MAINTENANCE MANUAL
ALIGNMENT PROCEDURES
FOR
SIMULCAST

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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.

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2. Tektronix 2430A Digital Storage Oscilloscope **Amplitude Measurement** From Test Receiver Start-up Procedure

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4. Exciter Deviation Adjustment

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8. Analog Delay Check

9. Clock Reference Edge Check

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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

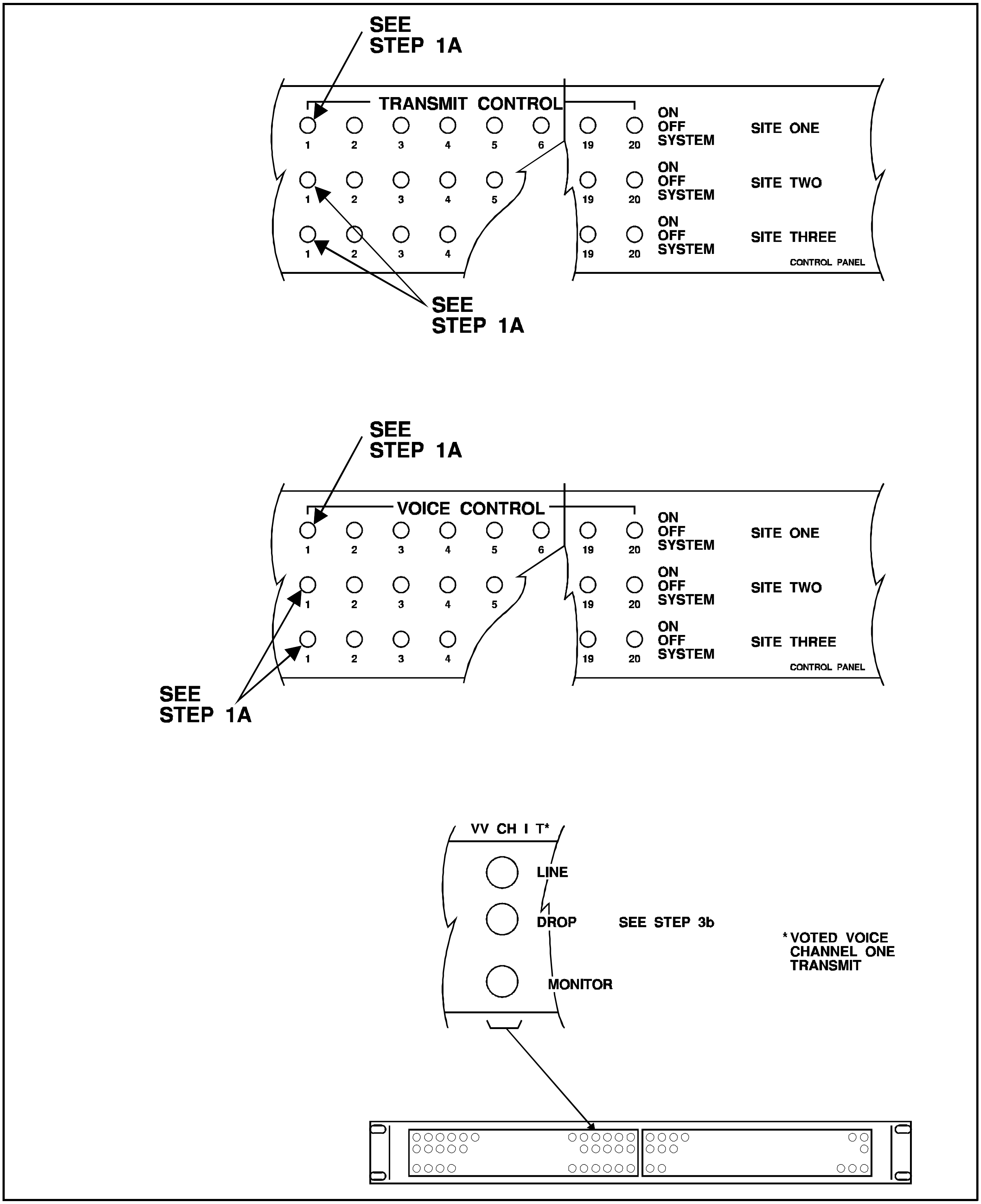

Figure 1 - Exciter Level Adjustment

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**.

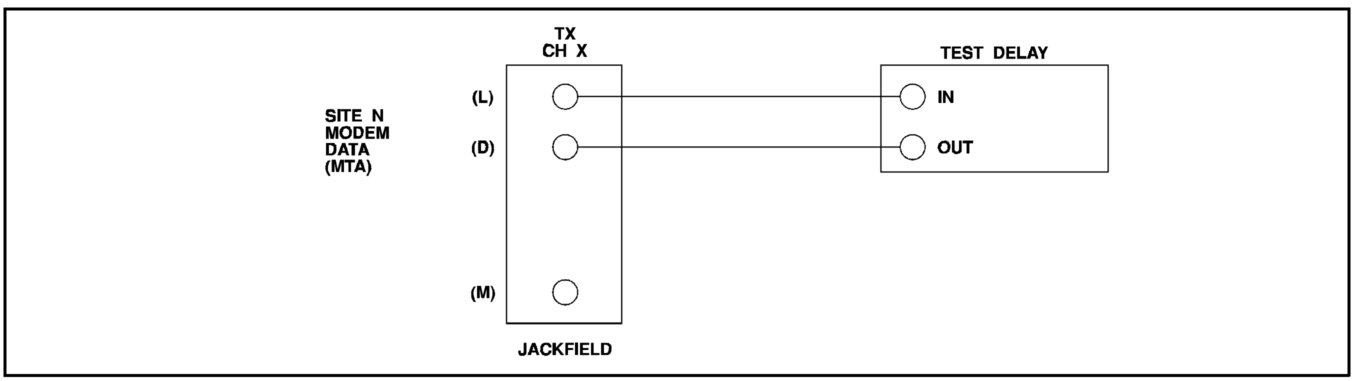

Figure 2 - Test Hook-Up

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

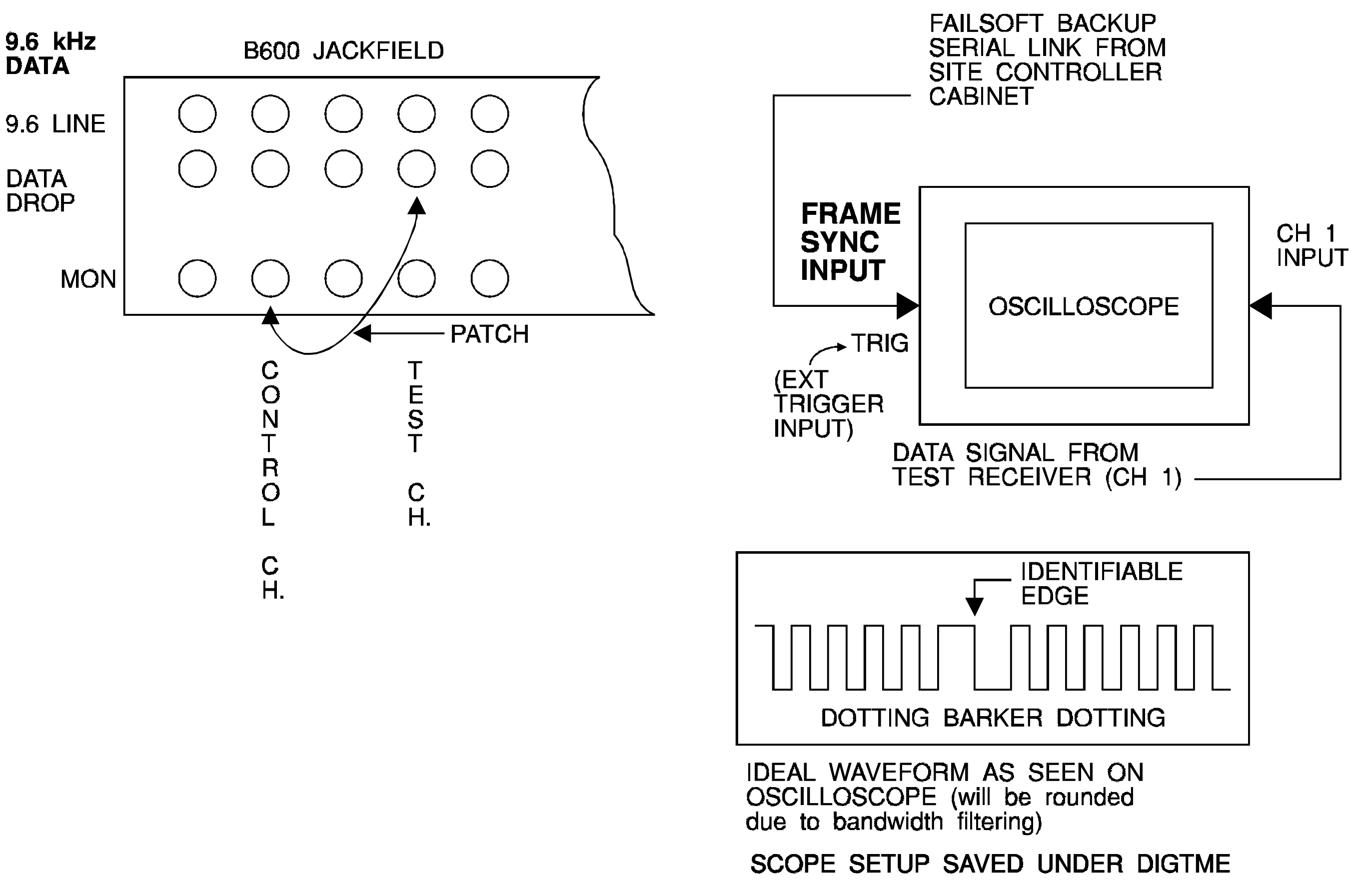

Figure 3 - Digital Delay Adjustment

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

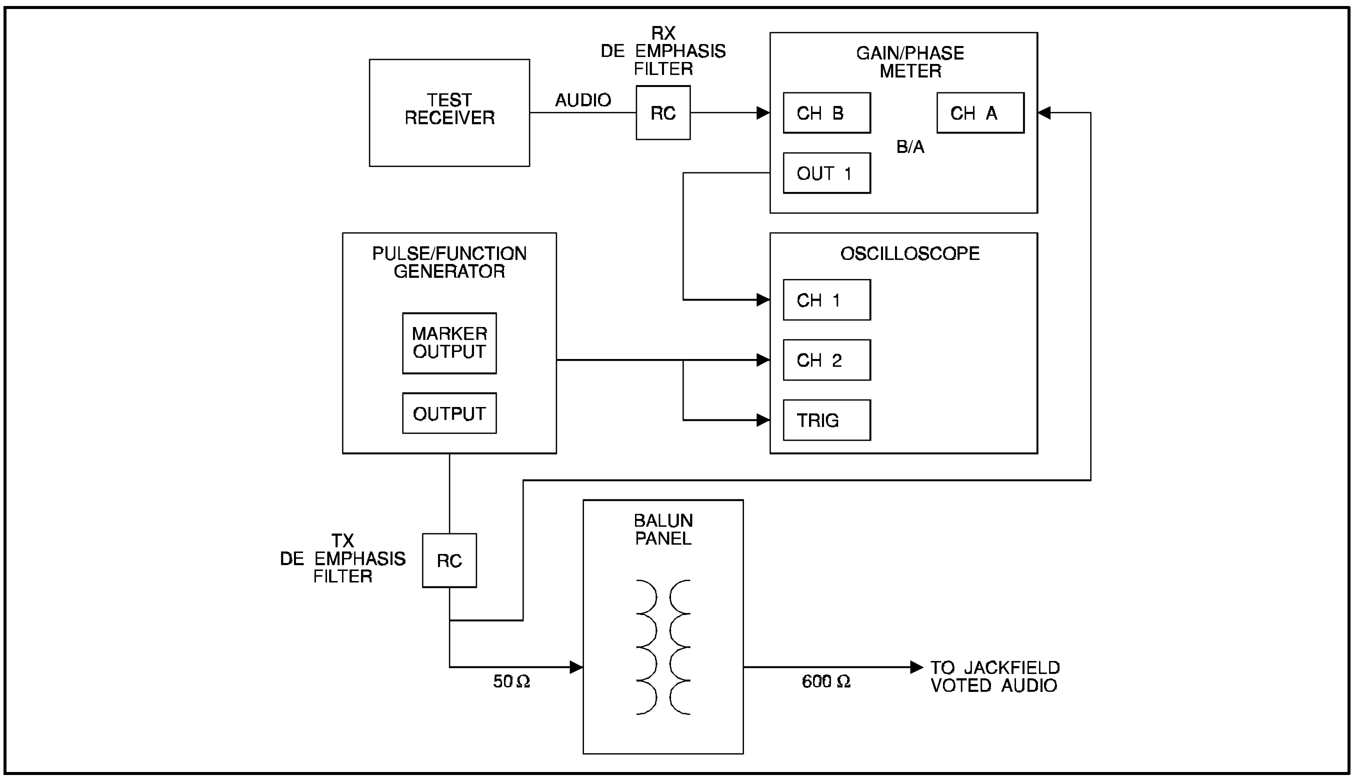

Figure 4 - Amplitude Equalization Alignment

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.

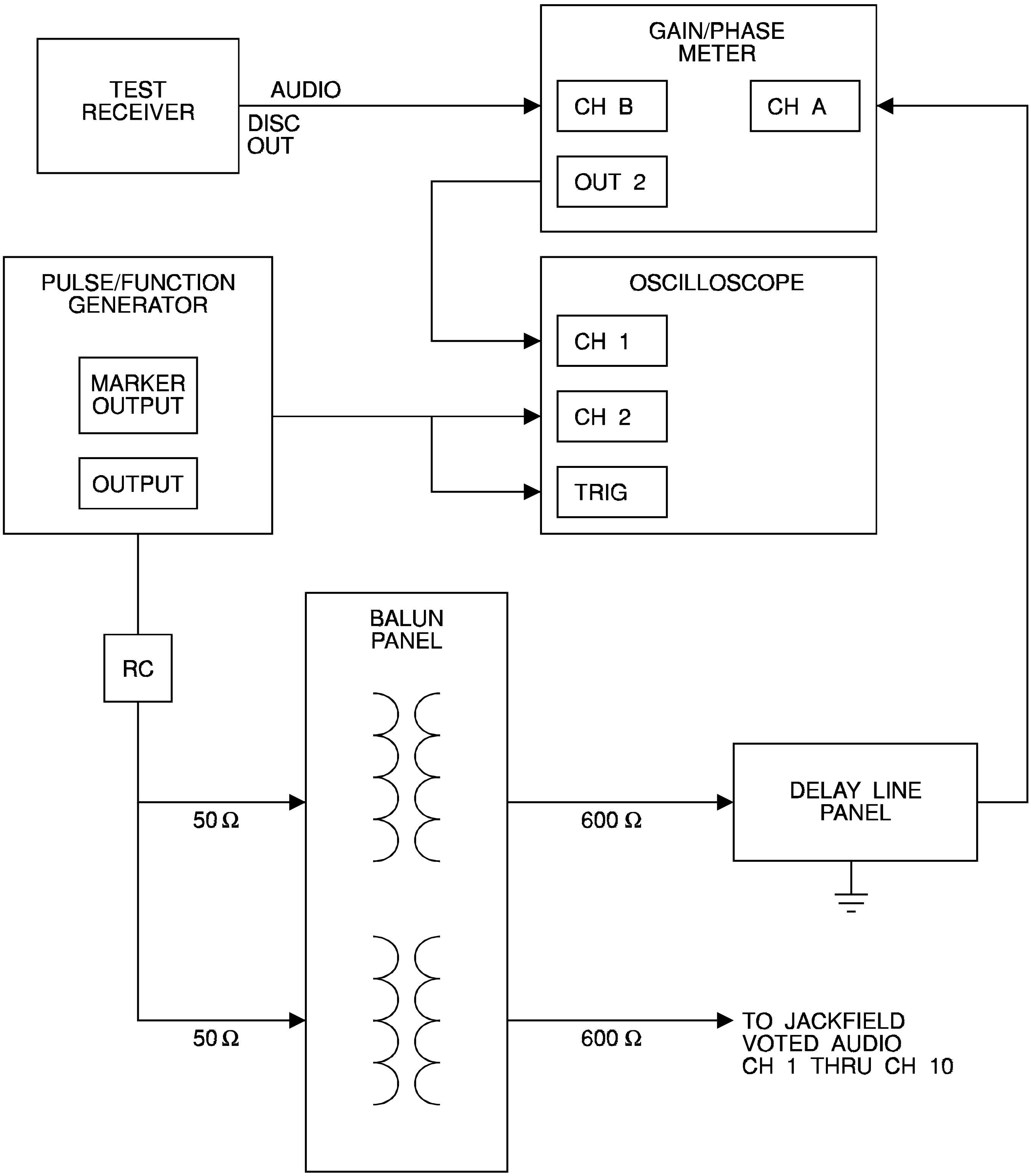

Figure 5 - Phase Equalization Alignment
(Amplitude and Phase Alignment is repeated for all channels.)

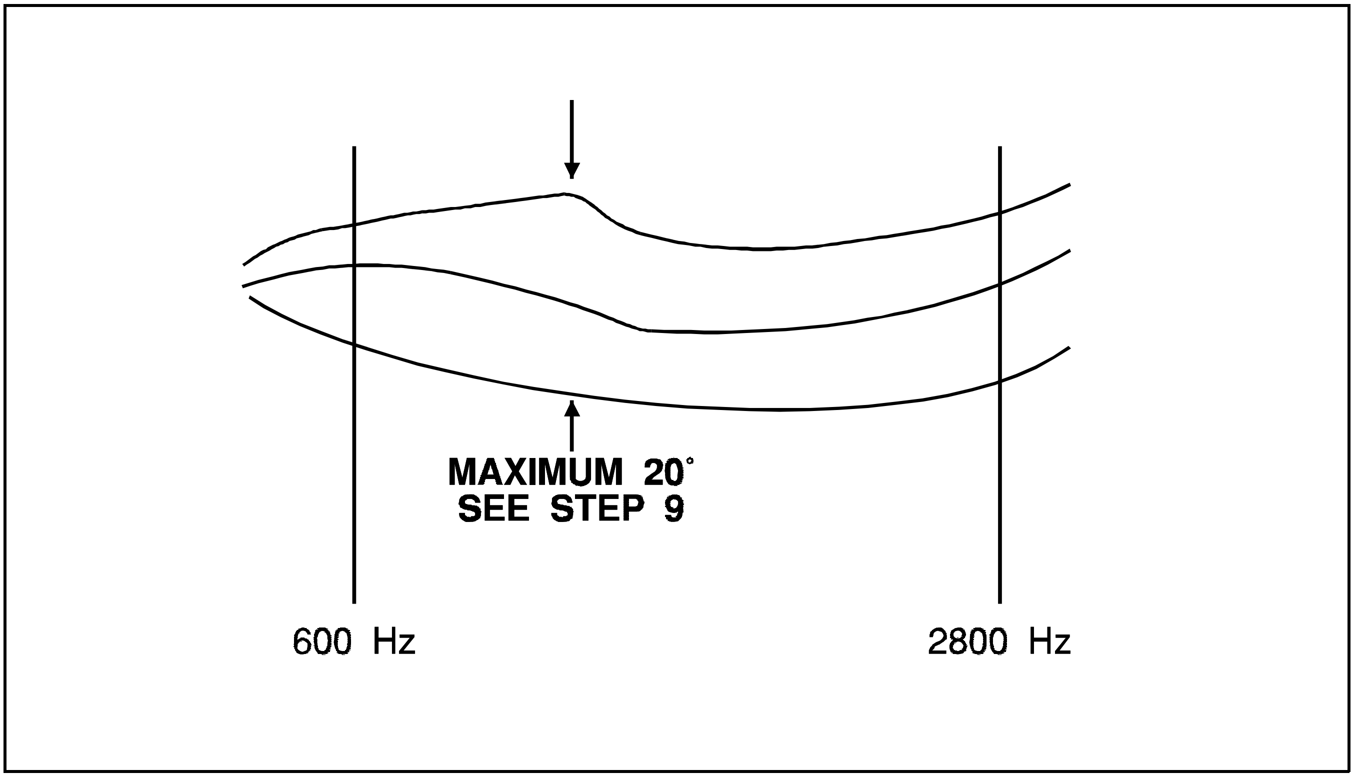

Figure 6 - Phase Equalization Alignment Waveforms

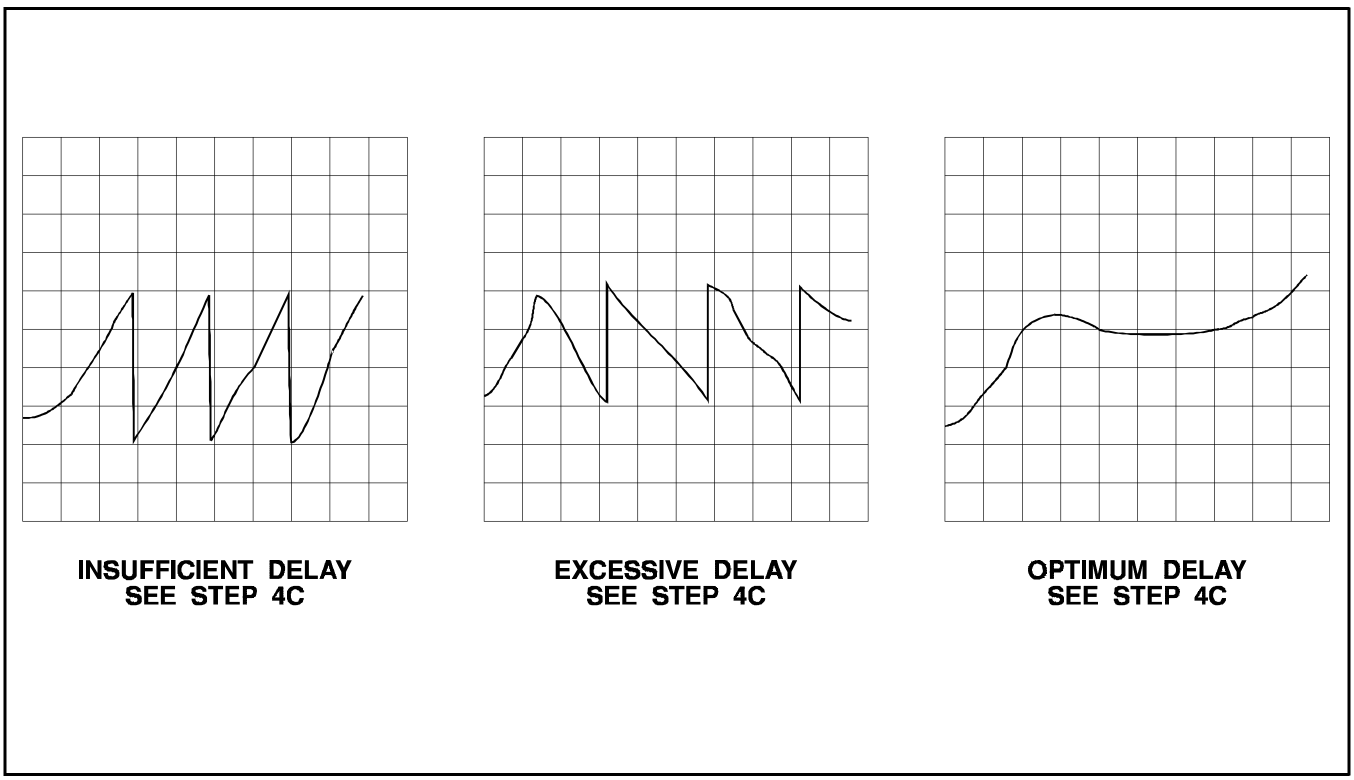

Figure 7 - Delay Waveforms

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
EDACS® SIMULCAST SYSTEMS
SYSTEM ALIGNMENT & FIELD TESTING PROCEDURES
(HP 35670A Sweep Analyzer w/MASTR II & MASTR IIe Stations)

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ERICSSON

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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.

NOTE

Prior to starting these procedures, obtain propagation times from each site to the alignment receiver and the timing offsets to be set for your specific system configuration. This information is available from the propagation group at Ericsson Inc. Global Application Engineering (GAE) and is required to complete Tables 1 and 2 in this procedure.

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. Delay Line Panel
4. Balun Panel assembly
5. Transmission Test Set - CONVEX 806RM
6. Extender Panel - CONVEX C120/REX

Test Equipment Required But Not Supplied

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

NOTE

Alternate monitors that may be used include the IFR 1500 and HP8920A. Each of these have settings marked in this procedure. All instruments do not give exactly the same reading - even when the same model is used. ***Use one monitor for setting all channels at all sites.***

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.
5. MIII Utilities Software, TQ3353.
6. MIII Programming Cable, TQ3356.

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.

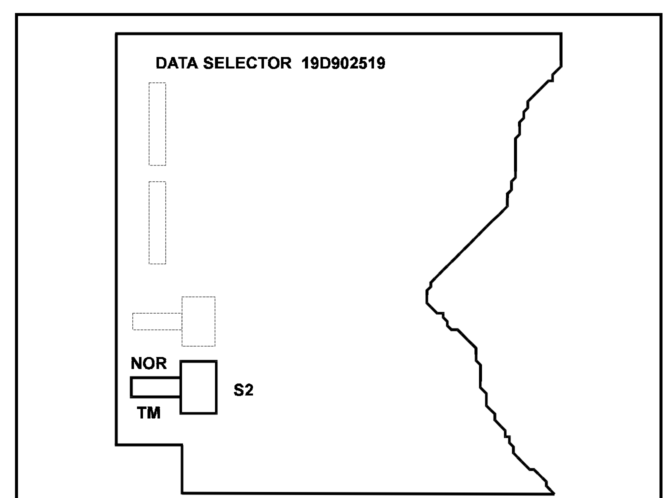


Figure 1 - Data Selector Module, S2 Location

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.

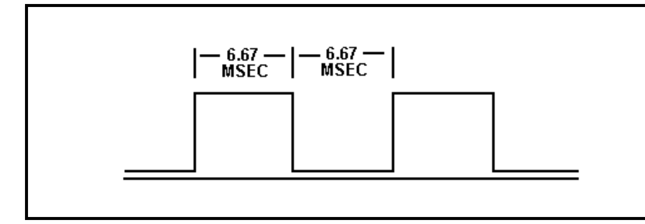


Figure 2 - RXD 75 Hz Symmetry

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.

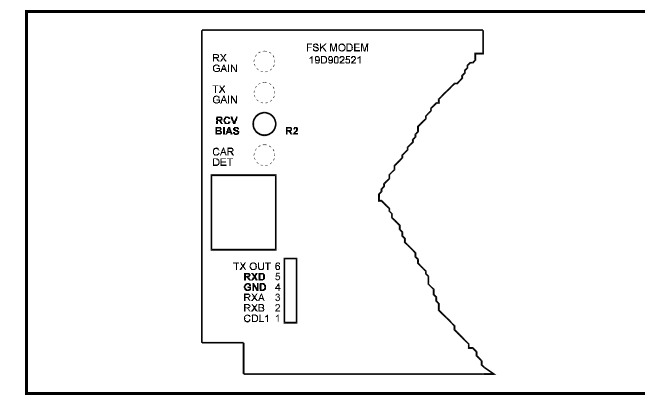


Figure 3 - FSK Modem Component Location

4.3 EQUALIZER PRE ALIGNMENT

4.3.1 TELLTABS 4041 Equalizer Pre Alignment

THE FOLLOWING PROCEDURE APPLIES ONLY TO TELLABS 4041 EQUALIZERS

NOTE

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

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.

4.3.2 CONVEX C20 Equalizer Pre Alignment

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 and threshold of compression set to 0 dBm.

1. Set LIMIT RANGE switch (S3) on compressor to HIGH.
2. Feed a 1 kHz, -10 dBm test tone into the input jack of the compressor being set.
3. Measure output by inserting a longframe plug into output jack of compressor. Set meter to terminate 600 ohms.
4. With GAIN = NORMAL and COMP = OFF, set gain to achieve 5 dB higher than its input out of compressor (-5 dBm).
5. Increase input of 1 kHz tone level to +5 dBm.
6. With GAIN = NORMAL and COMP = NORMAL, set compression to 0 dBm output.
7. 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 Frequency Compensation

At The Control Point:

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.

At The Transmit Site:

1. Connect the exciter directly to the input of the Communication Service Monitor.
2. Set the Communication Service Monitor to FM NAR operation and tune to receive the RF channel under test.
3. Observe the 150 baud data pattern on the IFR 1200 Service Monitor (field tests indicate the HP8920A will not display the same result.) A properly set low speed frequency compensation (R40 MII exciter) should display a trace resembling a square wave with varying period. The long periods should show virtually no slope either up or down. If a noticeable slope exists, adjust R40 on the MASTR II exciter per the flattest trace. See Figure 3A below.

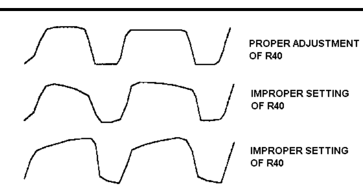


Figure 3A. Proper Adjusment of R40

4. Repeat test for remaining sites/channels by turning each respective site's PTT and A/D switch to ON for the channel under test. All other PTT and A/D switches are set to OFF.

4.5.2 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. Take the channel being tested out-of-service to avoid channel assignment by the system.

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.

At The Transmit Site:

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

Similar settings for the HP8920A are:

IF Filter =	15 kHz
Filter 1 =	< 20 Hz
Filter 2 =	300 Hz LPF

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.

Remove J17 on GETC if present.

Repeat step 4 of procedure.

Set GETC dip switches to their original settings.

Press "RESET".

Remove ground from TB10-5 and reconnect original wire.

Reinstall J17 to its original position on the GETC if it was removed above.

Restor the channel to service.

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 the communications service monitor and adjust R50 (CG) on the MASTR II/MASTR IIe exciter. Adjust deviation for 0.75 kHz ± 10 Hz deviation (150 baud data) or (0.600 kHz ± 10 Hz if **NPSPAC**).
5. Disconnect communications service monitor and reconnect exciter to PA.
6. Remove Bantam plug from TRANSMIT audio jackfield and return the channel to service.
7. Repeat this test for the remaining sites/channels by turning each sites' respective PTT and A/D to ON for the channel under test. Set all other PTT and A/D switches to OFF.

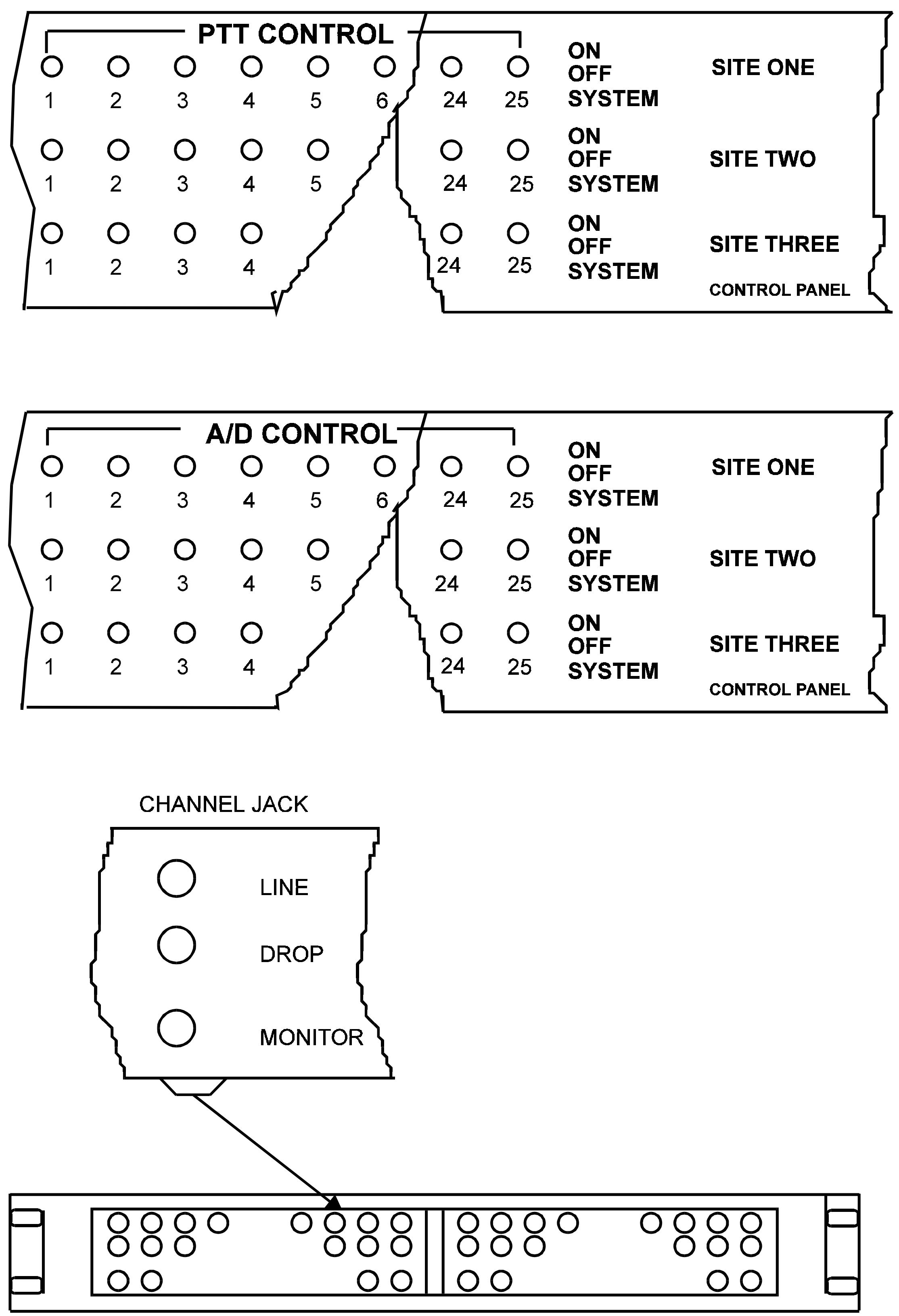


Figure 4 - Jackfield and Control Panel Detail

4.5.3 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 the channel voted voice drop circuit (A600 VVRX).
3. SET PTT and A/D switches to ON for channel/site under test.
4. Set the compressor COMPRESSION and GAIN switches to OFF.

At The Transmit Site:

> **WARNING**
>
> Users on an active system will experience communications disturbance during this test, so take the channel being tested out-of-service to avoid channel assignment by the system.

1. Remove J4 on the GETC Interface board for the channel under test.
2. Connect the exciter directly to the input of the communications service monitor.
3. Set communication service monitor to FM NAR and observe the display. Adjust R52 in the exciter to set the deviation for 3.75 kHz (3.3 kHz if NPSPAC).

> **NOTE**
>
> Settings on HP8920A for this section are:
> IF Filter = 15 kHz
> Filter 1 = < 20 Hz
> Filter 2 = 15 kHz LPF

At The Control Point:

1. Reduce the test tone level of the transmission test set to -10 dBm.

At Each Transmit Site:

1. Verify approximately -17 dBm is present at the transmitter audio input (jackfield T600 TXV) line circuit with meter terminated in 600 ohms.
2. Remove meter from the (T600 TXV) jackfield.
3. With the communications service monitor set to **FM NAR**, observe the deviation.
4. Adjust the equalizer level control at the Control Point to achieve 3.0 kHz ± 0.05 (2.4 kHz if NPSAC) deviation.
5. Disconnect communications service monitor, reconnect exciter to the PA, and reinstall J4.
6. Return the channel to service.
7. Repeat this procedure for the remaining sites on this channel, then complete the procedure for the remaining channels.
8. When completed on this channel, restore the compressor GAIN and COMPRESSION switches to ON.

4.5.4 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 Each Transmit Site:

1. Connect the exciter directly to the input of the communications service monitor.
2. 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**
>
> Settings on HP8920A for this section are:
> IF Filter = 230 kHz
> Filter 1 = < 20 Hz
> Filter 2 = 15 kHz LPF

3. Reconnect exciter output to transmitter PA input.

5. Repeat 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.

At The Control Point:

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.

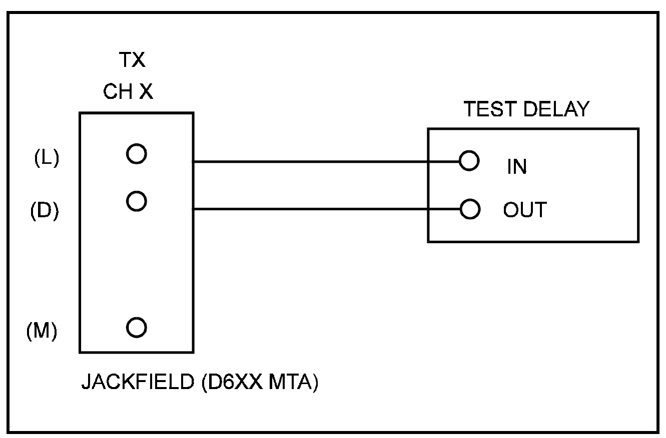


Figure 5 - Test Setup, 300 Hz Polarity Check

NOTE

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

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 control panel, only the site under test should have PTT ON(See Figure 6 for "dotting/barker" region and oscilloscope hook up). If no sync out is present, use FSL Cable. Refer to Figure 7.

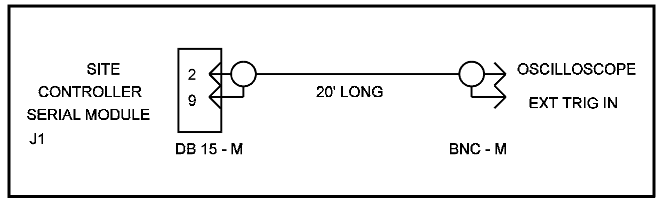


Figure 7 - FSL Cable

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 control channel.

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:

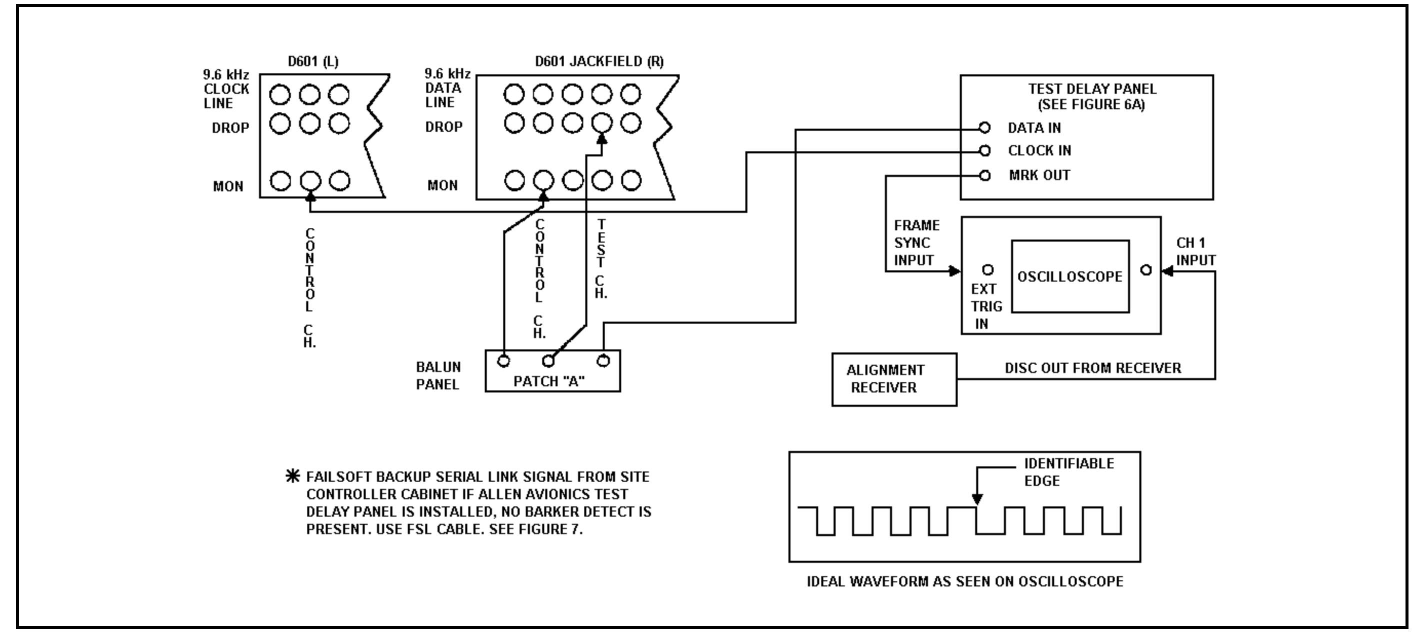


Figure 6 - Digital Delay Adjustment

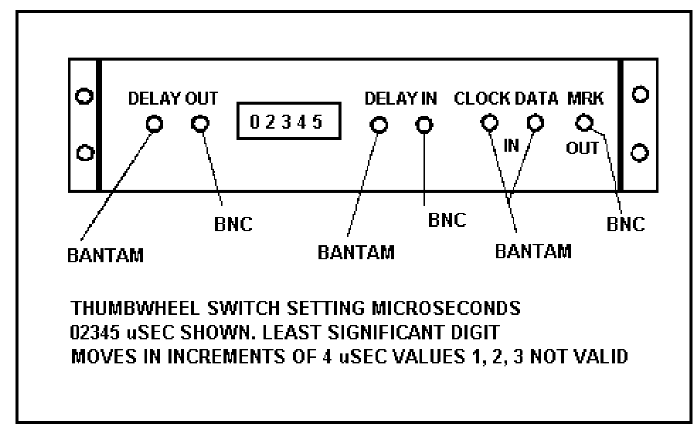


Figure 6A. Test Delay Panel

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.

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

Before starting this procedure, copy Table 1 from this Manual to use as a working copy. Enter your system specific data in the columns for propagation delay, offset delay, total delay, and measured delay (See Table 1 "NOTES"). If for any reason, the offset delays are changed after running this procedure, recalculate total and measured delays, then repeat the procedure with new values.

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 & S6-1) are in the "A" position on delay card(Closed), except for loop systems, switches should be open to allow "B" select.

1. Set Site 1 (REFERENCE) "A" and "B" delays on its digital delay cards to 256 microseconds as an "arbitrary" starting point. This allows adjustment of other sites forward or backward in time relative to the REFERENCE site.
2. Connect the test equipment as shown in Figure 6.

NOTE

There will be more than one card per site if the system has more than 10 channels.

3. Patch data from the control channel to the test channel.

4. Starting with the REFERENCE site (site 1) on the Control Panel, set the following switches for the channel being tested:
   - REFERENCE site PTT **ON**.
   - REFERENCE site A/D **OFF**.
   - All other sites PTT **OFF**.
   - All other sites A/D **ON**.

5. Set the oscilloscope to view the first "dotting/ barker" region of data after the scope triggers using delayed sweep. Pick a uniquely identifiable zero crossing of data (see Figure 6). You may want to use AVERAGE of the oscilloscope traces to display a smoother trace.

6. If the system requires an alternate delay for the REFERENCE Site (loop system and the REFERENCE Site is **not** co-located with the Control Point), then digital "B" select is activated. Observe the data and identify whether it is "early" (left of the original point) or late (right of the original point). Adjust the "B" delay for the reference site by adding time (if early) or subtracting time (if late). Wait after setting to allow for Resync of the data. Keep adjusting "B" delay until the data is at the same point as the original REFERENCE. Record this value in the REFERENCE Sites' Delay "B" column in Table 1. Restore the loop to normal.

7. 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**.

8. 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 position offset from the REFERENCE data point by the amount listed in the column "measured delay" in Table 1 for this site. (+) would indicate this point is to the right of REFERENCE and (-) would be to the left of REFERENCE. Wait after setting the digital delay for "Resync" to occur to verify that the correct amount of time was added or subtracted. Set this value in the second digital delay card for this site if the system has between 10 and 20 channels and a third digital delay card if the system has more than 20 channels.

9. Record the digital delay setting obtained for this site in the Digital "A" column.

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. Adjust the "delayed sweep" knob to place the identifiable data point in the center of the screen. (REFERENCE Site only).

IMPORTANT NOTE

Once a reference has been established, do not touch the horizontal position knob or the "B" Delay Time Position knob when adjusting digital delays for other sites.

NOTE

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 µsec/bit).

10. If the system requires an alternate delay setting (loop systems), then digital "B" must be set. Place the loop system for this site in the alternate path. verify the "B" select for the site involved is activated. Repeat Step 8 for the alternate path.

11. Record the digitla delay setting obtained for this sites alternate path in the Digital "B" column.

12. Restore the loop to normal.

13. 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.

14. 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.

4.8.2 Amplitude Equalization Overview (With HP35670A)

Audio Equalization Alignment as follows provides phase and amplitude adjustment combined with timing delays. The phase and amplitude adjustment 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 in the REFERENCE Site 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 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 9.

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

1. Ensure the A/B select switch (S2-1) is in the "A" position (closed) except in loop systems, switch should be open to allow "B" select.

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.

2. On the analog delay cards, set site 1 (REFERENCE) audio delay to 256 microseconds as an arbitrary starting point. This allows adjustment forward or backward in time relative to the REFERENCE site.

3. Set up cabling between HP 35670A, Delay Panel, Test Radio, and Balun Panel as shown in Figure 10.

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

4. 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.

5. **<u>At the Control Site</u>**, 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.
6. Copy Table 2 from this manual to use as a working copy. Enter your system specific data in columns for propagation delay, offset delay, total delay, and measured delay. These values will be the same as those used in Table 1. If for any reason, the offset delays are <u>*changed*</u>, after running this procedure, recalculate total and measured delays, then repeat this procedure with the new values.

NOTE

It has been determined that the *Allen Avionics* delays used in the Test Delay Panel introduce loss and produce distortion. 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.

A new Test Delay Panel (shown in Figure 6A) will replace the Allen Avionics Panel. If your system has an Allen Avionics Panel, an alternative is to build special cables to plug into the back of the Analog Delay shelf (See Figure 8). 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. This arrangement *will* allow *simultaneous* Amplitude and Phase adjustment.

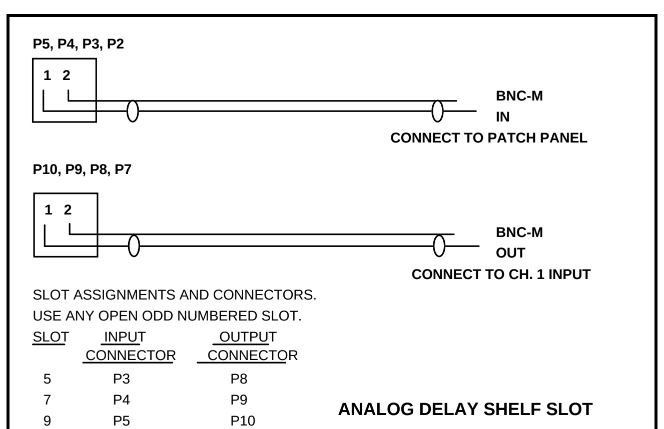


Figure 8 - Interconnect Cables, Analog Delay Backplane

4.8.4 <u>Preliminary Reference Setup using HP 35670A Sweep Analyzer:</u>

1. Turn compressor COMPRESSION and GAIN OFF for channel under test.
2. Take channel out of service at the System Manager.
3. Insert the swept signal into A600 VVRX voted voice drop circuit for Channel 1.
4. Set the REFERENCE Sites PTT and A/D switches to ON for Channel 1.
5. 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.
6. Exercise the Convex equalizer card for the REFERENCE site/channel to ensure the BYPASS switch is in the NORM position, and the FLT switch is in the LD position.
7. Adjust the **GENERATOR ADJUSTMENT LEVEL** of the HP35670A source to obtain 2 kHz non-limited deviation during the sweep. Verify with a communications 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. And can be restarted at anytime during the sweep.

8. 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.

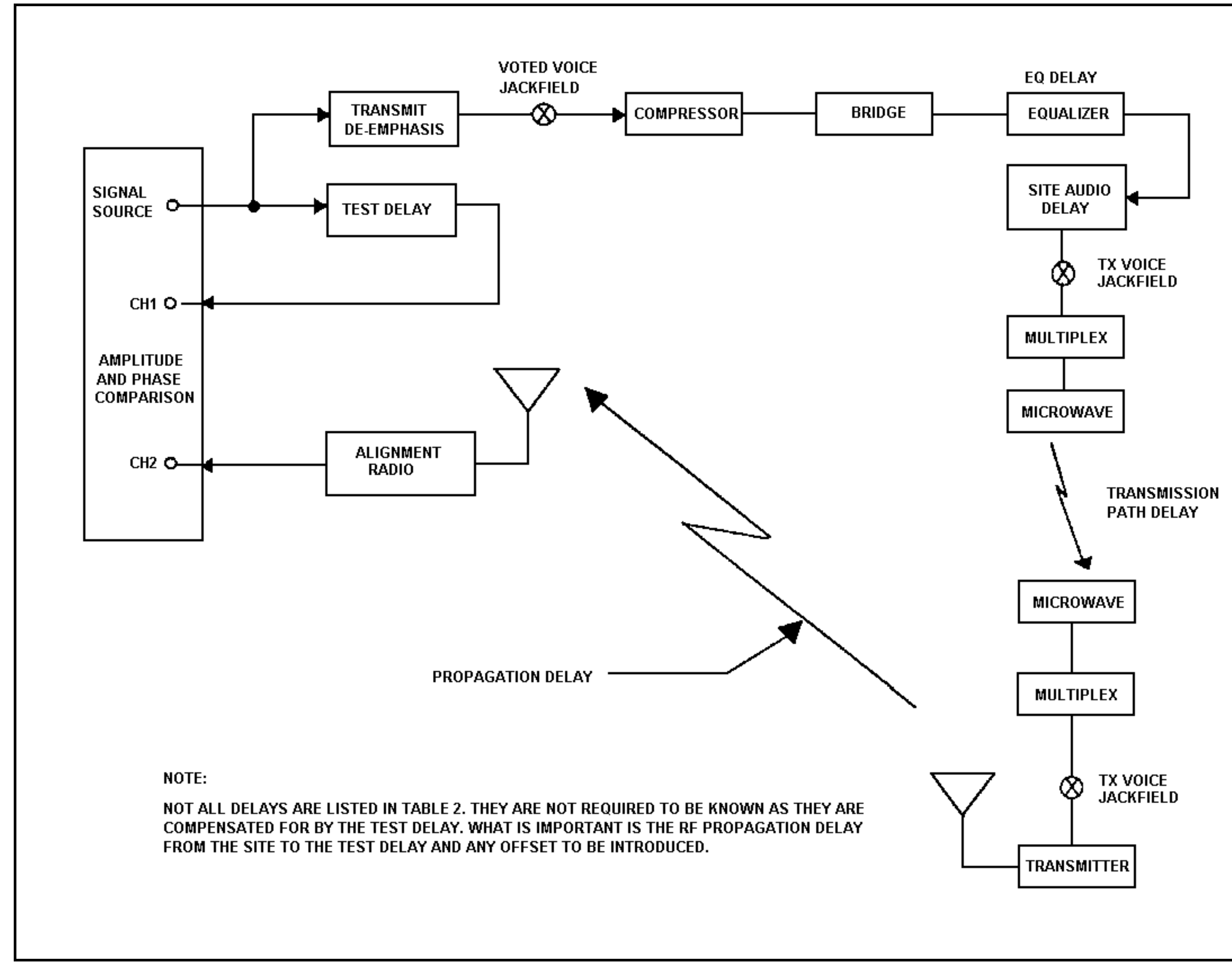


Figure 9 - Simulcast Audio Alignment

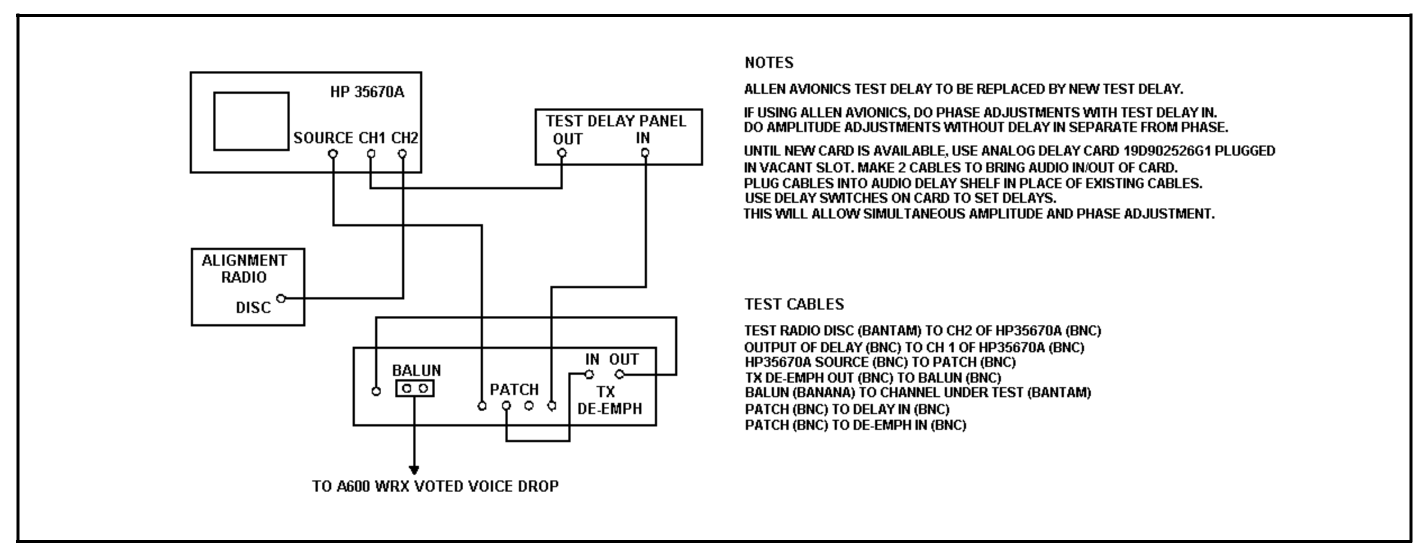


Figure 10 - Simulcast Alignment Test Setup Using HP 35670A Sweep Analyzer

9. 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.

10. Adjust the test delay to "match" the equipment and propagation delays to/from the REFERENCE Site/Channel. It is usually in the order of several milliseconds, and can be found empirically by "removing the sawteeth" resulting from the 360 degree wrap-around as shown in Figure 11. Record the delay value obtained in the Test Delay column for the REFERENCE Site. Test Delays must now be calculated for the remaining sites per the instruction for the Test Delay column in Table 2.

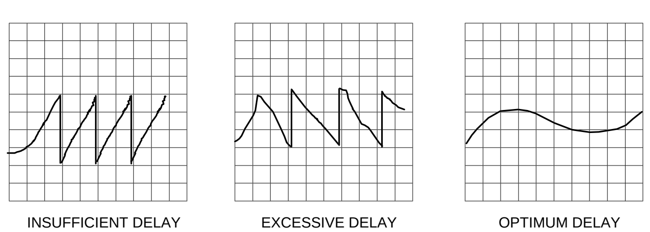


Figure 11 - Delay Waveforms

11. Experience has shown improved performance by adjusting the equalizer HF GAIN counterclockwise 3 to 4 turns to force the 2600 to 3000 Hz trace to "roll off" more than normal. Compare to a trace run prior to adjusting HF AMPL. (Dotted line on Figure 12).

12. 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 ± 0.15 dB and phase delay within ± 15 degrees.

13. If this system requires an alternate delay for the REFERENCE Site (loop system and the REFERENCE Site is not co-located with the Control Point), then Analog Delay "B" must be set. Place the loop system for the REFERENCE Site in the alternate path. Verify the "B" select is activated. Observe the sweep phase curve and adjust the "B" delay value to match the shape obtained earlier. Do not adjust TEST Delay setting. Record the value for the "B" delay in the REFERENCE Site "B" Analog Delay Column in Table 2. Set the additional card's Analog "B" setting for this site if over 10 channels.

14. Restore the loop to normal.

4.8.5 Alignment using HP 35670A Sweep Analyzer

1. Prior to beginning the test, exercise each CONVEX equalizer card's BYPASS switch to ensure it is in the NORM position, and the FLT switch is in the LD position.

2. 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 within ± 5 dB of the weakest site using the RF attenuator on the alignment receiver.

3. **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.

4. Change the test delay of this site according to the value established in the test delay column of Table 2.

   For example, if the measured delay for a site is + 25 microseconds relative to the REFERENCE Site, 25 microseconds are added to the test delay value obtained for the REFERENCE Site and used as the Test Delay value for this site.

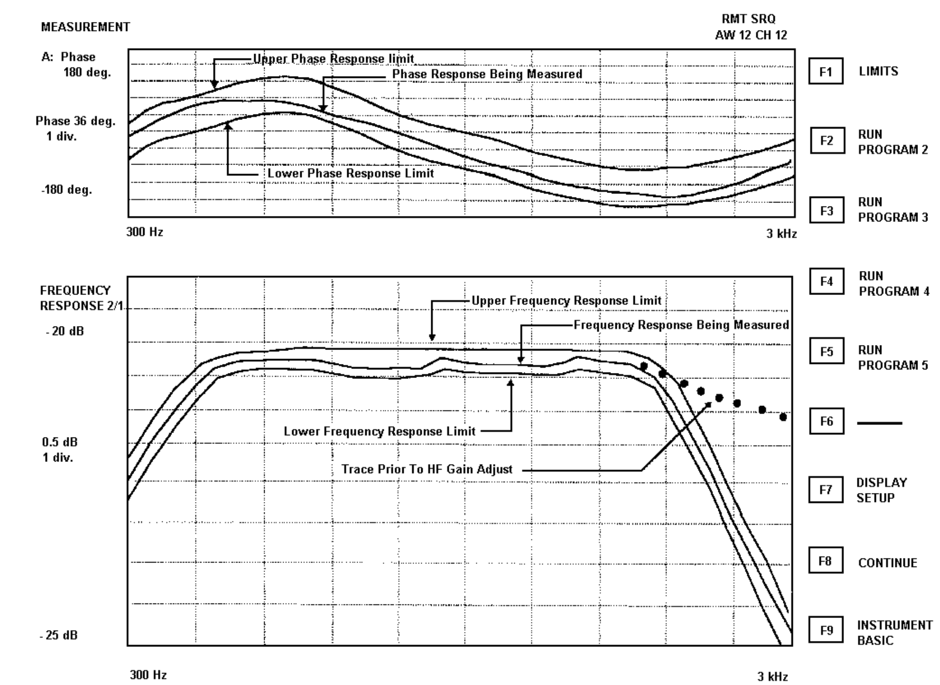


Figure 12 - Equalization Alignment Waveforms

5. Set the analog delay card "A" Delay switches 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 be changed as a result of Offset Delay change for the Site. 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.

6. Record the analog delay value obtained for this site in the Analog Delay "A" column in Table 2.

7. If the system requires an alternate delay setting (loop systems), then Analog "B" must be set. Place the loop system for this site in the alternate path. Verify the "B" select for this site is activated. Repeat step 5 for the alternate path, using the "B" delay switches on the card.

8. Record the analog delay "B" setting obtained for this sites' alternate path in the Analog Delay "B" column in Table 2.

9. Restore the loop to normal.

10. 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 C120/REX extender card. Plug the equalizer card into the CONVEX C120/REX panel in the test rack. Install the DB9 to DB9 jumper cable between the C120/REX and C120/REX. This allows easier access and adjustment of equalizer cards. When alignment of the equalizer card is complete, remove it from the C120/REX panel and reinstall in its normal location in the Analog 1 Shelf.

11. Adjust amplitude and delay 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. Delay pots adjust delay, not phase directly. Make small adjustments in delay near the points where phase change is required. Resweep and verify the desired result.

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 to match the REFERENCE.

12. When this site is aligned satisfactorily, turn OFF its PTT control and turn ON the PTT and A/D switches for the next site. Remove existing equalizer adjusted fron the C120 REX Panel and reinstall it in its original location in Analog 1 Shelf. Install the equalizer for the next site in the C120REX per step 10 above.
13. Repeat the alignment steps for this site.
14. Repeat for the remaining sites on this channel.
15. 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.

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.

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.

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 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. With a digital voltmeter connected between U1-1 and ground, adjust R9 on the voting tone board for 3.00 Vdc.
7. Set the 1950 voting tone level pot (R19) on the voting tone board to produce -10 dBm at the transmission test set.
8. Set the transmission test set to measure input frequency. Verify 1950 Hz ±5 Hz is being sent. Adjust R5 on the voting tone board to set the tone frequency.
9. 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 TX 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 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 For AUX RX Sites (NOT SIMULCAST TX SITES):

At Aux Rx Site:

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.

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, adjust R2 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 Voted Audio jackfield LINE jack for the channel under test.
4. Temporarily remove W.O.R. wire from J2 on the digital voter receiver GETC for the site/channel under test.
5. Adjust "OUTPUT ADJ" 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. This is not required if completed in step 4.9 for the Remote TX 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.

At Aux Rx Site:

1. Remove 1000 Hz, -10 dBm test tone from the remote site receiver.

At the Control Point:

1. 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.
2. 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 -12 dBm indicated on the transmission test set.
4. Remove the transmission test set from the AUX receiver GETC modem TX terminals.
5. Repeat steps 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), including low speed data (150 baud) deviation and symmetry.

   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 site coverage are used to predict non capture areas and to estimate site timing offsets. Accurate determination of non capture areas and timing offsets are accomplished by use of the multiple receiver tool developed by Ericsson Inc. Engineering. Each site is set to transmit carrier on a different frequency from other sites. The coverage area is driven and information gathered automatically by the tool which collects location, signal strength of each site at each measured point, trunking access. This data is then processed by Propagation Engineering to determine overlap areas and optimize timing offset values for the sites.
5. The tool will take into account everything that propagation predictions cannot, such as buildings, reflections or shadows from terrain or man-made objects.

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

SITE	Propagation To Test RX	Offset Delay	Measured Delay	Digital "A" (Microseconds)	Delay "B" (Microseconds)
TX Site 1 REFERENCE			∅	256	
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:

OBTAIN PROPAGATION AND OFFSET DELAY VALUES FOR YOUR SPECIFIC SYSTEM FROM THE PROPAGATION GROUP IN GLOBAL APPLICATIONS ENGINEERING AT ERICSSON INC.

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. **Total Delay**: Is the sum of the "Propagation To Test Rx Delay" and "Offset Delay" values.
4. **Measured Delay**: Is zero for the REFERENCE Site. All other sites' Measured Delays are the Total Delay of the site being measured *minus* the Total Delay for the REFERENCE Site (can be a negative value).
5. **Digital Delays**: Are the actual values set in the Digital Delay cards for "A" and "B" directions for a site. Refer to paragraph 4.8.1 to determine these values.

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

SITE	Propagation To Test RX	Offset Delay	Measured Delay	Test Delay	Analog Delays (Microseconds)	
					A	B
TX Site 1 REFERENCE			∅		256	
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						

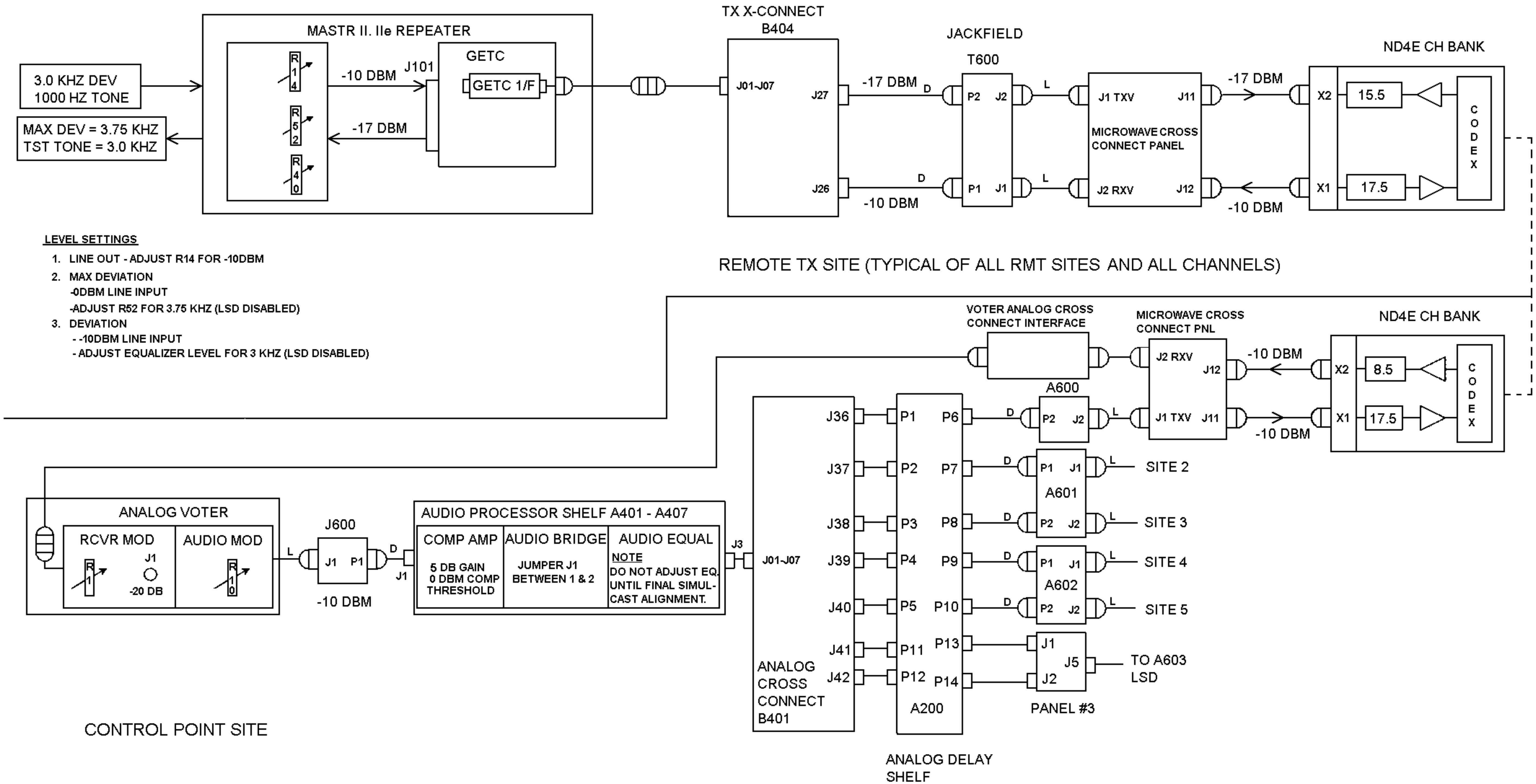
NOTES:

OBTAIN PROPAGATION AND OFFSET DELAY VALUES FOR YOUR SPECIFIC SYSTEM FROM THE PROPAGATION GROUP IN GLOBAL APPLICATIONS ENGINEERING AT ERICSSON INC.

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. **Total Delay**: Is the sum of the "Propagation To Test Rx Delay" and "Offset Delay" values.
4. **Measured Delay**: Is zero for the REFERENCE Site. All other sites' Measured Delays are the Total Delay of the site being measured *minus* the Total Delay for the REFERENCE Site (can be a negative value).
5. **Test Delay**: Is determined empirically for Site 1 REF, then calculated for the remaining sites as follows:
   Site 1 (REF) Test Delay = Determine empirically in Step 4.8.4,
   Site 2 Test Delay = Site 1 Test Delay + Site 2 Measured Delay,
   Site 3 Test Delay = Site 1 Test Delay + Site 3 Measured Delay,
   Site 4 Test Delay = Site 1 Test Delay + Site 4 Measured Delay,
   Site 5 Test Delay = Site 1 Test Delay + Site 5 Measured Delay,
   Site 6 Test Delay = Site 1 Test Delay + Site 6 Measured Delay,
   Site 7 Test Delay = Site 1 Test Delay + Site 7 Measured Delay,
   Site 8 Test Delay = Site 1 Test Delay + Site 8 Measured Delay,
   Site 9 Test Delay = Site 1 Test Delay + Site 9 Measured Delay,
   Site 10 Test Delay = Site 1 Test Delay + Site 10 Measured Delay,
6. **Analog Delays**: are the actual values set on the Analog Delay cards for "A" and "B" directions for a site. Refer to paragraph 4.8.5 to determine these values.

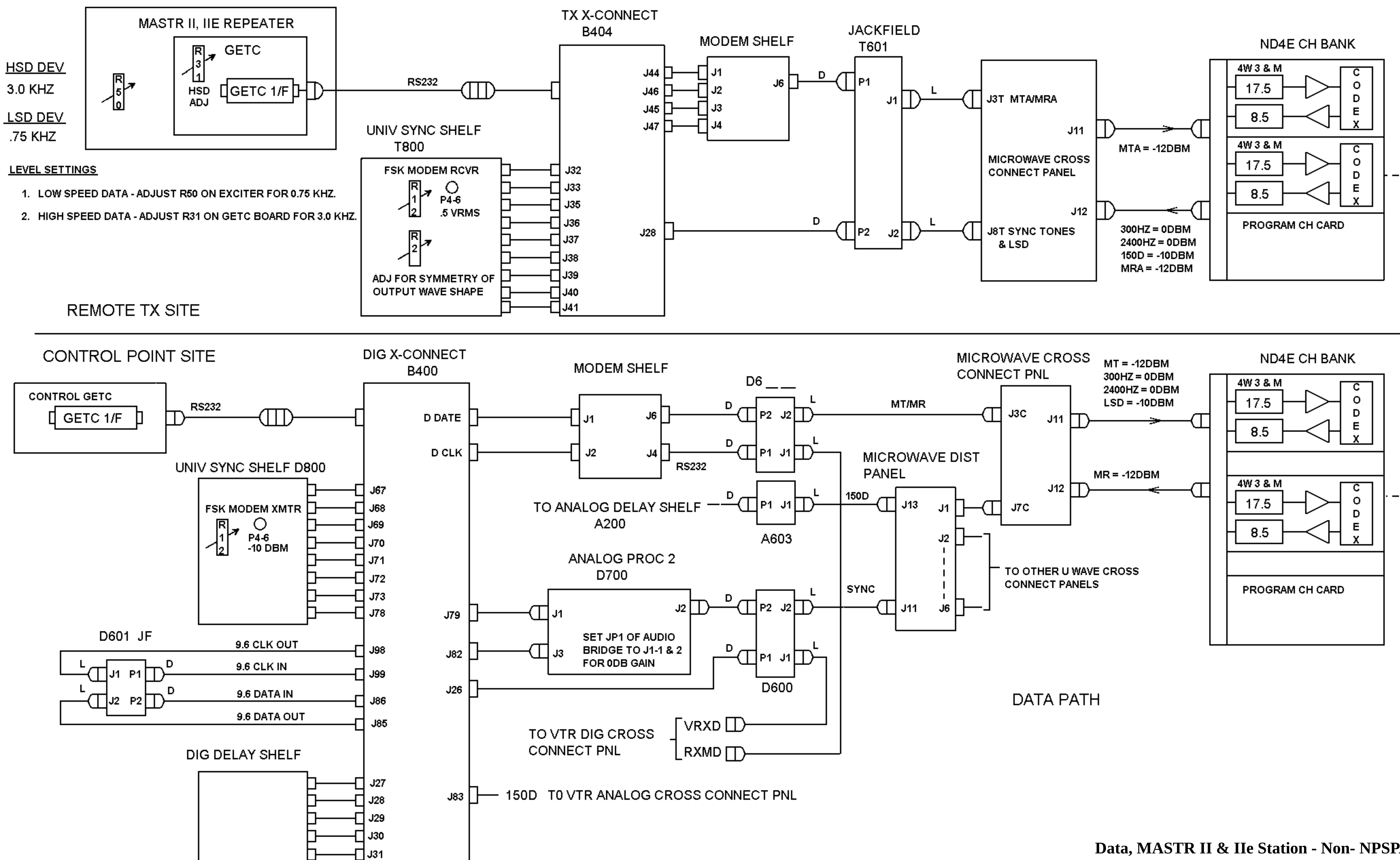
Table 3 - Routine Maintenance

MAINTENANCE CHECKS	INTERVAL BETWEEN CHECKS
Amplitude and Phase Sweep Check:	
Digital or Multiplex systems	12 Months
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).	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:	12 Months
TX Deviation Check:	
Digital Multiplex Systems	12 Months
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).	6 Months or immediately following a Microwave PM check which may alter baseband levels



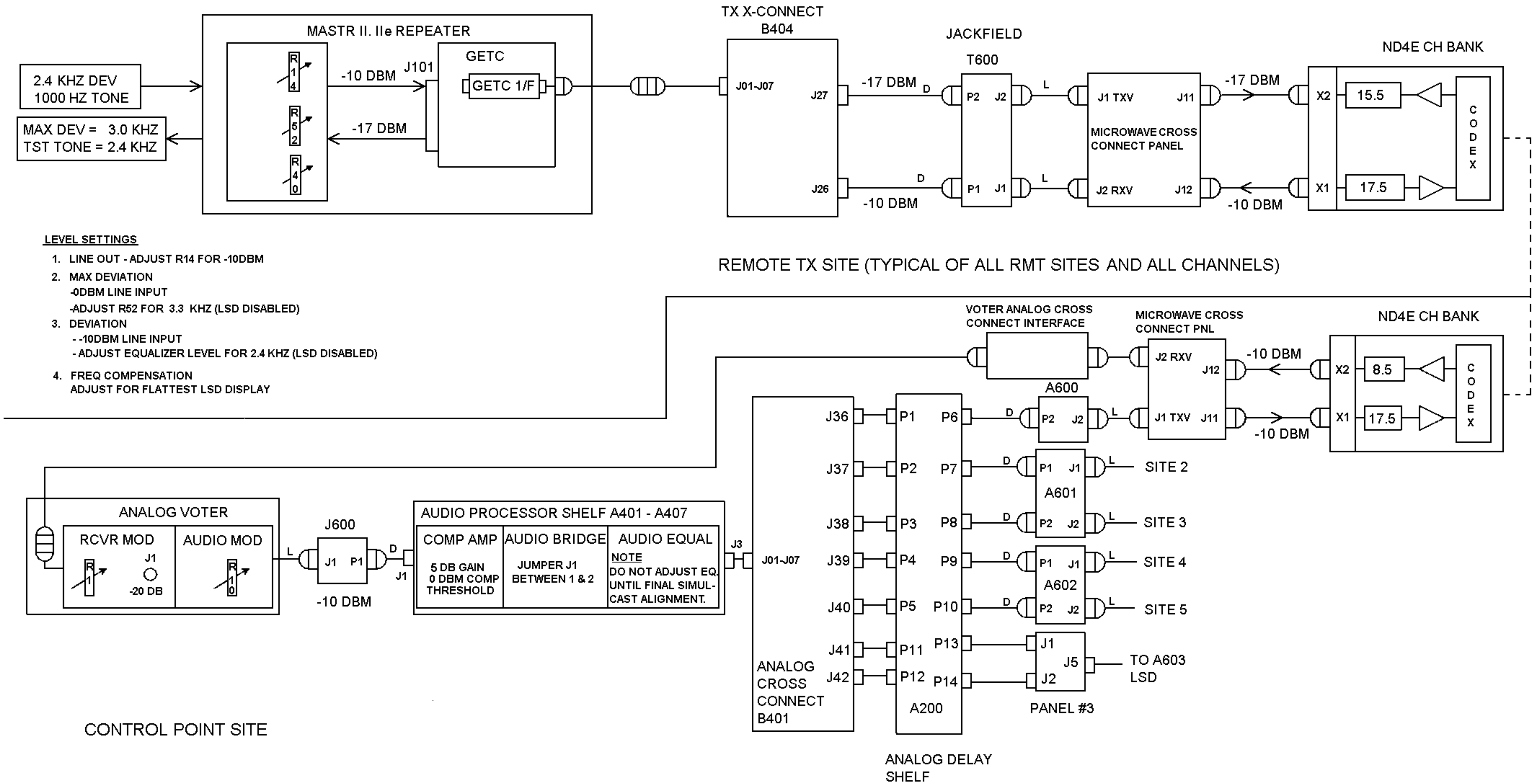
Voice, MASTR II & IIe Station - Non- NPSPAC

(19B804132 Sh. 1, Rev. 2)



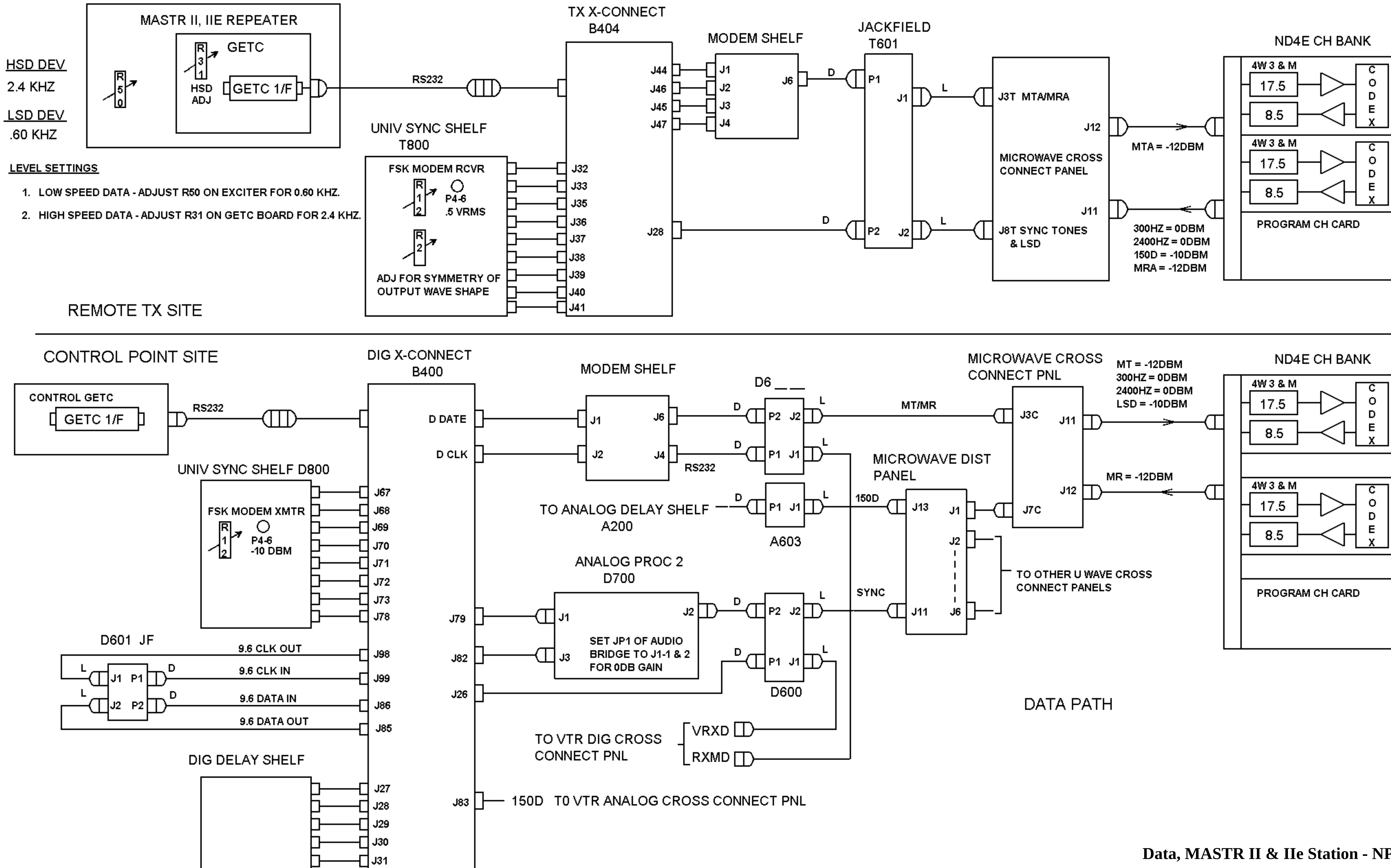
Data, MASTR II & IIe Station - Non- NPSPAC

(19B804132 Sh. 2, Rev. 1)



Voice, MASTR II & IIe Station - NPSPAC

(19B804132 Sh. 3, Rev. 2)



Data, MASTR II & IIe Station - NPSPAC

(19B804132 Sh. 4, Rev. 1)