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HD Radio
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FXi Exciter HD Injection Level Adjustment

Application Guide

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FXi Exciter HD Injection Level Adjustment
Application Guide

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1 FXi Exciter HD Injection Level Adjustment

1.1 Overview of adjusting the HD Injection Level.

The purpose of this document is to assist the user in adjusting the HD carrier levels to elevated levels allowed by FCC. This procedure will show how to adjust the digital carriers to levels from -20dB up to -10dB or any level in between and reduce the out of band harmonics. Both upper and lower subcarriers will be adjusted equally.

Adjusting the HD carrier levels uses a laptop or desktop computer and HyperTerminal. This procedure does not guarantee results as they are affected by power levels, carrier frequency and linearity of the transmitter.

2 Installation Preparation

2.1 Requirements

It is recommended that your Exciter have the latest software before you perform this conversion. Please check the Support section of the BE website at www.bdcast.com/support

This procedure will detail adjusting the HD carrier sideband power levels from the exciter.

2.2 Overview / Estimated Completion Time For the conversion

The FXi Exciter HD injection level adjustment will take about 1 hour to complete by an experienced technician.

2.3 Items / Tools required for the Conversion Process

- ☐ Computer with "HyperTerminal"
- ☐ A spectrum analyzer
- ☐ Null modem cable
- ☐ A suitable pot adjustment tool

3 Connect Computer

Connect computer to exciter using a null modem cable and open HyperTerminal. Adjustments will be made on HyperTerminal and on the exciter.

3.1 Connecting Null modem cable

a) Connect a null modem cable from a PC to the Exciter's Serial Port J10.

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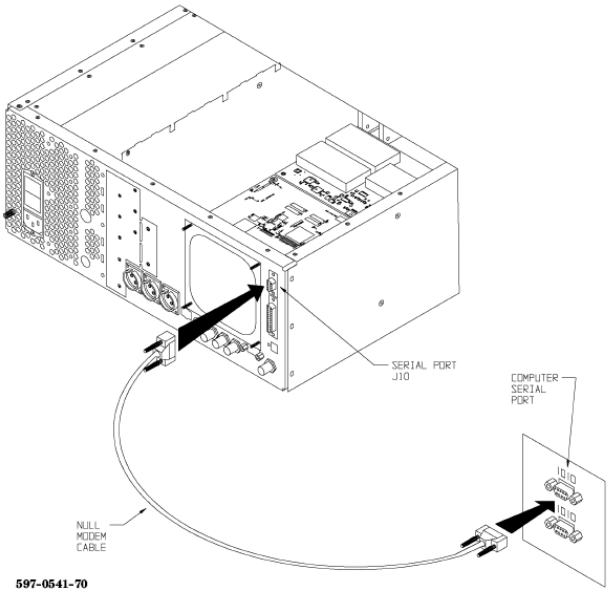

Figure 1 – PC to FXi Serial Port Null Modem Cable Connection

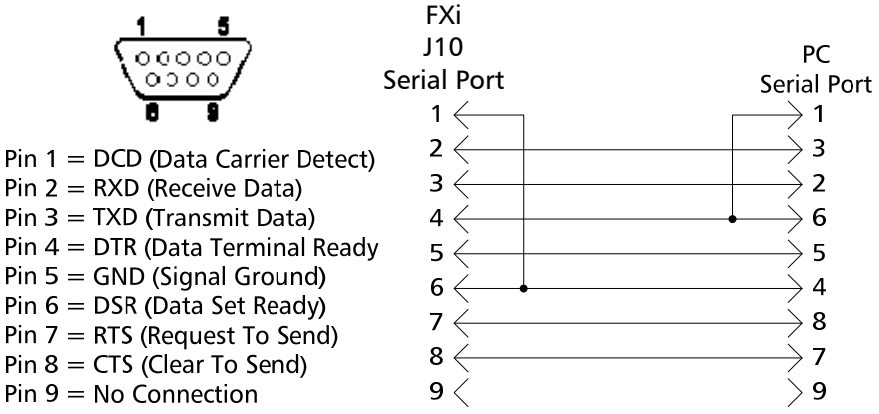

Figure 2 – Serial Cable / Null Modem Adapter Pinout

b) From the Desktop go to: **START-> ALL PROGRAMS-> ACCESSORIES-> COMMUNICATION-> HYPERTERMINAL** and click the mouse.

c) The HyperTerminal dialog box should now be displayed. In the **CONNECTION DESCRIPTION** box, enter the name of the shortcut that you want to be created such as *FXi Connection*.

d) Select and click **OK**.

e) The **CONNECT TO** dialog box will now appear. In the **CONNECT USING** dialog box, ensure that the correct COM Port is selected (typically **COM 1** is used) and then click **OK**.

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f) The **COM1 PROPERTIES** dialog box will appear. Move the cursor to the **BITS PER SECOND** dialog box and select **19200**.

g) Move the cursor to the **DATA BITS** dialog box and select **8**.

h) Move the cursor to the **PARITY** dialog box and select **NONE**.

i) Move the cursor to the **STOP BITS** dialog box and select **1**.

j) Move the cursor to the **FLOW CONTROL** dialog box and select **NONE**.

k) Select **OK** and the HyperTerminal communication window will appear.

l) Type "**?**" and the **Supplemental Command Menu** will then appear..

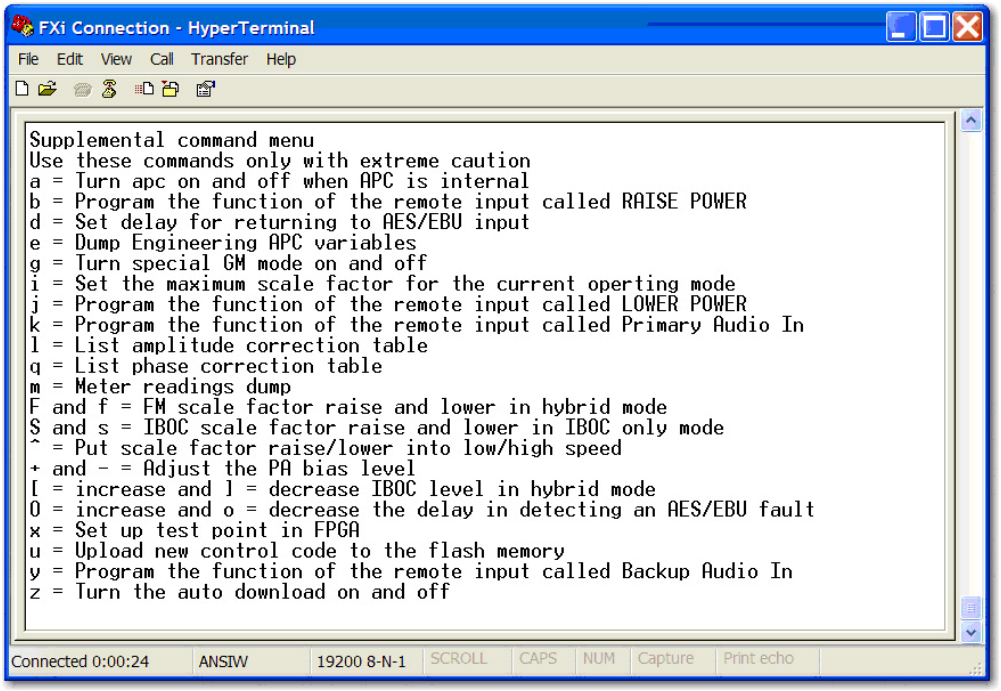

Figure 3 – HyperTerminal Supplemental Command Menu

4 Setting up the Spectrum Analyzer

4.1 Reference

Setting the reference for the measurement is critical to taking accurate data and the following steps should be taken. When setting this reference point the analyzer detector MUST be set to peak, Averaging Off, and no modulation present on the FM carrier.

1) The reference level on the spectrum analyzer should be set at 0dBm. That is the top line on the spectrum is 0dBm. All measurements should be referenced to this point.

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2) Apply an un-modulated FM signal to the spectrum analyzer input (external variable and/or fixed attenuation should be in line with the front to avoid overdriving or damage to the spectrum analyzer). Set the resolution bandwidth to 1MHz.

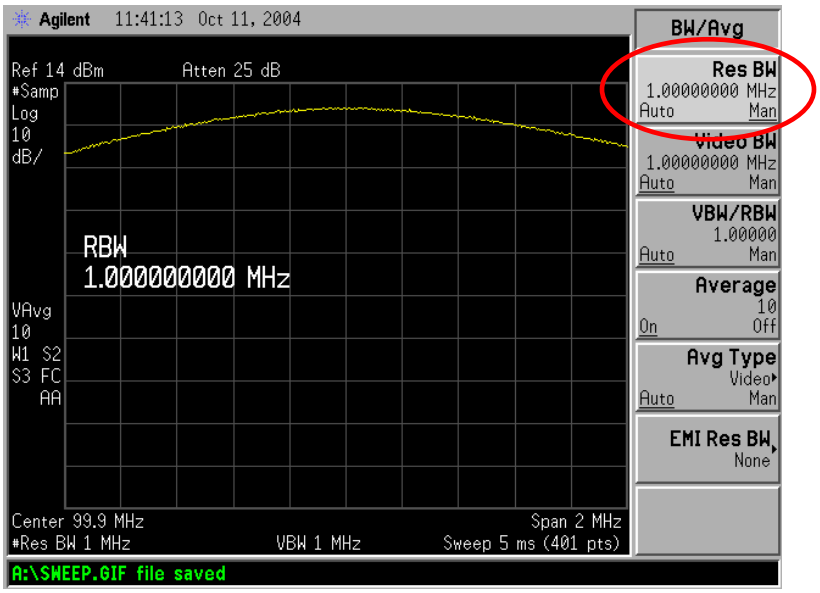

Figure 4 – Setting the top reference at 1MHz RBW.

Adjust the external variable attenuator or the Amplitude adjustment on the Spectrum Analyzer until the un-modulated FM carrier is at the 0dBm reference line. Return the resolution band width to 1kHz setting. NOTE: that after returning to 1kHz resolution bandwidth, it may appear on the display that the center frequency is no longer to the top line on the analyzer display. This is due to differences in the sweep and sampling rates of the analyzer in relation to the actual RF peak. DO NOT readjust the amplitude adjustment.

4.2 Resolution Bandwidth, Span, Detector, and Averaging

When measuring an FM HD spectrum the spectrum analyzer must have the Resolution Bandwidth (RBW) set to 1 kHz and Video Bandwidth (VBW) set to 1 kHz. The Span setting of 2 MHz is not required but is a good setting to view performance. The Detector should be set to Sample and Averaging over a minimum time span of 30 seconds and minimum of 100 sweeps.

When measuring the HD signal the FM carrier should have normal program modulation applied. The Modulated FM Transmitter Spectrum that is properly aligned should appear as shown in Figure 5. The modulated FM carrier will vary depending on program content. The primary sidebands should be ~42dB down from the un-modulated carrier and the secondary sidebands (re-growth) should be a minimum of ~74.4 dB down from the un-modulated carrier. In a good system the re-growth will be ≤ 80 dB down as shown below.

All measurements MUST be made into a known good 50 ohm load prior to putting Transmitter into antenna.

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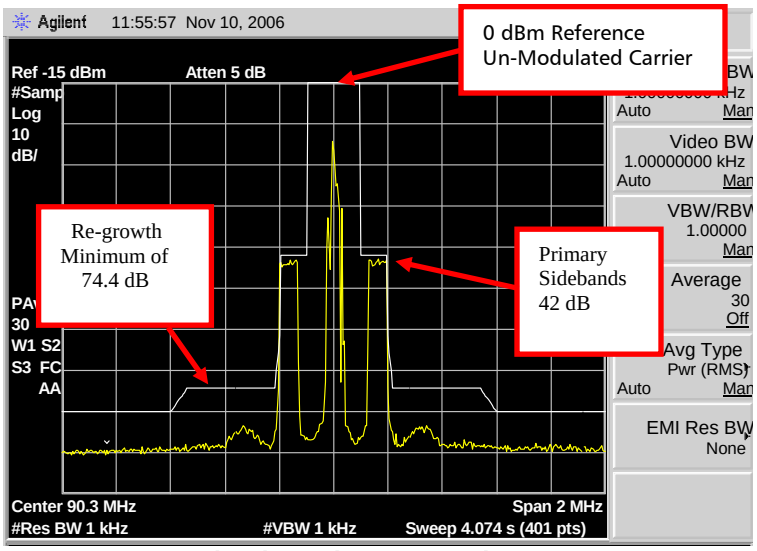

Figure 5 – Properly Aligned FM HD Radio™ Spectrum at -20dB

5 Review of Affecting controls

There are several parameters that you will adjust to raise the subcarrier levels and reduce the harmonic regrowth. These controls interact with one another and are affected by the power level of the exciter.

- HyperTerminal "[" and "]" keys = adjust the subcarrier level
- HyperTerminal "+" and "-" keys = adjust the PA bias level
- Distortion Null pot on rear of Exciter to reduce harmonics

When in HyperTerminal the "+" and "-" keys will adjust the exciter PA bias level, and the "["and "]" keys will adjust the subcarrier level. The null adjustment on the rear of the exciter will reduce regrowth as will lowering the front panel exciter power. All will interact with each other and at some frequencies, some transmitters may not be capable of reaching elevated (> -20dB) subcarrier levels while meeting spectrum requirements.

Before adjusting the exciter, select "e" on HyperTerminal to view the APC scales shown below. Record your numeric values for FM+IBOC scale and maximum FM+ IBOC scale. When the APC scale level reaches the maximum, it cannot respond correctly, thus the limit would need to be raised to allow proper operation. The maximum is the upper limit the scale can reach. Monitor these values, it may be necessary to raise the limit to allow further adjustment.

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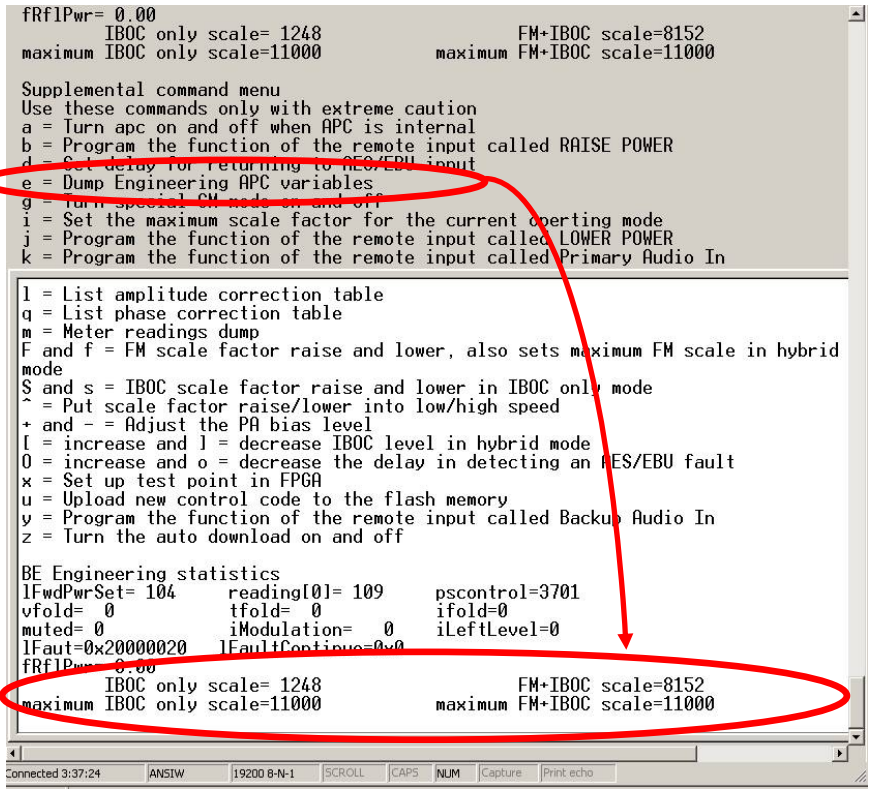

Figure 6 – HyperTerminal Engineering APC Menu

To raise the maximum scale factor, press "**i**" on the HyperTerminal menu, the following command prompt will appear. Enter a slightly higher AGC Scale setting and press **Enter.**

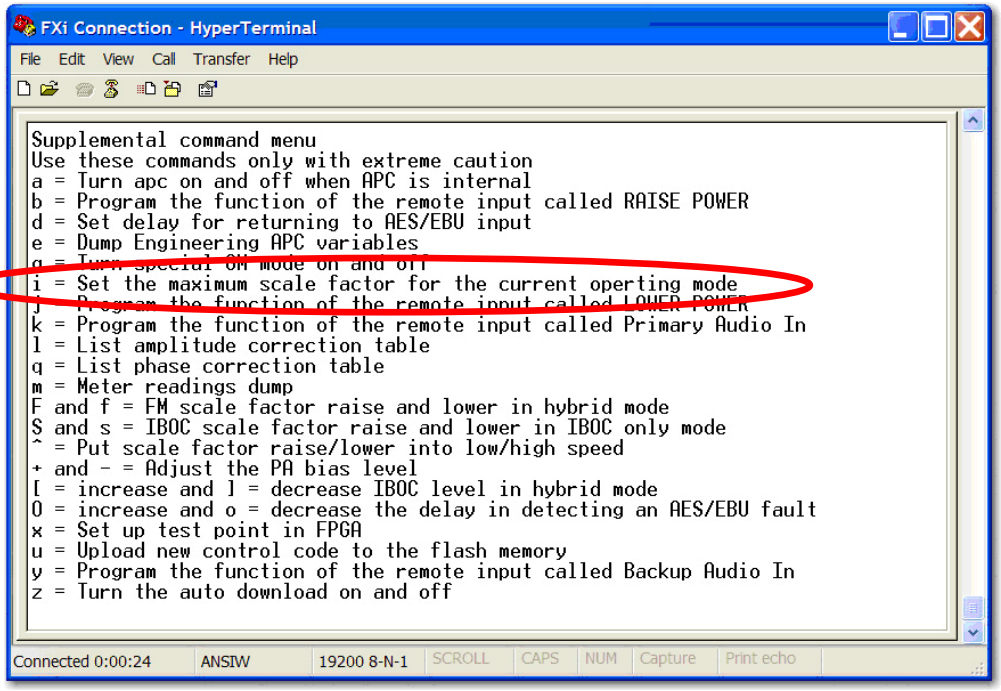

Figure 7 – Maximum scale factor

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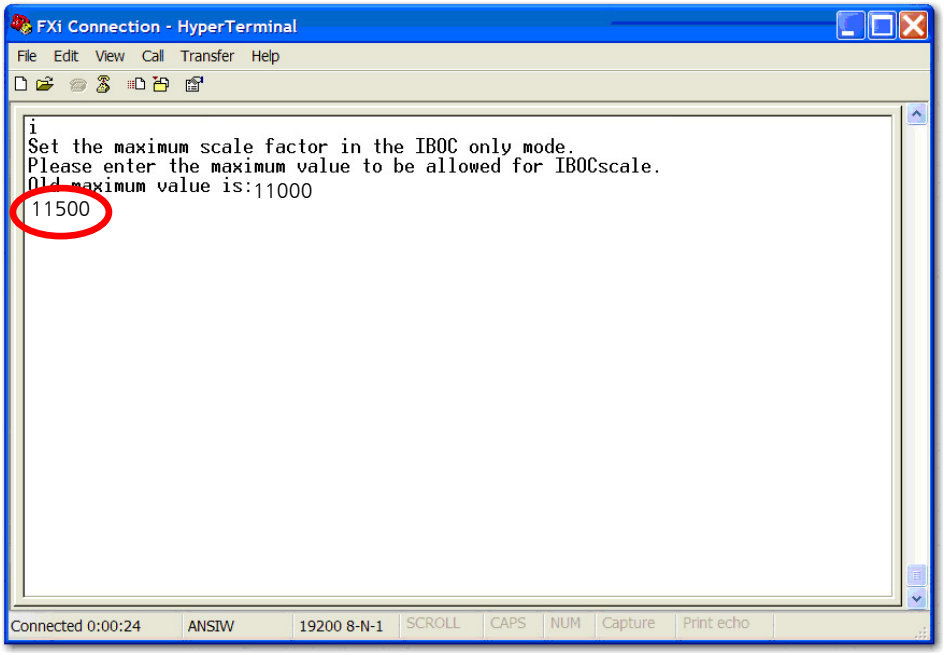

Figure 8 – "i" Command to Change Maximum Scale Factor

6 Adjusting the Exciter

While observing the HD signal on a spectrum analyzer adjust the sideband carrier level to the desired level.

On the HyperTerminal enter "[" (left bracket) to increase the HD carrier level. Enter "]" (right bracket) to lower the HD carrier level. Note that when raising the HD carriers, the spectral regrowth (out of band harmonics) will also rise.

Viewing the RF output on a spectrum analyzer, slowly start making small adjustments to the carrier level. First raise the sideband carrier level by using the "[" key. You will see the regrowth increase. You will observe on the HyperTerminal an "offset" value change every time you press the "[" or "]" keys.

Example:
Offset=-24
Offset=-23
Offset=-22
Offset=-21

The default starting point is Offset = -25. As you press the left bracket to increase the HD carrier levels, the Offset value will be less negative as in the above example.

NOTE: If the Offset value is set equal to or above (less negative) "-14" the value will not be retained after a power cycle ON/OFF. Instead it will revert back to the default value of "-25" which corresponds to -20dBc on the spectrum analyzer.

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As you make small adjustments to the HD carrier levels using the left and right brackets, make small adjustments to the bias using the +/- keys to reduce the regrowth. Do not adjust very far. You should see where one bias adjustment reduces the regrowth and then at a point it starts to increase. Return to the place where it was at a minimum.

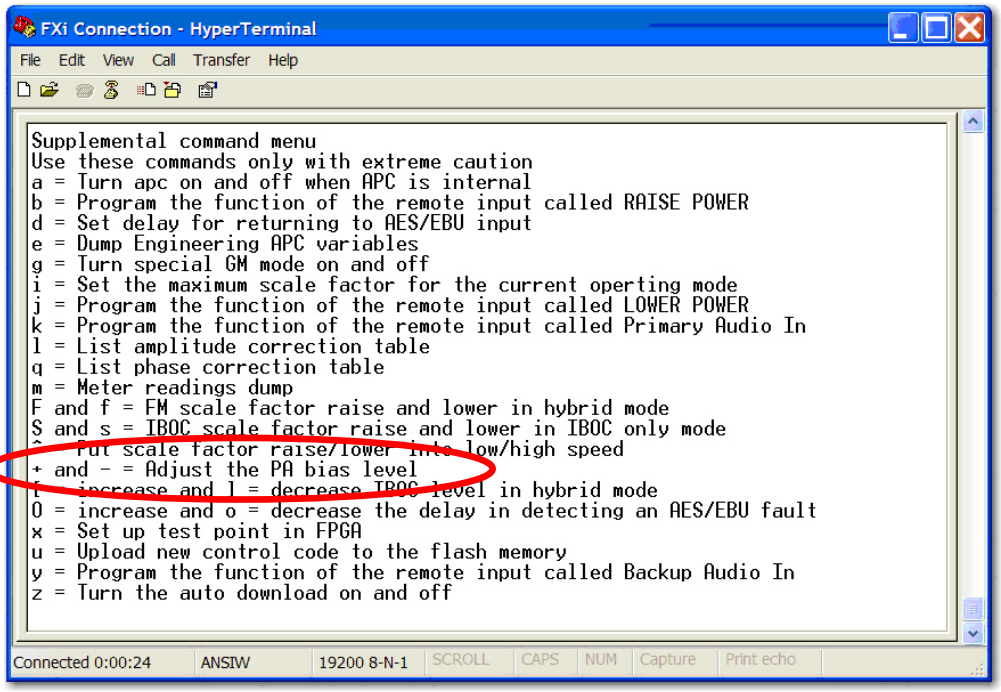

Figure 9 – "+" and "-" Command to Change Exciter PA bias

Then adjust the Distortion Null potentiometer on the rear of the exciter to minimize regrowth. Make small adjustments to the null pot and allow the exciter APC time to respond, you will see the FM+IBOC APC scale change on the HyperTerminal. Wait 30 seconds or restart the averaging on the Spectrum Analyzer to accurately view the response.

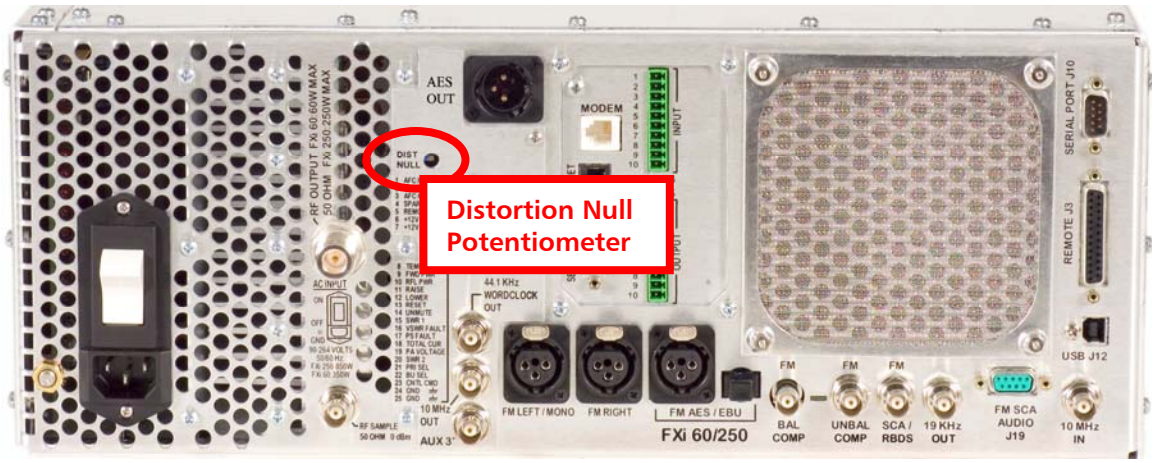

Figure 10 – Distortion Null Adjustment

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Ensure that all carriers and sidebands are below the mask. Verify that all spurs and impulsive noise are > 80 dB down. The Spectrum should look similar to Figure 11 below when properly aligned.

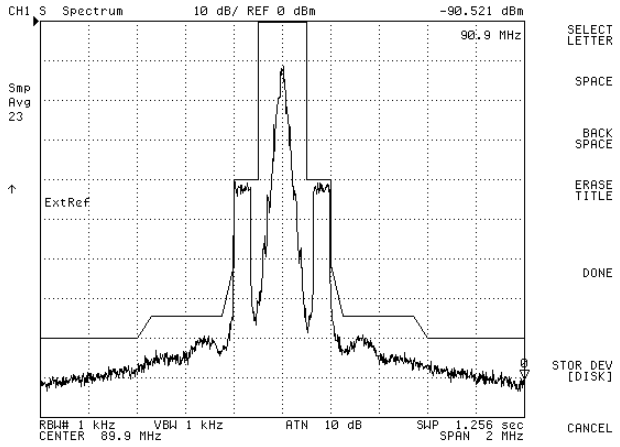

Figure 11 – Typical Properly Aligned FM+HD (-20dB Hybrid) Spectrum

If during the adjustment the FM+IBOC scale has reached the maximum limit, you will have to increase the limit by entering "i" to set the maximum scale factor for the current operating mode of the exciter. Then enter in the value you wish the maximum to be. Make small adjustments each time and reduce the regrowth to allowable levels.

If you are unable to keep the out of band harmonics under the mask, you will need to reduce the HD carrier levels using the "]" (right bracket) to lower the HD carrier level until the out of band harmonics are under the mask.

Below is a chart showing the HD carrier levels, and corresponding Spectrum Analyzer scale readings relative to the top of the screen.

HD Carrier Level	Spectrum Analyzer screen
-10	-31
-12	-33
-14	-35
-16	-37
-18	-39
-20	-41

7 Related Documents

Other Application Guides that are closely related to this guide that may prove beneficial:

- FXi 60/250 Maximum Scale Factor Application Guide; 597-0541-004
- FXi 60/250 U41 FW Upgrade Application Guide; 597-0541-009
- FMi 31/73/106/201/301/402 HD Spectrum Application Guide; 597-5001-002
- FMi 703/1405 HD Spectrum Tuning Application Guide; 597-1012-009

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8 Troubleshooting

Problem: HD Carrier levels that were adjusted greater than -20dBc have returned to -20dBc.

Cause: Offset values less negative than -15 are not saved during a power cycle (ON/OFF). This includes Offset values of -14, -13, -12… corresponding with elevated HD carrier levels close to -10dBc or greater.

Solution: Upgrade the FXi controller version to 2.xx.48 or later to prevent a loss of the offset values after an AC power cycle. Note: The xx refers to the firmware on the Clock Filter board; that firmware is independent of the Control Board software.

9 RF Technical Services Contact Information

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