dB of gain when 10 dB below test tone (System Test Tone is typically -10 dBm).

1. Input a 1 kHz tone, 10 dB below test tone, into compressor being set (typically -20 dBm).

2. With **GAIN = NORMAL** and **COMP = OFF**, set gain to achieve 5 dB below test tone (typically -15 dBm) out of compressor.

3. Increase input of 1 kHz tone level to 5 dB above test tone (typically - 5 dBm).

4. With **GAIN = NORMAL** and **COMP = NORMAL**, set compression to achieve System Test Tone (typically -10 dBm).

5. Repeat for each channel compressor.

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APPENDIX A
SYSTEM ALIGNMENT & FIELD TESTING
FOR
EDACS® SIMULCAST SYSTEMS
WITH MASTR II® & MASTR IIe® STATIONS

TABLE OF CONTENTS

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1. INTRODUCTION

This manual contains the complete system level alignment procedures for a Simulcast Communication System. These alignment procedures are applicable to systems equipped only with **MASTR II** or **MASTR IIe Stations**. (For MASTR II Stations with earlier models of test equipment refer to LBI-38579 - Alignment Procedures for Simulcast). All procedures must be completed for each RF channel in the sequence given. The alignment sequence is identified below. Read the entire procedure before beginning.

Alignment Sequence:

1. Combiner Power Output
2. FSK Modem Symmetry Adjustment
3. Equalizer Pre-Alignment
4. Compression Setting Procedure
5. Exciter Level Adjustment
6. 300 Hz Reference Polarity Check
7. 9.6 kHz Clock Reference Edge Check
8. Digital Delay Adjustment
9. Amplitude Equalization Alignment
10. Voter Setup and Alignment
11. Preventive Maintenance
12. Field testing

2. RELATED PUBLICATIONS

It may be necessary to refer to one or more of the following maintenance manuals when aligning the simulcast system. These manuals will provide additional information should you encounter technical difficulties during the alignment process. If a conflict exists in procedures, this document shall take precedence for Simulcast System Level Adjustments.

MASTR II Transmitter	LBI-38585
FSK Modem	LBI-38487
Delay Unit Shelf	LBI-38941
Voter Selector Panel	LBI-38676
Universal Sync Card	LBI-38488

3. RECOMMENDED TEST EQUIPMENT AND CABLES

The test equipment required to complete the alignment procedure is listed in two separate lists: Test Equipment Supplied (Test Rack) and Test Equipment Required But Not Supplied. The test equipment identified in the second list is portable and must be supplied by the servicing technician.

Test Equipment Supplied

The following test equipment is provided and included in the Test Equipment Rack.

1. Digital Storage Oscilloscope, configured for rack mount - Tektronix 2232A
2. Sweep Analyzer - Hewlett Packard HP35670A
3. HP100 Color Pin Plotter with Option 01 and GPIB cable (optional)
4. Delay Line Panel
5. Balun Panel assembly
6. Transmission Test Set - CONVEX 806RM
7. Extender Panel - CONVEX C120/REX

Test Equipment Required But Not Supplied

1. Communications Service Monitor FM/AM 1200S with Spectrum Analyzer - IFR Systems Inc.
2. Miscellaneous Test Leads:
   - 4 BNC - BNC 12" plug (Pomona - 2249-C-12)
   - 3 BNC - BNC 24" plug (Pomona - 2249-C-24)
   - 2 BNC - Bantam Plug 40" plug (Make from ADCPJ77 Plug Kit, Coax & BNC Male)
   - 1 BNC - Banana plug Adaptor (Pomona 1269)
   - 2 BNC Male - Banana Female Adaptor (Pomona 1452)
   - 1 Banana to Bantam Plug 6 foot (ADC/PAT 100028)
   - 2 Bantam to Bantam Plug 4 foot (ADC/PJ718)
   - 2 Bantam to Longframe Adapter Plug (ADC P051)
3. Extender Cards for Simulcast Modules.
4. Portable Transmission Test Set.

NOTE

Ideally, the test equipment used at each site should be identical or calibrated against one another using a "master" site to take into account any differences.

4. ALIGNMENT PROCEDURES

4.1 COMBINER POWER OUTPUT (TX SITES ONLY)

1. At a Transmit Site, measure the output power of each channel from its associated combiner. Note and record the channel having the lowest power (highest port loss). If more than one combiner is used at a site, use the lowest power of the two.
2. Set all transmitter PA power outputs to achieve the same power output (±5 watts) from the combiners.

4.2 FSK MODEM SYMMETRY ADJUSTMENT

Refer to Maintenance Manual LB-38487 for FSK modem.

At the Control Point (Universal Sync IShelf):

1. Set test enable switch S2 on the 150 baud digital selector board to the TM (test mode) position and verify that the red "test" LED DS1 is ON. See Figure 1.

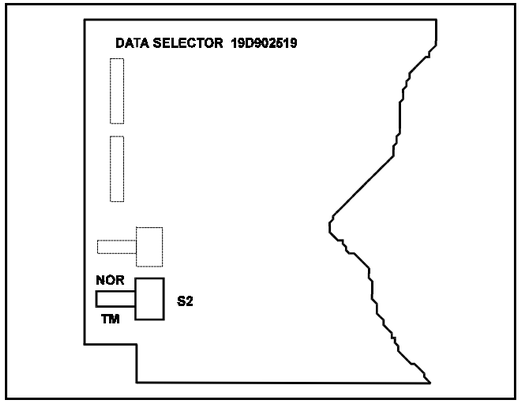


Figure 1 - Data Selector Module, S2 Location

At Each TX Site:

1. Connect oscilloscope to RXD & GND test points on FSK Modem card in Universal Sync Shelf.
2. Adjust RCV BIAS control R2 on FSK Modem to achieve 50/50% symmetry of 75 Hz square wave. (See Figure 2). High & Low" should equal 6.67 milliseconds. Note: An extender board may be necessary to gain access to R2. See Figure 3.

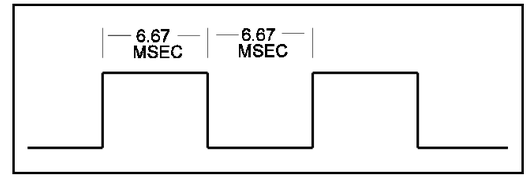


Figure 2 - RXD 75 Hz Symmetry

3. When adjustment is complete, disconnect the oscilloscope leads from FSK modem RXD & GND.
4. At the Control Point (Universal Sync Shelf), set test enable switch S2 on the 150 Baud Digital Selector board to the NOR (normal) position and verify that the red "test" LED DS1 is OFF.

4.3 EQUALIZER PRE ALIGNMENT

THE FOLLOWING PROCEDURE APPLIES ONLY TO TELLABS 4041 EQUALIZERS

NOT required for **CONVEX** equalizers. **CONVEX** equalizers are factory preset, "flat" with the **FLT** switch in the **LD** switch position.

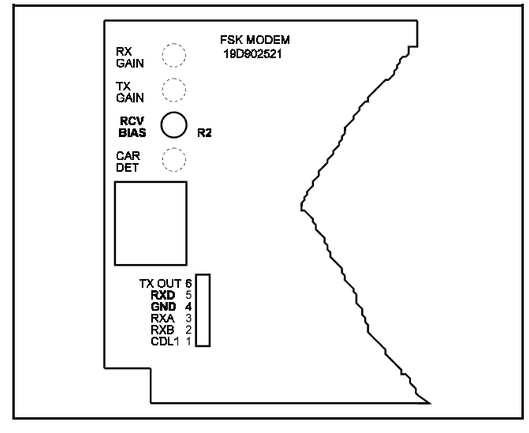


Figure 3 - FSK Modem Component Location

Perform the steps in the order given. Refer to delay amplitude equalizer document for Tellabs 4041 Equalizers.

At The Control Point:

1. Preset all controls per manufacturer's instructions.
2. Mechanically preadjust all 13 amplitude and all 13 delay pots as follows:
   (1) Rotate pot counterclockwise 15 turns.
   (2) Rotate pot clockwise 4 turns. This mechanical adjustment "presets" all cards alike and gives a starting point to work from.
3. Repeat steps 1 and 2 for each site on channel 1.
4. Repeat procedure for each channel.

THE FOLLOWING PROCEDURE APPLIES ONLY TO CONVEX C20 EQUALIZERS.

Set the LEVEL control for each equalizer to provide "net zero" gain.

1. Inject a -10 dBm, 1 kHz tone into the Channel 1 voted voice jackfield, drop side (A600 VVRX).
2. Set Channel 1 compressor GAIN and COMPRESSION switches to OFF.
3. Monitor Channel 1 transmit audio for each site, at the TRANSMIT audio jackfield, drop side, 600 ohm termination (A6XX TXV).
4. Adjust each site's corresponding equalizer LEVEL control to achieve -10 dBm at the monitor point.
5. After all site equalizers are set for Channel 1, repeat steps 1 through 4 above for remaining channels.

4.4 COMPRESSION SETTING PROCEDURE

For Analog Shelf #1 compressor module. Compression is set with 5 dB of gain when input signal is 10 dB below test tone (System Test Tone is typically -10 dBm). Be sure that the limit range switch (S3) on compressor is set to the HIGH position.

1. Input a 1 kHz tone, 10 dB below test tone, into compressor being set (typically -20 dBm) at Voted Voice Jackfield (D600) or directly into compressor through the longframe plug.
2. Measure output by inserting a longframe plug into output jack of compressor. Set meter to terminate 600 ohms.
3. With GAIN = NORMAL and COMP = OFF, set gain to achieve 5 dB below test tone (typically -15 dBm) out of compressor.
4. Increase input of 1 kHz tone level to 5 dB above test tone (typically - 5 dBm).
5. With GAIN = NORMAL and COMP = NORMAL, set compression to achieve System Test Tone (typically -10 dBm).
6. Repeat for each channel compressor.

4.5 EXCITER LEVEL ADJUSTMENT

Two technicians are required to properly adjust the exciter level: one at the Control Point and one at the Transmit Site. Before beginning the adjustment procedure, establish a communications link to the technician at the Control Point. Perform each step of the procedure in the sequence given.

4.5.1 Low Speed Data Deviation

NOTE

It is important that the same (or exactly matched) deviation measurement equipment be used at each site.

At The Control Point:

WARNING

Users on an active system will experience communications disturbance during this test.

1. On the control panel, set the following switches (See Figure 4).
   - Site 1, PTT switch 1 to ON.
   - Site 1, A/D switch 1 to ON.
   - For all other sites, set switch 1 PTT and A/D to OFF.
2. Set test enable switch S2 on the 150 baud data selector board to the TM (test mode) position and verify that the red "test" LED DS1 is ON. See Figure 1.

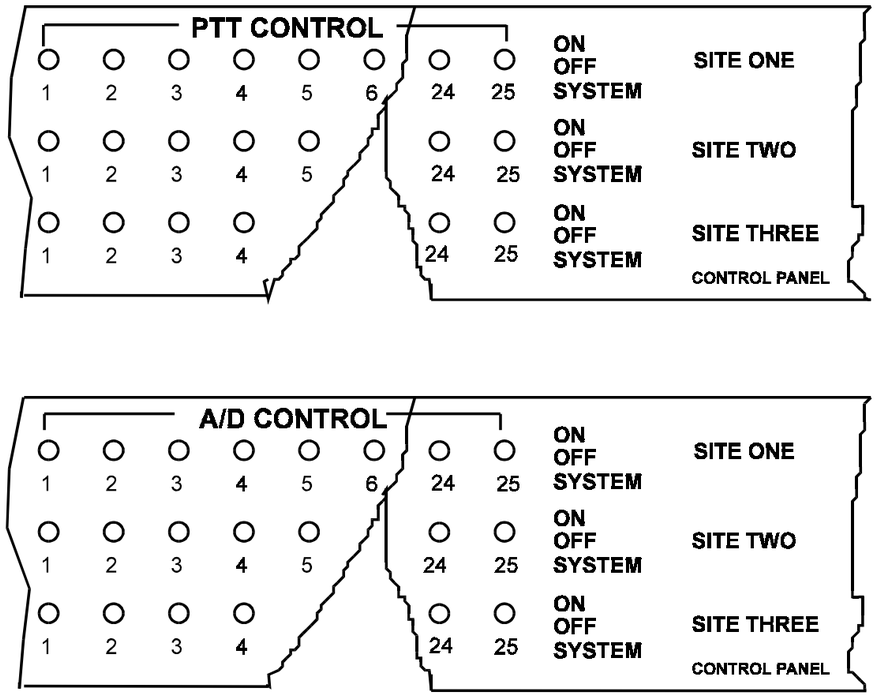


Figure 4 - Jackfield and Control Panel Detail

At The Transmit Site:

1. Connect the exciter output directly to the input of the communication service monitor. This reduces external interference that can disturb the accuracy of the settings.

2. Set the communication service monitor to FM NAR operation and tune to receive the RF channel under test.

> **NOTE**
>
> On an IFR 1200S, the Pre Filter is 15 kHz, and the Post Filter is 8 kHz in **FM NAR**. **FM1** on an IFR 1500 is the same setting.

3. Insert a Bantam plug in the TRANSMIT audio jack (T600 TXV) drop circuit for the channel being adjusted. This removes MUX idle channel low level audio and prevents it from interfering with this adjustment.

4. Observe modulation analog meter on communication service monitor and adjust R50 (CG) on the MII/MIIe exciter. Adjust deviation for 0.75 kHz ±10 Hz deviation (150 baud data), or (0.600 ±kHz 10 Hz if **NPSPAC**).

> **NOTE**
>
> To check 150 baud deviation on a channel after system is installed and operating, do the following:
>
> At the Control Point Site, perform step 1.
>
> From the System Manager, remove the channel under test from service.
>
> At the Transmit Site perform steps 1, 2, and 3 above.
>
> Remove existing lead from TB10-5 of station GETC and replace it with a ground to invoke "BYPASS".
>
> Record existing settings of station GETC dip switches. Set GETC dip switches as follows:
>
> S1 1-8 closed
> S2 1-7 closed
> S3 1 open, S3 2-8 closed
>
> Press and release "RESET" on station GETC.
>
> Repeat step 4 above. Remove the signal.
>
> Set GETC dip switches to their original settings.
>
> Press "RESET".
>
> Remove ground from TB10-5 and reconnect original wire.

4.5.2 Limiter Deviation Adjustment

At The Control Point:

1. Set the CONVEX transmission test set for a -0 dBm, 1 kHz tone. This is 10 dB above test tone level.

2. Insert the signal into jackfield voted audio channel 1 drop circuit (A600 VVRX).

3. Turn OFF compressor of channel under test.

At The Transmit Site:

> **WARNING**
>
> Users on an active system will experience communications disturbance during this test.

1. Remove the FSK modem from the sync unit D100 assembly. This removes the low speed data from all channels.

2. Unplug the Sub Alarm module from the sync unit D100 assembly. This prevents site BYPASS.

3. Remove 16 dB (minimum) of attenuation on the station end MUX card for the channel under test.

4. Set communication service monitor to FM NAR and observe the display. while adjusting R52 (Limiter pot) on the MII/MIIe exciter. Set the deviation for 3.75 kHz (3.0 kHz if NPSPAC).

5. Remove Bantam plug from TRANSMIT audio jackfield and return the channel to service.

6. Reinsert attenuation removed in step 3.

> **NOTE**
>
> In an active system, to *avoid* pulling FSK and Sub Alarm modules, remove J4 on the GETC interface board (no 150 baud).
>
> Take the channel out of service before testing to avoid channel assignment and disturbance to users.
>
> Inject a 1000 Hz, 0 dBm tone at Transmit Site audio jackfield for the channel under test instead of sending from the Control Point.
>
> Reinstall J4 on GETC I/F board when done.

7. Return compressor to ON position at the Control Point.

8. Reduce the test tone level from 0 dBm to -10 dBm.

9. Verify -10 dBm is present at the Transmitter audio input (Jackfield T600 TXV). Adjust the site/channel equalizer level control for 3.0 kHz (±0.05 (2.4 kHz if NPSAC) deviation.

10. Replace the **FSK** modem and **Sub Alarm** modules.

4.5.3 High Speed Data Deviation Adjustment

Before making the high speed deviation adjustment, verify that the supply voltage at each modem shelf, measured at the modem shelf backplane at the Control Point and at each Transmit site, is 5 (0.25 Vdc. If not, individually adjust each redundant 5 Vdc power supply to achieve these limits. Verify that J2 and J3 of modem interface cards at Transmit and Control Modem shelves are in positions 2 and 3.

At The Control Point:

1. On the control panel, set Site 1 PTT to ON and A/D switches to OFF for the channel under test.

2. At the jackfield, patch the control channel data into the channel being set (D601 9.6 DATA). See Figure 6

At The Transmit Site:

1. Adjust R31 (data deviation) on the GETC circuit card assembly for 3.0 kHz ±50 Hz (2.4 kHz ±50 Hz if **NPSPAC**) deviation as observed on the communication service monitor display (FM MID).

> **NOTE**
>
> On an IFR 1200S, the Pre Filter is 200 kHz, and the Post Filter is 8 kHz in **FM MID. FM2** on an IFR 1500 is the same setting.

2. Reconnect exciter output to transmitter PA input.

4.5.4 Remaining Channels

Repeat all procedures for each channel and site. After exciter adjustments have been performed, return all switches on the control panel to the SYSTEM position.

4.6 300 Hz REFERENCE POLARITY CHECK

Before performing the 300 Hz Reference Polarity Check, refer to LBI-38488 and verify that all jumpers are correctly positioned. The polarity of the 300 Hz timing reference must arrive at the Transmit Site master universal resync card without an inadvertent inversion in the balanced audio lines. If the following check indicates this reference to a site is inverted from proper polarity, the condition can be corrected by:

- "flipping" the balanced pair line at either the Control Point end or the Tx end (not both) or
- by moving the position of "J3" on the tone interface card at the transmit site in question.

1. Remove J69 on Control Point GETC for active control channel.

2. Connect the test delay in series with the Tx modem audio going to the site under test on the control channel as shown in Figure 5.

Refer to Digital Delay Card manual LBI-38941.

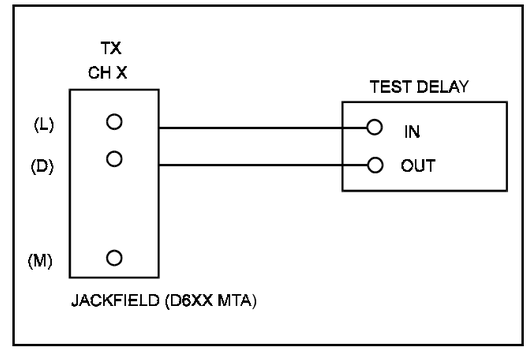


Figure 5 - Test Setup, 300 Hz Polarity Check

> **NOTE**
>
> The control channel data can be patched into a "Disabled" channel at the Tx. 9.6 data jackfield to minimize system interruption for this test. (D601 9.6 DATA).

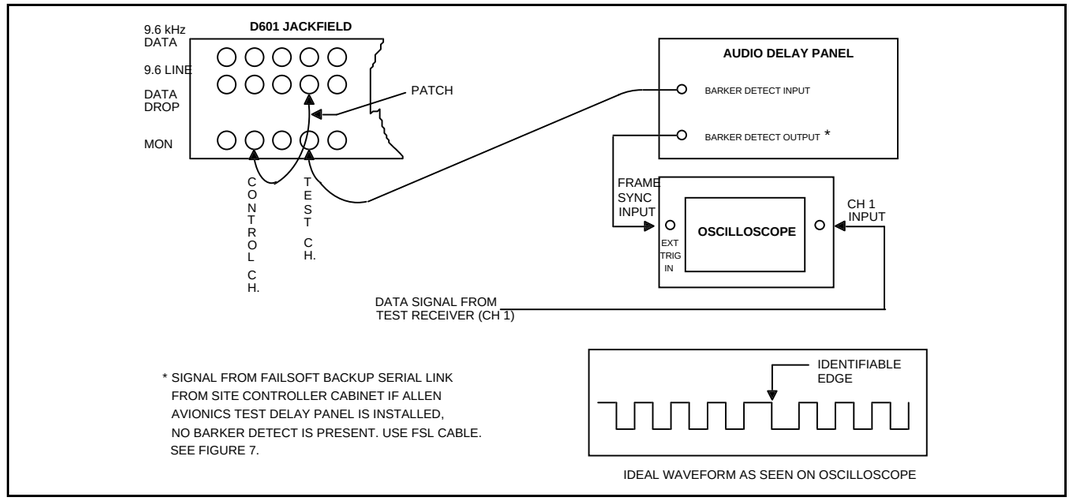


Figure 6 - Digital Delay Adjustment

3. With the test delay set to zero "0", use delayed sweep on the oscilloscope to display the "dotting/barker" region of the control channel data (External trigger on FSL, discriminator output of the test radio set to the proper RF channel). On the test panel, only the site under test should have PTT (See Figure 6 for "**dotting/barker**" region and oscilloscope hook up). If no barker detect is present, use FSL Cable. Refer to Figure 7.

4. Set one cursor at the reference edge and the other 3.3 milliseconds later (allow sufficient time for resync, up to 56 seconds).

5. Add one (1) millisecond of delay on the test delay; the edge will reappear after the modem retrains at some random point. Wait for resync. The reference edge should come back to the first cursor. If the reference edge "**Resyncs**" to the second cursor, the 300 Hz polarity is inverted going to the site and must be changed.

6. Increase the delay to 2.5 milliseconds. After retraining and resync the reference edge should be at the second cursor. If the reference edge "**Resyncs**" to the first cursor, the 300 Hz polarity is inverted going to the site and must be changed.

7. Repeat this for all sites.

8. Replace J69 on Control Point GETC of active

4.7 9600 HZ CLOCK EDGE REFERENCE CHECK

This procedure checks the polarity of the 9600 Hz clock relative to the rising edge of the 300 Hz signal to determine if jumpers P8, P12, P16, and P20 are in their correct position. These jumpers are located on the universal resync cards and ***must*** be in the same location at a given site. It is possible that their position at one site may be different from their position at another site.

1. At the remote site, remove a resync card and reinstall it on an extender card.

2. Using a dual channel oscilloscope, check for the following:

   a. Channel 1 - a 300 Hz reference signal at U32-1.

   b. Channel 2 - 9600 Hz clock out at U12-16.

   c. Channel 1 - Trigger.

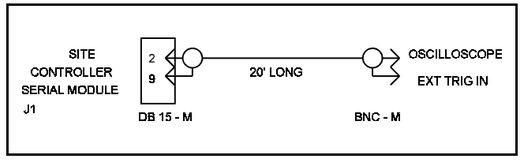


Figure 7 - FSL Cable

3. The 9600 Hz clock out polarity is chosen (using the jumpers) so that the rising edge of this clock is as close as possible to the rising edge of the 300 Hz signal. Note that there only two choices. The four jumpers are one for each channel and all four must be installed in the same position. These jumpers on all universal sync cards in the shelf should be set the same.

4.8 DELAY EQUALIZATION AND ALIGNMENT

4.8.1 Digital Delay Adjustment

Perform the steps in the order given. Refer to the Figure 6 and to Delay Unit Shelf Assembly Maintenance Manual LBI-38941. Ensure delay A/B select switch (S2-1) is in correct position on delay card.

1. Connect the test equipment as shown in Figure 6.

2. Patch data from the control channel to the test channel. Use 9600 Hz data jackfield (D601 (9.6 DATA), and plug into the MONITOR jack of the control channel and the DROP side of the test channel. Plug the BARKER DETECT input cable into the MONITOR side of the test channel.

3. Starting with the transmit site farthest from the Control Point, on the Control Panel, set the following switches for the channel being tested:

   - Farthest site PTT **ON**.
   - Farthest site A/D **OFF**.
   - All other sites PTT **OFF**.
   - All other sites A/D **ON**.

NOTE

The different equipment delays may cause the most distant site NOT to be electrically the farthest. It is acceptable to start with any site; it is the relative time between sites that must be correct once finished.

4. Set the oscilloscope to view the first "dotting/ barker" region of data after the scope triggers using delayed sweep. Record the time from trigger to a uniquely identifiable zero crossing of data. You may want to use AVERAGE of the oscilloscope traces to display a smoother trace.

5. At the Control Point Control Panel, set the following switches:

   - Next site PTT ON.
   - Next site A/D OFF.
   - All other sites A/D ON, PTT OFF.

6. Observe the oscilloscope display. This site should arrive at a "different" point than the prior site. Adjust digital delay for this site to move the identified data point to the time recorded for the prior site. Wait after setting the digital delay for "Resync" to occur to verify that the correct amount of time was added.

NOTE

To zoom in on a portion of the oscilloscope trace, do the following:

1. View the dotting/Barker region with the "A and B" sec/div knob set to 2 msec, and with the MODE switch set to "A".

2. Set the MODE switch to BOTH.

3. Pull out the Delayed Sweep knob, and set it to 0.2 or 0.1 msec.

4. Adjust the "Intensity " knob for low intensity on "A" and high intensity on "B". Part of the "A" trace is now highlighted. The "B" trace shows an expanded view of the highlighted portion of the "A" trace.

5. Adjust the "B Delay Time Position" knob to zoom in on the Dotting/Barker region.

6. Continue to rotate "Delayed Sweep" knob clockwise and adjust the "B" Delay Time Position knob to zoom in on the Dotting/Barker region.

7. Set the MODE" switch to "B" to view the "B" trace only.

IMPORTANT NOTE

Once a reference has been established for site 1, don’t touch the horizontal position knob or the "B" Delay Time Position knob when adjusting digital delays for other sites.

7. Continue with remaining sites per procedure. It may be necessary for some sites to use a remote test receiver to receive a distant site. Use a previously adjusted site that is strong enough for the remote test receiver to use as a reference. Use this new reference signal from the remote test receiver to time remaining sites.

8. Digital delays are set/adjusted on the Digital Delay cards. Two sites are on each card. The setting is on a binary weighted DIP switch (1.0 µS/bit).

9. It is advisable to patch the Control Channel data to each channel for the site and verify that each "Resyncs" to the same place in time.

10. These settings must be offset to compensate for the geographic difference in location of the overlap regions and the alignment receiver. The propagation time from each Transmit site to the alignment receiver must be known, as well as propagation times between all the Transmit sites. "Offset" delays are calculated to place the equal arrival time of data in the center of the overlap zone.

11. Create a test delay table for the system being aligned.

The Test Delay Table contains time delay offsets relative to the site chosen as the "**REFERENCE**" site. The reference site's time delay value = 0. This chart must include the RF propagation time differences from each site to the test receiver, and any induced time delay offset desired.

A suggested format is shown in Table 1.

4.8.2 Amplitude Equalization Alignment (With HP35670A)

Amplitude Equalization Alignment as follows provides phase and amplitude adjustment combined with timing delays. The phase and amplitude alignment is done by sweeping each channel at all sites and matching them to a REFERENCE chosen for the system. This is to ensure that audio signals in overlaps have the same modulation characteristic.

Amplitude Alignment is simply matching the deviation levels across the swept audio spectrum from all transmitters to match the REFERENCE within the limits set in the HP35670A.

Phase Alignment first requires that each Transmit Site's overall delay setting (Analog Delay Card) provides sufficient delay to approximately match the REFERENCE site's phase curve. The delay, inserted on a per site basis, may include addition or subtraction of time (offset) for centering the site's audio in the overlap zone. Fine adjustments on the equalizer card remove the differences in phase caused by slight variations in hardware in the path between the Control Point and Transmit Sites.

The initial delay of 256 microseconds is set for all sites to allow the addition or subtraction of analog delay to match the phase portion referenced above.

The settings used from Table 2 compensate for the Alignment Receiver not being in the center of each overlap zone. The propagation of the s signal from the Transmit Site to the Alignment Receiver, combined with any offset delay relative to the REFERENCE Site sets the Test Delay value. Analog delay for the site being aligned is then adjusted to cause its swept phase curve to roughly match the shape of the REFERENCE Sites phase curve (remove the sawteeth).

An overall view of the components involved in Amplitude alignment is shown in Figure 8.

Perform the steps below in the order given. For each site, the amplitude and phase adjustments must be repeated until the displayed curves are within the limits shown on the HP35670A.

4.8.3 Alignment Set Up using HP 35670A Sweep Analyzer

NOTE

Refer to HP 35670A Operator's Guide and Quick Start Guide. On-line Help may be consulted as necessary for clarification of instrument set up and operation.

1. On the analog delay cards, set each site's audio delay to 256 microseconds as a "nominal" starting point. This allows adjustment forward or backward in time by adding or subtracting delay.

2. Set up cabling between HP 35670A, Delay Panel, Test Radio, and Balun Panel as shown in Figure 9.

   This allows *simultaneous* measurement/adjustment of the amplitude and phase response.

3. Setup the HP35670A, Dynamic Signal Analyzer as follows:

- Turn HP35670A ON
- If the power up default is not correct, insert the alignment disk in the HP35670A
- Press SAVE/RECALL
- Press "F8" to toggle catalog to ON
- Use thumbwheel to select ALIGN
- Press "F5" for Recall State
- Press "F1", ENTER
- Use thumbwheel to select LIMITS
- Press "F6" RECALL MORE
- Press "F5" RECALL PROGRAM
- Press "F1" ENTER
- Press BASIC. The top graph is Phase and the bottom graph is Amplitude.
- Press START to initialize the standard sweep.

NOTE

A sweep may be restarted at any point by pressing START. Refer to Figure 12, Equalization Alignment Waveforms as needed during this procedure

4. **At the Control Site**, set the following switches:
   - PTT ON for the Channel/ Site being aligned.
   - Set PTT OFF for all other sites on the same channel.
   - A/D ON for all sites on the channel being aligned.

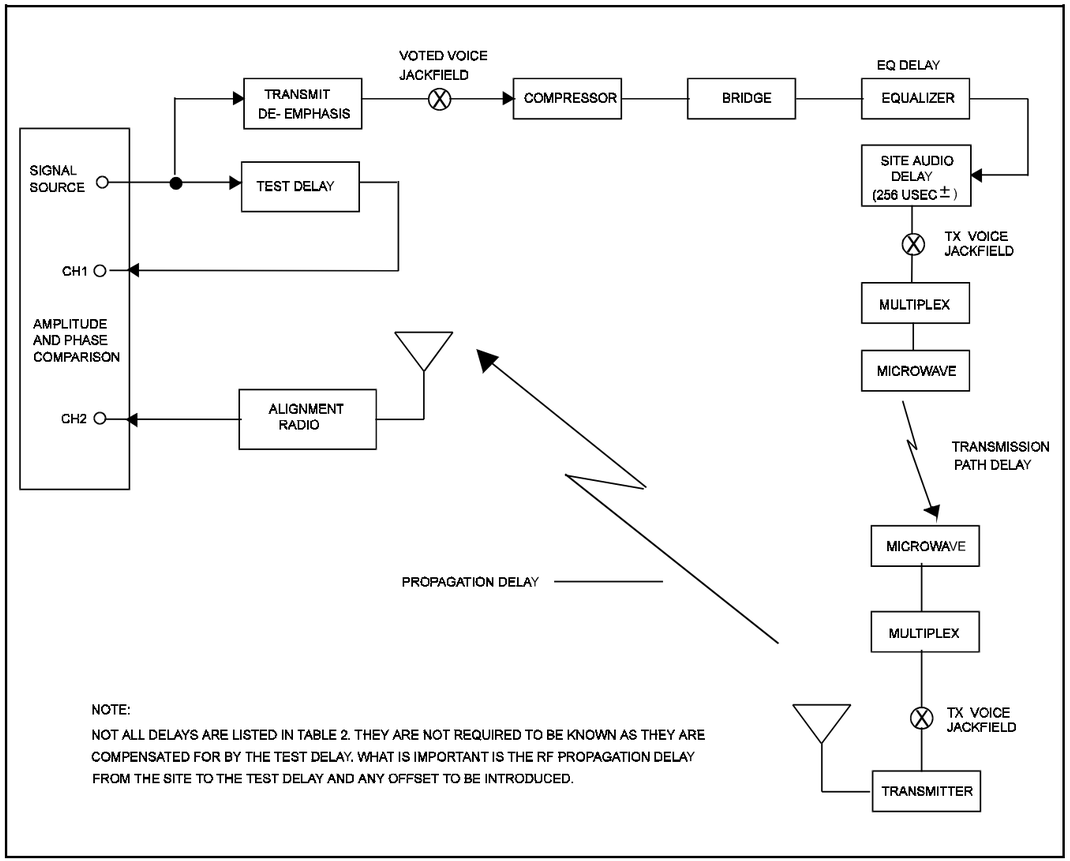


Figure 8 - Simulcast Audio Alignment

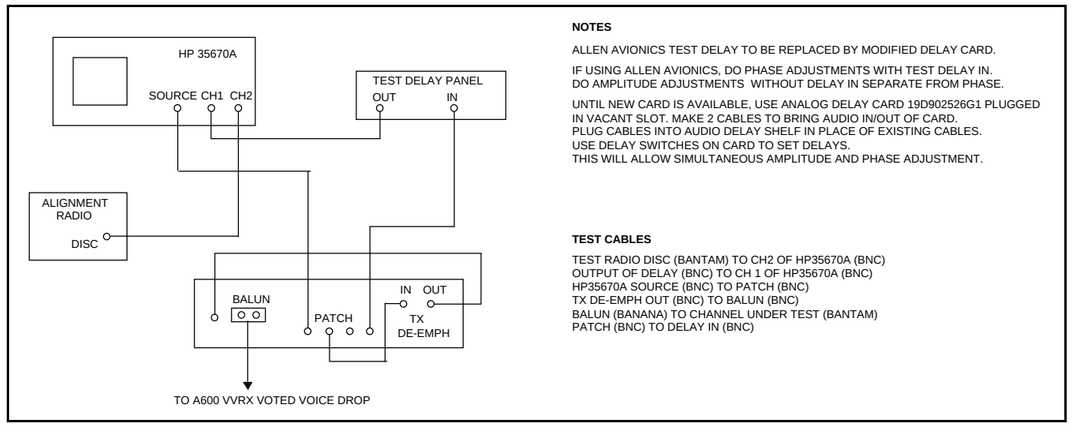


Figure 9 - Simulcast Alignment Test Setup Using HP 35670A Sweep Analyzer

5. **Analog Delay Adjustment**. Create a test delay table to record the analog delay adjustments for the system being aligned. Ensure Delay A/B select switch (S2-1) is in the correct position on delay card.

This will be a table of time delay offsets relative to the site chosen as the "**REFERENCE**" site. The reference site's time delay value = 0. This table must include the RF propagation time differences from each site to the test receiver, and any induced time delay offset desired. Create an additional column for test delay, which will be filled in during the remainder of the alignment procedure.

A suggested format is shown In Table 2.

NOTE

It has been determined that the *Allen Avionics* delays used in the Test Delay Panel introduce loss and produce distortion. New versions of the Simulcast Test Rack will replace the present Test Delay Panel with a modified version of the audio delay card. It is recommended to run amplitude and phase separately, even with the HP35670A, if using the *Allen Avionics* panel. Adjust amplitude without the Test Delay Panel in circuit. Adjust phase with the Test Delay panel in circuit.

An alternative to the *Allen Avionics* delay panel is to build special cables to plug into the back of the Analog Delay shelf (See Figure 10). This will allow plugging in an "extra" Analog Delay card in an unused slot. Connect the test setup to the Analog Delay card in place of the *Allen Avionics* panel. Use the delay switches to change the delay in binary weighted steps starting with 1 of this arrangement *will* allow *simultaneous* Amplitude and Phase adjustment.

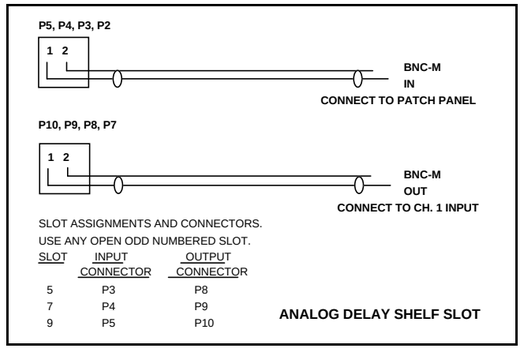


Figure 10 - Interconnect Cables, Analog Delay Backplane

4.8.4 Preliminary Reference Setup using HP 35670A Sweep Analyzer:

1. Turn compressor COMPRESSION and GAIN OFF for channel under test.

2. Take channel out of service at the System Manager.

NOTE

Insert the swept signal into the A600 VVRX voted voice drop circuit for Channel 1.

3. Set the REFERENCE Sites PTT and A/D switches to ON for Channel 1.

Table 1 - Time Delay Offsets Relative to Reference Site, Digital Delay

SITE	Propagation To Test RX	Offset Delay	Measured Delay	Digital "A"	Delay "B"
TX Site 1					
TX Site 2					
TX Site 3					
TX Site 4					
TX Site 5					
TX Site 6					
TX Site 7					
TX Site 8					
TX Site 9					
TX Site 10					

NOTES:

1. **Propagation to Test Receiver**: Is the point to point time taken by the RF signal to travel from a TX site to the Test receiver location (Approximately 5.2 microseconds per mile).

2. **Offset Delay**: Is the amount of shift in time required of a TX site, to move the center of its overlap with another site. This may be a *positive* number (later) or *negative* number (earlier).

3. **Measured Delay**: Is the sum of the Propagation delay and offset delay values.

4. **Digital Delays**: Are the actual values set in the Digital Delay cards for "A" and "B" directions for a site.

4. Turn ON PTT for each site, one at a time, and note the weakest RF site (Test RX meter is lowest). It is necessary to pad the REFERENCE Site down to the weakest site signal using the RF attenuator on the alignment receiver before running the preliminary reference.

5. Adjust the **GENERATOR ADJUSTMENT LEVEL** of the HP35670A source to obtain 2 to 2.5 kHz deviation during the sweep. Verify with a service monitor and adjust as necessary.

   - Press DISPLAY FORMAT.
   - Press "F7" MEASURE STATE. Use thumbwheel to page down to "SOURCE LEVEL".

   The sweep is started by pressing the "START" button. The sweep can be restarted at anytime during the sweep. Adjust the source level as required to obtain 2 - 2.5 kHz deviation during sweep.

6. Adjust the input range values for the HP35670A input 1 and 2 if the overload LED is ON or the half scale LED is OFF on either channel.

   For CH. 1, use thumb wheel to select INPUT RANGE. Adjust value as required while sweeping.

   For CH. 2, adjust R101 on the audio bridge located on the Alighment Receiver Shelf. The proper settings for the jumpers and dip switches on the alignment receiver bridge card which feeds CH. 2 are:

J1 OMIT, J2 1-2, J3 2-3, J4 1-2, SW1-1 = ON, SW2 = ALL OFF, SW3-3 = ON, all others = OFF.

Return to the phase amplitude display by pressing F4 "UPPER/BIG LOWER".

Start a sweep and observe the amplitude display (lower display). See Figure 12.

The scale of the amplitude may need to be adjusted to position the results where desired (centered and entirely visible). To do this, press the "SCALE" button, then select F4 "BOTTOM REFERENCE" it may be convenient to then select F1 "AUTOSCALE ON".

Once these adjustments are made, the set up may be saved to disk as well as to autostate (for power up) as a customized set up which can be recalled at any time.

Saving Settings To Disk

- Press SAVE/RECALL.
- Press "F8" to toggle catalog to ON.
- Turn thumbwheel to highlight ALIGN.
- Press "F2" SAVE STATE. Press "F1" ENTER. Press "F3" OVER WRITE.
- Press BASIC.
- Press DISPLAY FORMAT.
- Press "F4" UPPER/BIG LOWER or whichever screen format is needed.

7. Adjust the test delay to "match" the equipment and propagation delay to/from the site/channel being measured. It is usually in the order of several milliseconds, and can be found empirically by "removing the sawteeth" resulting from the 360 degree wraparound as shown in Figure 11. Write down the delay value required for the reference site.

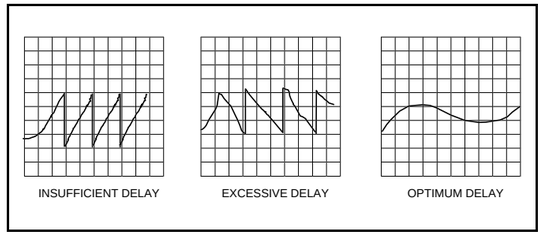


Figure 11 - Delay Waveforms

8. Once the reference sweep has run, press "BASIC" then "F1" LIMITS to show the limits.

NOTE

Running this program will put preset "limit" traces around the current trace which then may be used as a reference. Run this program to "save" the reference amplitude and phase response limits. These will be used to match the other sites by adjusting within these boundaries. The boundaries keep the amplitude within (0.125 dB and phase delay within (12.5 degrees.

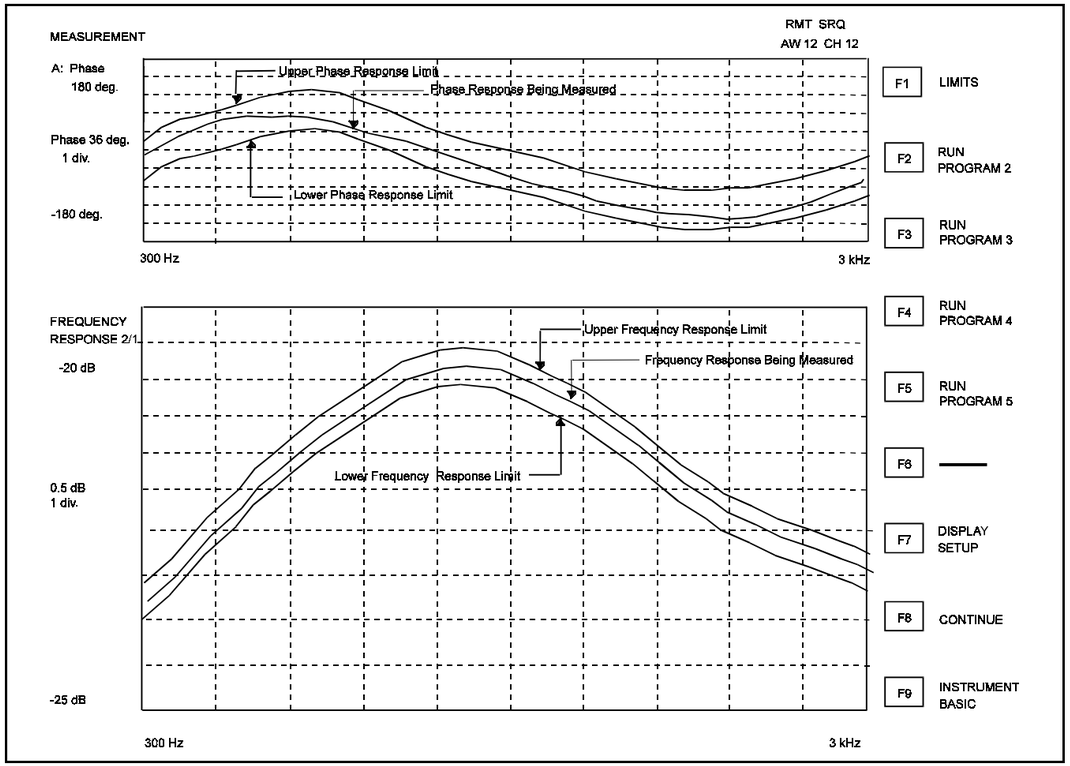


Figure 12 - Equalization Alignment Waveforms

Alignment using HP 35670A Sweep Analyzer

1. Turn on PTT for each site, one at time, and note weakest RF site (Test Rx meter). Close attention is necessary to pad each site down to the weakest site signal using the RF attenuator on the alignment receiver.

2. At the Control point:

   - Turn **OFF** the PTT for the reference site.
   - Turn **ON** the PTT and A/D for the next site to be aligned.

3. Change the test delay of this site according to the value established in the test delay chart. The empty column set up in Table 2 for test delay will be filled in at this point.

   For example, if the measured delay is + 25 microseconds relative to the reference site, 25 microseconds are added to the test delay setting recorded in the "Alignment Setup" (using the HP 35670A Sweep Analyzer). This value is added to the chart. (Actual setting values for all sites may be calculated and recorded at this time.)

4. Set the analog delay card for this site to get the phase response as close as possible to falling within the limits established. **DO NOT** adjust this card again, for the other channels. It will only change if the desired test delay chart is changed. This setting affects the delay of all channels at the site. Copy the settings to the additional card for this site if over 10 channels.

5. Prior to beginning test, exercise the equalizer card bypass switch to ensure it is in the NORM position and the FLT switch to the LD position.

Table 2 - Time Delay Offsets Relative to Reference Site, Analog Delay

SITE	Propagation To Test RX	Offset Delay	Measured Delay	Test Delay	Analog Delays	
					A	B
TX Site 1						
TX Site 2						
TX Site 3						
TX Site 4						
TX Site 5						
TX Site 6						
TX Site 7						
TX Site 8						
TX Site 9						
TX Site 10						

NOTES:

1. **Propagation to Test Receiver**: Is the point to point time taken by the RF signal to travel from a TX site to the Test receiver location (Approximately 5.2 microseconds per mile).

2. **Offset Delay**: Is the amount of shift in time required of a TX site, to move the center of its overlap with another site. This may be a *positive* number (later) or *negative* number (earlier).

3. **Measured Delay**: Is the sum of the Propagation delay and offset delay values.

4. **Test Delay**: Is the amount of test delay panel delay introduced to smooth the phase curve.

5. **Analog Delays** are the actual values set on the Analog Delay cards for "A" and "B" directions for a site.

6. Unplug the equalizer card to be adjusted from its position in Analog Shelf 1 for the site/channel being aligned. Replace it with the CONVEX C120EX extender card. Plug the equalizer card into the CONVEX C120REX panel in the test rack. Install the DB9 to DB9 jumper cable between the C120EX and C120REX. This allows easier access and adjustment of equalizer cards. When alignment of the equalizer card is complete, remove it from the C120REX panel and reinstall in its normal location in the Analog 1 Shelf.

7. Adjust amplitude and phase pots to achieve amplitude and phase variation within limits from the reference sweep (note that phase is required for 600 Hz to 2600 Hz). The cursor may be scrolled across the trace to read the frequency at any point of interest on the trace. This helps you identify which equalizer pot to adjust.

NOTE

CONVEX equalizers are shipped and pre aligned with the FLT switch in the LD position. This allows LF and HF pots for SHP and AMP to be active. These can be *carefully* adjusted to change the high end and low end response.

8. When this site is aligned satisfactorily, turn OFF its PTT control and turn ON the PTT and A/D for the next site. Install the equalizer for this site/channel in the C120REX per step 6 above.

9. Repeat the alignment steps for this site.

10. Repeat for sites on this channel.

SERVICE TIP

CURSOR: The cursor can be used to quickly determine the frequency for an out of limits point by rotating the thumbwheel to place the cursor on the spot in question. To use the cursor you must activate the graph it is on.

1. Press "ACTIVE TRACE"

2. Press "F1" for the top graph or "F2" for the bottom graph

SCALE: To change the scale on a graph, you must select the graph.

1. Press "ACTIVE TRACE"

2. Press "F1" for the top of the graph or F2" for the bottom graph

3. Press "SCALE".

4. Press "F2" top reference.

5. Rotate the thumbwheel slowly while watching the previous trace until the trace fits completely on the screen.

6. Press "BASIC" to exit from this mode.

NOTE

It may be necessary for some sites to use a remote test receiver to receive a distant site. Use a previously adjusted site that is strong enough for the remote test receiver to use as a reference. Adjust the delay line panel to obtain a similar pattern as was originally displayed for the reference. Use this new reference signal from the remote test receiver to align the remaining sites.

11. The remaining channels are aligned by repeating the steps used for the channel shown above.
    - Return all PTT's and A/D's for the completed channel at all sites to the SYSTEM position.
    - Return the completed channel's Compressor GAIN and COMPRESSION to ON.
    - Return the channel to service via the System Manager channel screen.

4.9 VOTING SELECTOR SETUP AND ALIGNMENT

Perform the steps in the order given. Refer to Voting Selector Panel LBI-38676 for additional detail.

At the Remote Site:

1. Connect a transmission test set, receive input set to 600 Ohm load, to channel 1 receive audio jackfield T600 RXV drop side.
2. Apply an on frequency 1000 microvolt signal modulated by 1000 Hz with 3.0 kHz deviation (±2.4 kHz NPSPAC) to the receiver antenna jack. Press and hold the station GETC RESET button.
3. Set the Line Out pot using the MIII handset or MIII Utility software to produce -10 dBm at the transmission test set.
4. Release the station GETC RESET button.
5. Remove the RF signal from the receiver input.
6. Set the 1950 Voting Tone gain pot using the MIII handset or MIII Utility software to produce -10 dBm at the transmission test set.
7. Set the transmission test set to measure input frequency. Verify 1950 Hz ±5 Hz is being sent.
8. Remove the transmission test set from T600 jackfield.

At the Control Point:

1. Connect a transmission test set with receive input set to BRIDGE, to J1 on the voter receive card channel 1, and the site under test. Connect the other side of the input to the Voter GND pin on the power supply card.
2. With 1000 Hz, -10 dBm test tone received from the remote site receiver (per remote site Step 2), adjust "INPUT ADJ" pot on the voter receive module for a reading of -20 dBm.
3. Connect transmission test set with receive input set to 600 Ohm load to A600 VVRX Voted Audio jackfield LINE jack for the channel under test.
4. Temporarily remove the W-O-R wire from J2 on the digital voter receiver GETC for the site/channel under test. The W-O-R wire connects to the voter interface board next to the GETC main board.
5. Adjust "OUTPUT ADJ" pot on the voter audio module to achieve a reading at the transmission test set of -10 dBm 0.1 dB. This only has to be done once per voter channel, not for every site.

> **NOTE**
>
> The voting selector will "fail" a receive module with constant tone after approximately 20 seconds. Interrupt the tone momentarily to restore the receive card from failure before taking this reading.

6. Replace the W-O-R wire removed above.
7. Disconnect transmission test set from A600 VVRX.
8. Remove 1000 Hz, -10 dBm test tone from the remote site receiver.
9. With 1950 Hz idle voting tone received from the remote site, verify its level is -20 dBm ± 6dB at J1 of the voter receive module. **DO NOT** adjust R2 at the receiver module.
10. With 1950 Hz idle voting tone received from the remote site, set the transmission test set to measure frequency. Verify its frequency is 1950 Hz ± 5 Hz.

At the Remote Site:

1. Remove the signal generator from the receiver input and reconnect antenna input cable to receiver.

Remaining Channels:

1. Repeat the "Voting Selector Setup and Alignment" procedure for all for remaining channels at the site.

Remaining Remote TX Sites:

1. Repeat the "Voting Selector Setup and Alignment" procedure for all for the remaining remote TX sites.

4.9.1 At AUX RX Sites (NOT AT SIMULCAST TX SITES):

1. Connect a transmission test set, receive input set to 600 ohm load, to channel 1 Receiver line output at TB1 pins 1 & 2, at rear of receiver.
2. Unplug the 25 pair connector from EDACS RX Audio panel.
3. Apply an on frequency 1000 microvolt signal modulated by 1000 Hz with ±3.0 kHz deviation (±2.4 kHz NPSPAC) to the receiver antenna jack. Press and hold the AUX receiver GETC RESET button.
4. Set the Line Out pot R936 on the AUX receiver system board to produce -10 dBm at the transmission test set.
5. Release the AUX receiver GETC RESET button.
6. Remove the RF signal from the receiver input.
7. With a digital voltmeter connected between U1, pin 1 and ground, adjust R9 for 3.00 Vdc.
8. Set the 1950 Hz Voting Tone level pot R19 on the voting tone board in the AUX receiver to produce -10 dBm at the transmission test set.
9. Set the transmission test set to measure input frequency. Verify that 1950 Hz ± 5 Hz is being sent. Adjust R5 on the voting tone board to set the tone frequency.
10. Remove the transmission test set from the AUX receiver output terminals.
11. Reinstall the 25 pair connector on the EDACS RX Audio panel.
12. Connect a transmission test set with receive input set to BRIDGE, to J1 on the voter receive card channel 1, and the site under test. Connect the other side of the input to the Voter GND pin on the power supply card.
13. With 1000 Hz, -10 dBm test tone received from the remote site receiver, adjust R2 on the voter receive module for a reading of -20 dBm.
14. Connect transmission test set with receive input set to 600 Ohm load to J600 Voted Audio jackfield LINE jack for the channel under test.
15. Adjust R10 on the voter audio module to achieve a reading at the transmission test set of -10 dBm ±0.1 dB. This only has to be done ***once per voter*** channel, not for every site.

> **NOTE**
>
> The voting selector will "fail" a receive module with constant tone after approximately 20 seconds. Interrupt the tone momentarily to restore the receive card from failure before taking this reading.

16. Disconnect transmission test set from J600.
17. Remove 1000 Hz, -10 dBm test tone from the remote site receiver.
18. With 1950 Hz idle voting tone received from the remote site, verify its level is -20 dBm ± 6dB at J1 of the voter receive module. DO NOT adjust R2 at the receiver module.
19. With 1950 Hz idle voting tone received from the remote site, set the transmission test set to measure frequency. Verify its frequency is 1950 Hz ± 5 Hz.

4.9.2 Internal Modem Setup (Voter Digital receivers to AUX RX sites & AUX RX GETC's):

Modem Transmit Audio level ***must*** be set before adjusting corresponding Receive end.

At the AUX Receive Site:

1. Connect a transmission test set, receive input set to 600 ohm load, to channel 1 Receiver modem TX output at TB10 pins 1 & 2, at rear of RX GETC.
2. Unplug the 25 pair connector from EDACS RX Data panel.
3. Adjust R2 (PH TX ADJ) on the GETC board for -10 dBm indicated on the transmission test set.

4. Remove the transmission test set from the AUX receiver GETC modem TX terminals.

5. Repeat steps 8. b. 1. through 4. for all channels at the AUX RX site.

6. Reinstall the 25 pair connector on the EDACS RX Audio panel.

4.9.3 At the Voter Digital RX GETC:
(corresponding to the site/channel adjusted above)

1. Connect an AC RMS voltmeter, input set to BRIDGE, to the voter digital receiver GETC between U18-1 and GND.

2. Adjust R1 (PH RX ADJ) on the GETC board for 85 mVRMS (400 mV P-P) as indicated on the AC voltmeter.

3. Disconnect the AC voltmeter from the voter digital receiver GETC.

4. Connect an oscilloscope vertical input probe between TP107 and GND.

5. Verify square waves are present on the display with periodic changes (approx. 1/ second) indicating AUX site status messages are being received at the voter digital receiver GETC.

6. Repeat steps 1. through 5 above for all Voter AUX site digital receivers.

5. FIELD TESTING

1. The initial settings of the system have been influenced by the Simulcast Interference plot produced by the propagation studies. Now a physical "tour" of the overlap areas is done to check on both audio and data working.

2. Part of the key to correctly setting up a simulcast system is that *all* transmit limiters and deviations must be set up identically (or as near as is humanly possible) and confirming that the low speed data (150 Hz) is symmetrical. This can be checked at the remote site FSK decoder and adjusted.

   The second part is that the audio amplitude and phase presented to all transmitters is identical and timed to arrive in the non capture areas within tolerance. Data must also be presented to all transmitters with the same deviation and timed to arrive in the non capture areas within tolerance.

   The preceding procedures set these parameters.

3. Non capture areas can be identified by keying a transmitter from each site involved in covering a certain area on a specific channel. Set up a different tone modulating each Tx site, so that each site may be identified. Presence of a single tone indicates the site is predominant (capturing) multiple tones heard in succession indicate an overlap. Move through the area slowly to identify all sites (tones) involved.

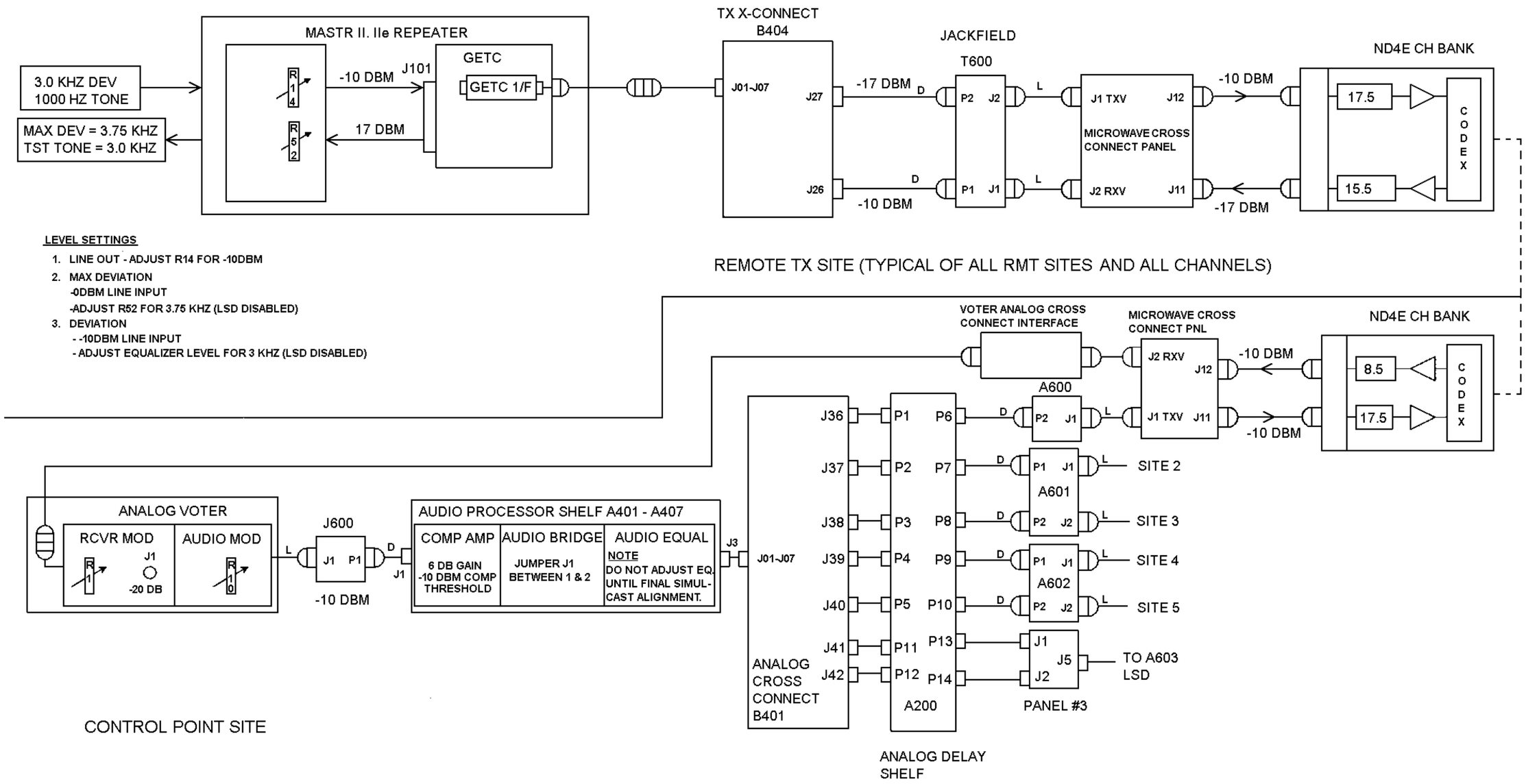
4. Physical plots of transmitter and site coverage can be used in conjunction with the predicted interference plots and then the system can be fine tuned. This can be accomplished by use of the multiple receiver tool developed by EGE Engineering. Each site will be transmitting carrier only on a different frequency from other sites. The area that is of interest is driven and information gathered automatically by the tool which includes location, signal strength of each site at each measured point.

5. This procedure will take into account anything that propagation predictions cannot, such as buildings, reflections or shadows from terrain or man-made objects.

6. Fine tuning consists of looking at the actual signals received in an area and their source. Path lengths can then be calculated and time delays adjusted for actual conditions.

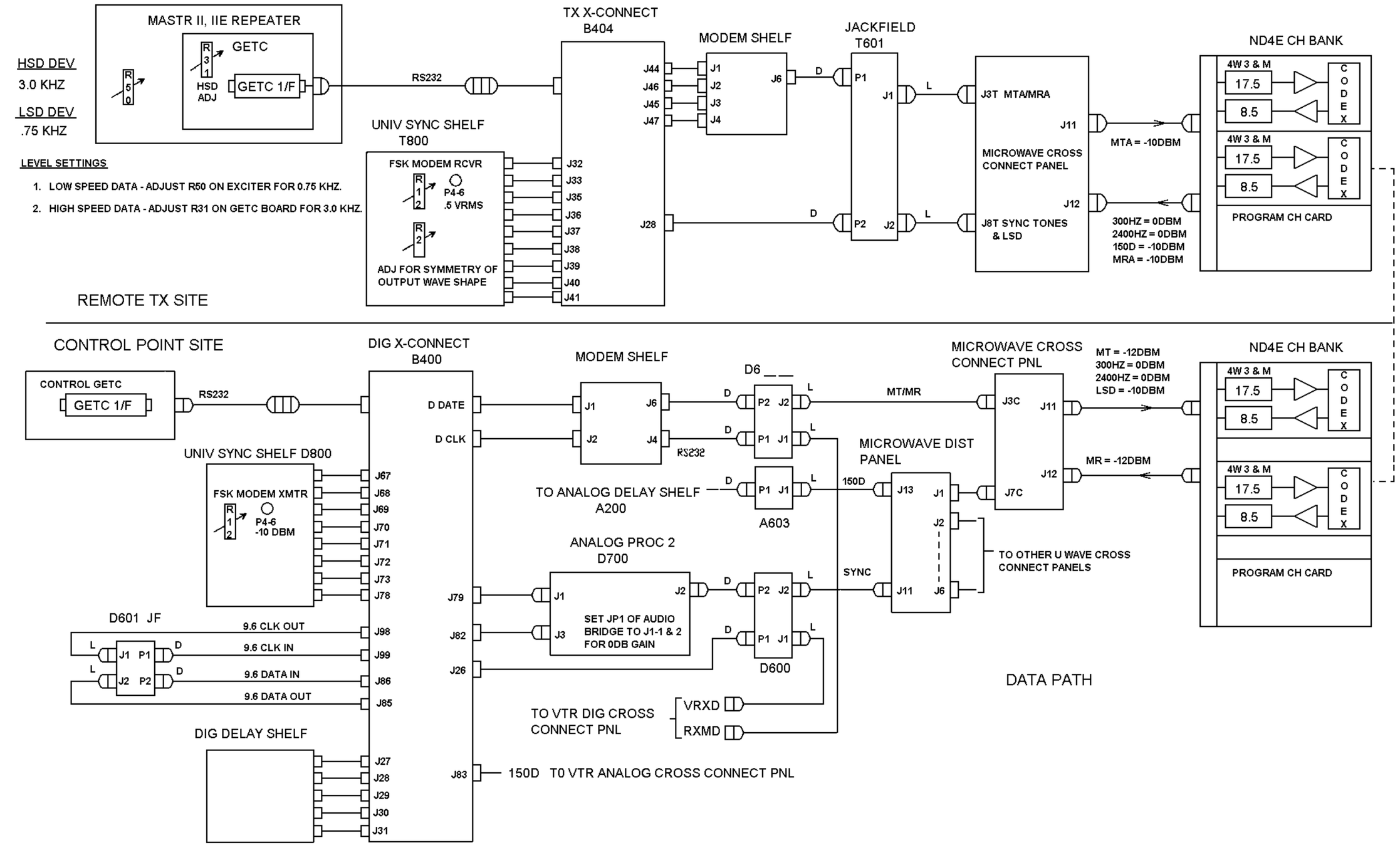
Table 3 - Routine Maintenance

MAINTENANCE CHECKS	INTERVAL BETWEEN CHECKS
Amplitude and Phase Sweep Check: Digital or Multiplex systems Analog Multiplex Systems **NOTE** The amplitude & Phase should be rechecked following replacement of any component in the transmit audio path (TX Exciter, GETC I/F card, MUX VF card at either end, or equalizer card).	 12 Months 6 Months or immediately following a Microwave PM check which may alter baseband levels.
Audio and Data Timing Check: Digital or Analog Multiplex Systems **NOTE** The audio and data timing should be rechecked following replacement of any component in the path: Data Path: (Digital Delay Card, Universal Sync Card, Tone I/F board, Program Card [Digital Multiplex], SC Card [Analog Multiplex]) Audio Path: (Analog Delay Card, Equalizer Card, GETC I/F Card)	 12 Months
TX Deviation Check: Digital Multiplex Systems Analog Multiplex Systems **NOTE** The TX Deviation should be rechecked following replacement of any component in the path: (Exciter Card, TX GETC, GETC I/F, MUX VF Card at either end, or the Equalizer Card).	 12 Months 6 Months or immediately following a Microwave PM check which may alter baseband levels



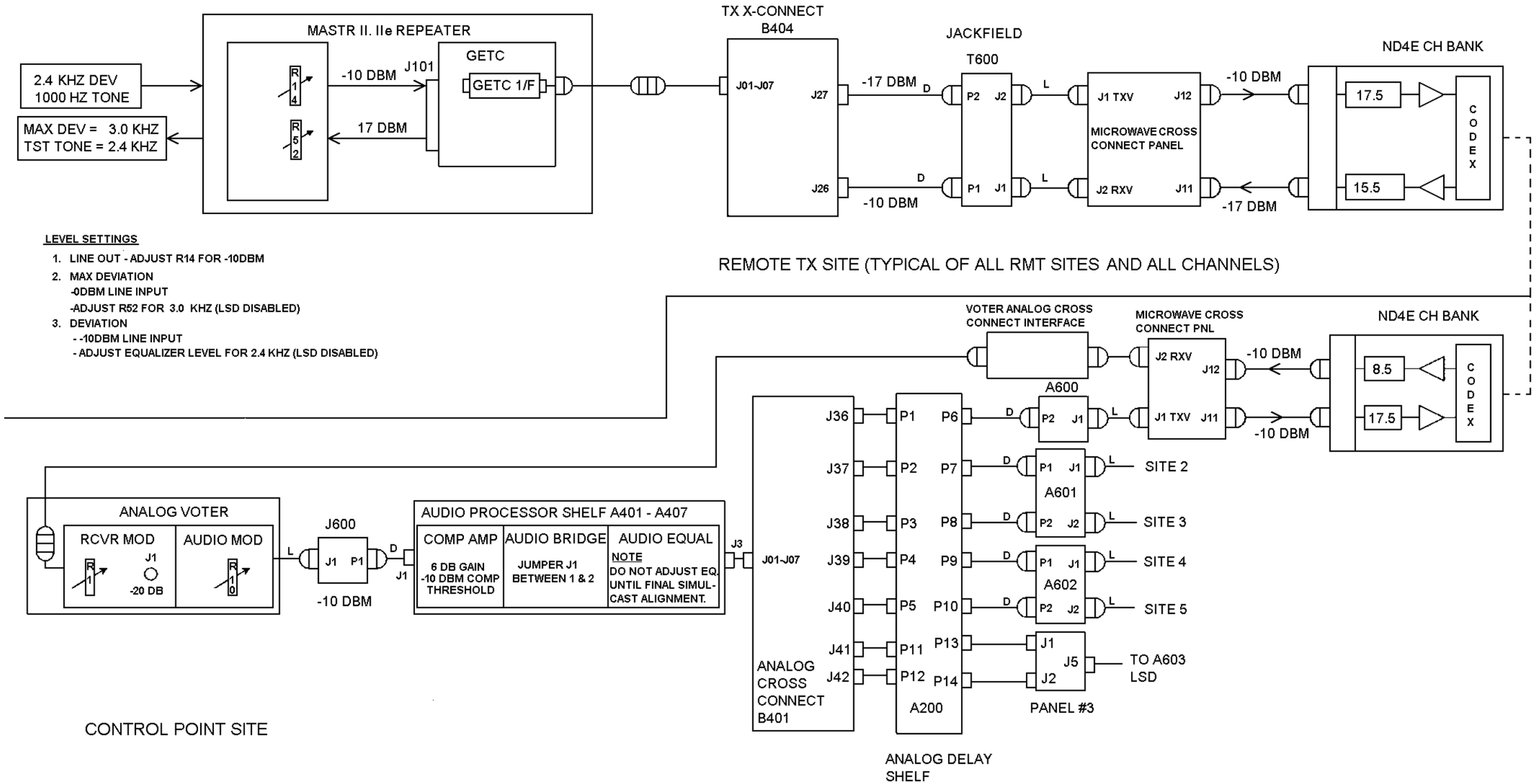
Voice, MASTR II & IIe Station - Non- NPSPAC

(19B804132 Sh. 1, Rev. 0)



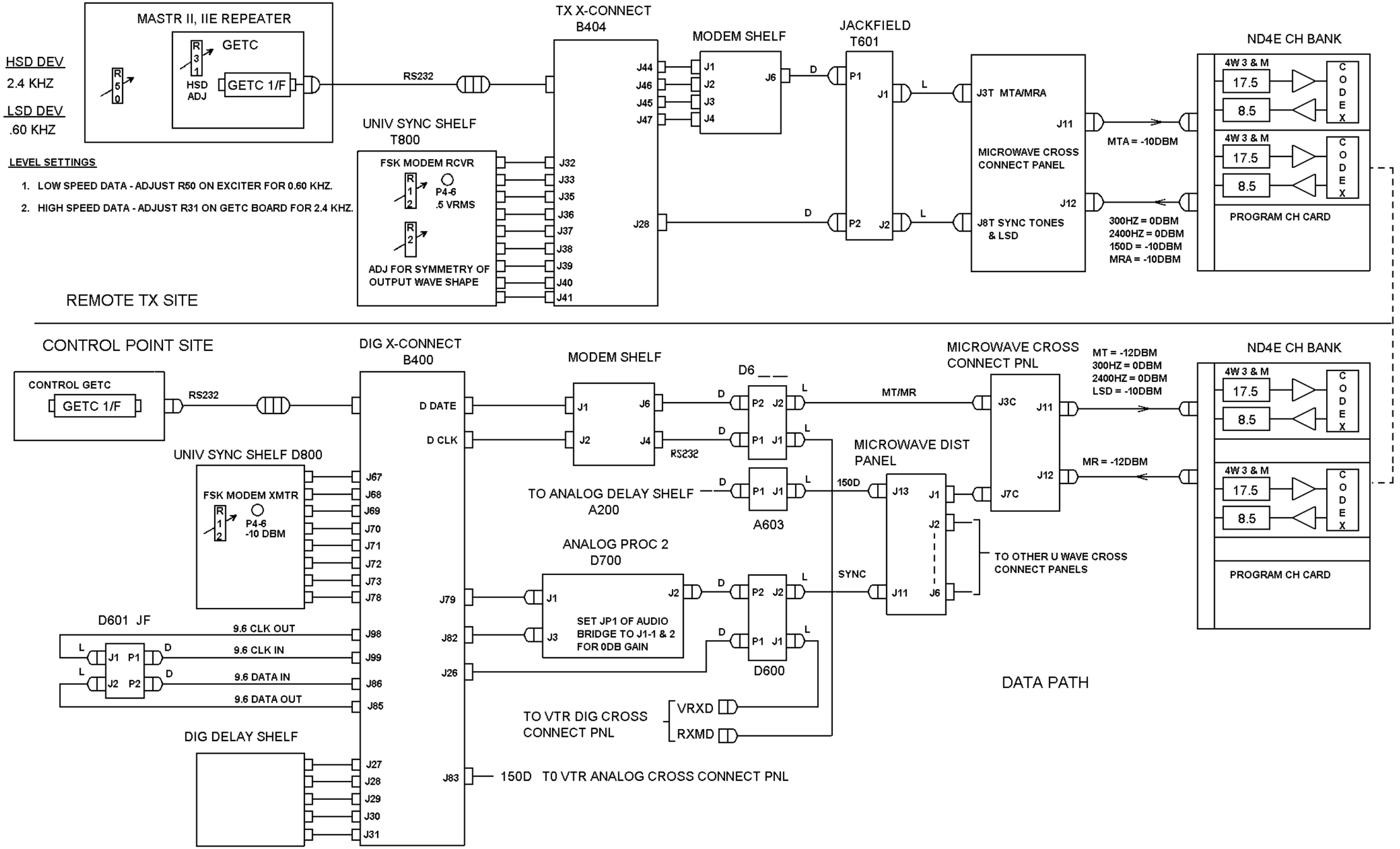
Data, MASTR II & IIe Station - Non- NPSPAC

(19B804132 Sh. 2, Rev. 0)



Voice, MASTR II & IIe Station - NPSPAC

(19B804132 Sh. 3, Rev. 0)



Data, MASTR II & IIe Station - NPSPAC

(19B804132 Sh. 4, Rev. 0)

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