Broadcast Electronics Inc.
4100 North 24th Street, Quincy, Illinois 62305 USA • Phone (217) 224-9600 • Fax (217) 224-9607 • www.bdcast.com • bdcast@bdcast.com

FMi 31, 73, 106, 201, 301 and 402 Series Transmitters

Tuning for Best HD Spectrum Application Guide

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FMi 31, 73, 106, 201, 301 and 402 Series Transmitters
Tuning for Best HD Spectrum

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1 Purpose of this Document

The following document describes the technique for accurately tuning and measuring the FM HD Radio™ Spectrum of an FMi 31, 73, 106, 201, 301 and 402 Series Transmitter.

NOTE: This procedure is not necessary for FM ONLY Transmitters!

2 Tools / Items Needed

- ☐ Spectrum Analyzer
- ☐ Personal Computer with Windows HyperTerminal Communication Program installed
- ☐ Null Modem Cable

3 Estimated Completion Time

Providing that you have the tools listed above, it will take approximately 1 hour to complete the tuning procedure for either HD ONLY or FM + HD operation.

< continue to next page >

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4 FM HD Spectral Measurements

The following document describes the technique for accurately tuning and measuring the FM HD Radio™ Spectrum of an FMi 31, 73, 106, 301 or 402 Series Transmitter.

4.1 FM Spectral Emissions Limits Mask

The following table is the emissions mask for FM HD Radio™ performance as specified by iBiquity. Note that all measurements are made in a 1 kHz bandwidth and relative to an un-modulated carrier.

FM HD FCC Spectral Mask	
Frequency, F, Offset Relative to Carrier	**Level, dB / kHz**
100 - 200 kHz offset	**- 40 dB**
200 - 250 kHz offset	**[- 61.4 dB – (frequency in kHz – 200 kHz) X 0.260]**
250 - 540 kHz offset	**- 74.4 dB**
540 - 600 kHz offset	**[- 74.4 dB – (frequency in kHz – 540 kHz) X 0.093]**
> 600 kHz offset	**- 80 dB**

Figure 1 - FM HD Radio™ Spectral Emissions Limits Mask in Tabular Form

Figure 2 shows the FM spectral emissions limits mask for HD. The limits shown are the implementation of the table in **Figure 1** above.

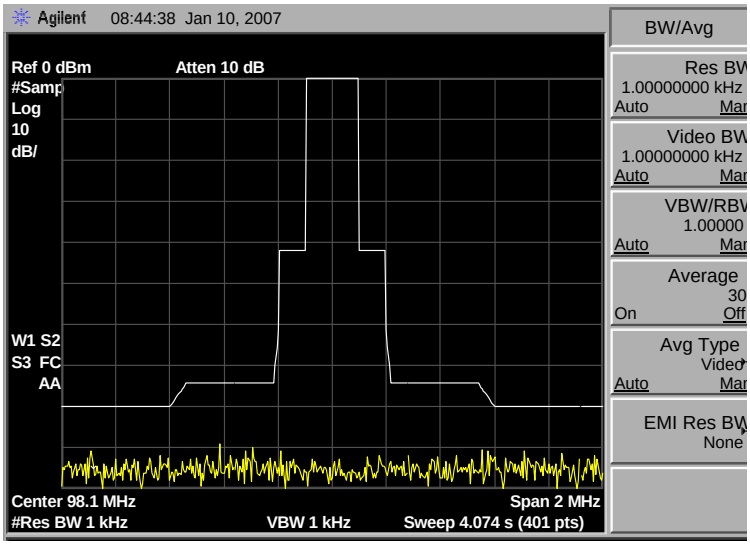

Figure 2 - FM HD Radio™ Spectral Emissions Limits Mask in Graphical Form

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4.2 Setting up the Spectrum Analyzer

4.2.1 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.

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). Adjust the external variable attenuator until the un-modulated FM carrier is at the 0dBm reference line.

3) If measuring an HD Only signal that does not have a reference carrier, the detector should be set to sample, 1 kHz RBW and the top of the HD carrier should be -42dB down. See Section 4.2.2.

4.2.2 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 3. 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.

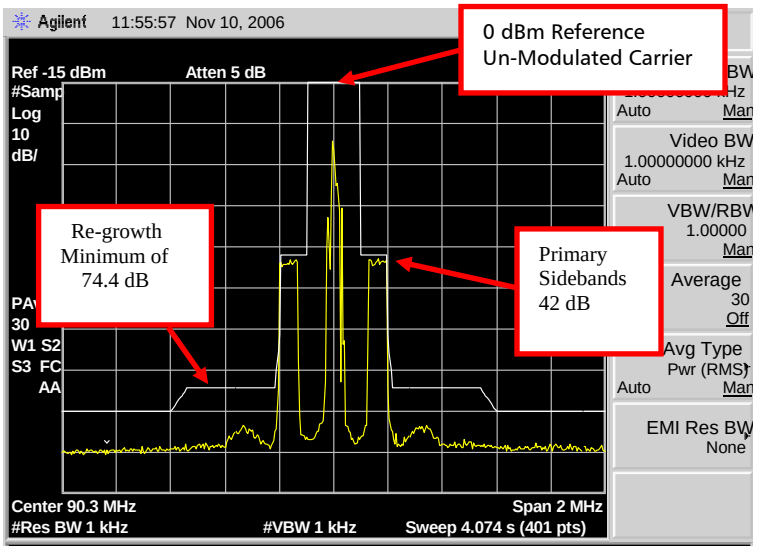

Figure 3 – Properly Aligned FM HD Radio™ Spectrum

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5 Prepare for Tuning

Step 1 – Ensure that the Transmitter is ON and operational.

Step 2 – Connect the Spectrum Analyzer through a step attenuator to the RF sample port of the Transmitter.

Step 3 – Setup the Spectrum Analyzer as discussed in Sections 1.1 and 1.2 of this document.

Step 4 – Connect a null modem cable from a PC to the Exciter's Serial Port J10.

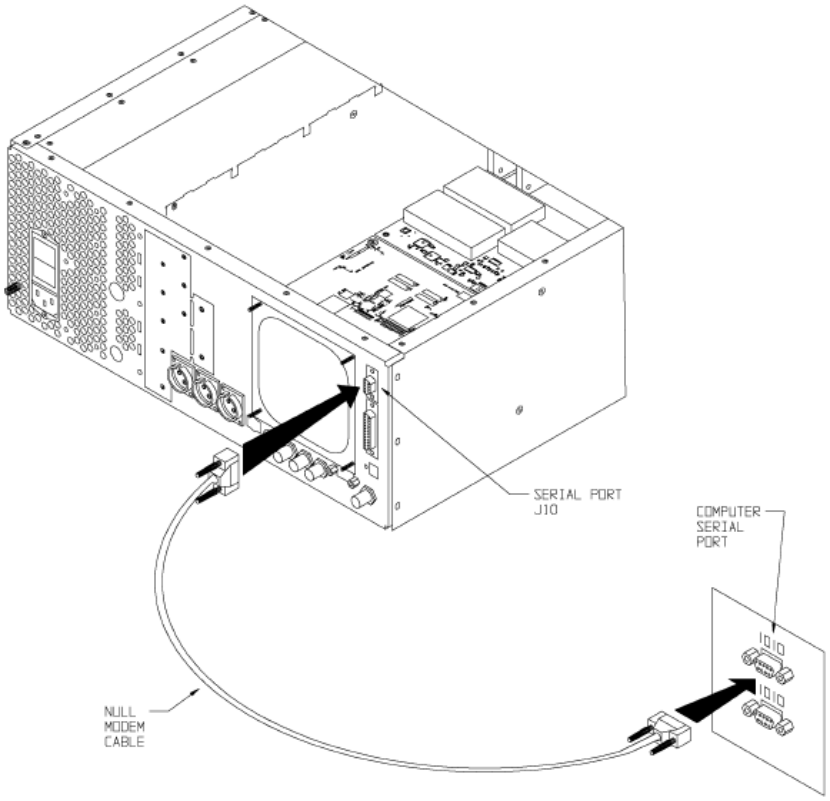

Figure 4 – PC to FXi Serial Port Null Modem Cable Connection

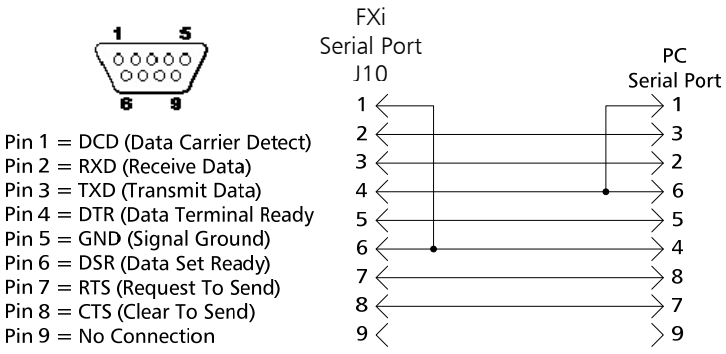

Figure 5 – Serial Cable / Null Modem Adapter Pinout

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Step 5 – Launch Windows HyperTerminal by going to **START -> ALL PROGRAMS -> ACCESSORIES -> COMMUNICATIONS -> HYPERTERMINAL.** Name the connection and then select **OK**.

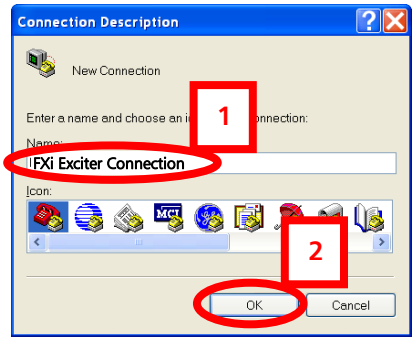

Figure 6 – HyperTerminal Connection Description Menu

Step 6 – The default telnet question box may appear. Select **Yes** if you want HyperTerminal to be your default telnet program. Select **No** if you do not want it to be.

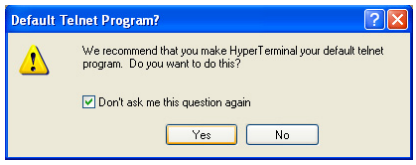

Figure 7 – Default Telnet Program Menu

Step 7 – Select the appropriate connection port (**COM1** is the most common) from the pull down, then select **OK**.

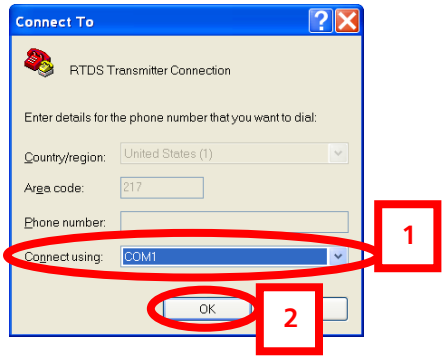

Figure 8 – HyperTerminal Connect To Menu

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Step 8 – Configure the **Port Settings** as shown below, select **Apply** then **OK**.

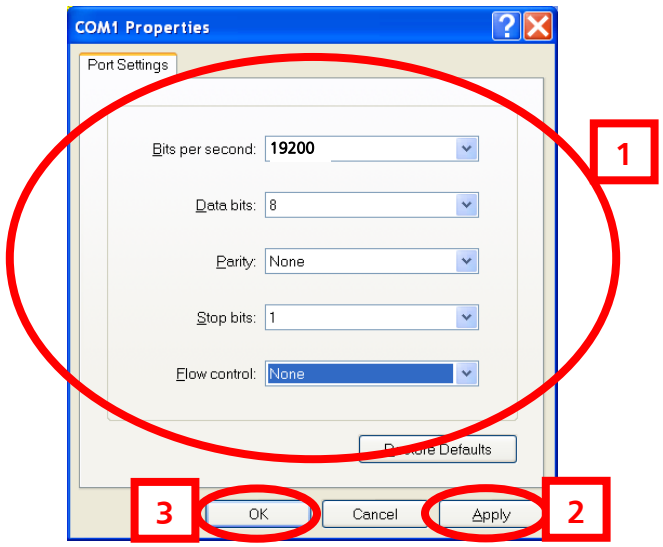

Figure 9 – Port Settings Menu

Step 9 – After selecting **OK** the HyperTerminal communication window will appear as shown on the following page.

Step 10 – Type "**?**" and the **Supplemental Command Menu** will then appear.

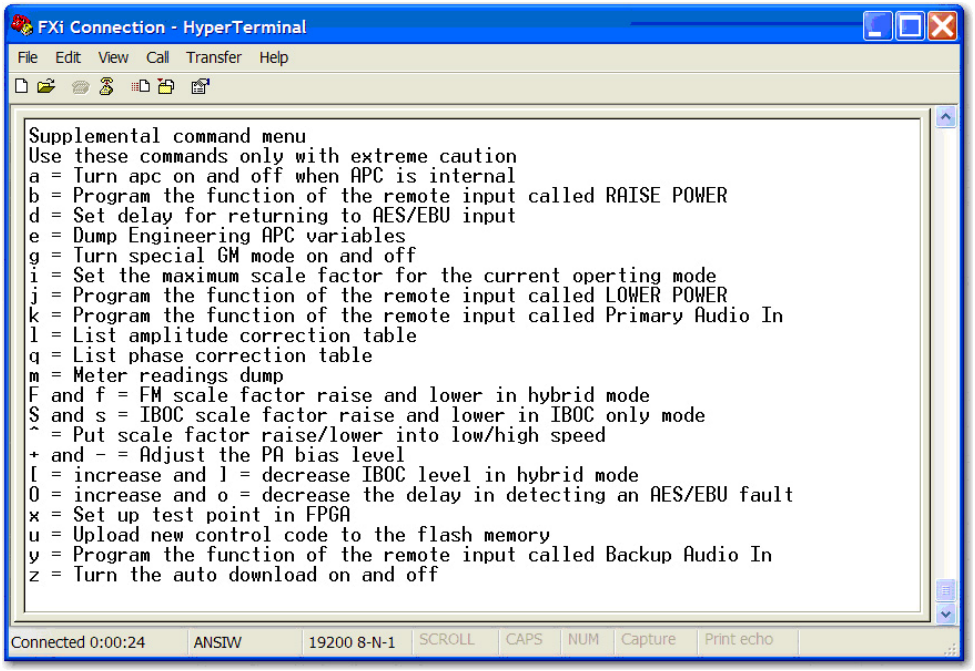

Figure 10 – HyperTerminal Supplemental Command Menu

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6 Verify P.A. Voltage

On the front of the transmitter select the P.A. Voltage multimeter button and ensure that it reads +48VDC.

Proceed to Section 7 if tuning for "**HD ONLY**" operation. Proceed to Section 8 if tuning for "**FM + HD**" operation.

7 Tuning for Best HD ONLY Spectrum

Step 1 – Go to the FXi Exciter GUI and select **OPER MODE** from the Main Menu.

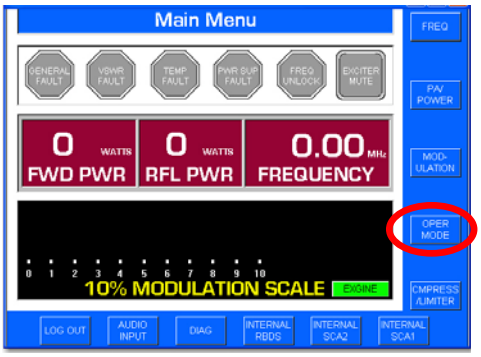

Figure 11 – FXi Main Menu

Step 2 – Select **IBOC MENU**.

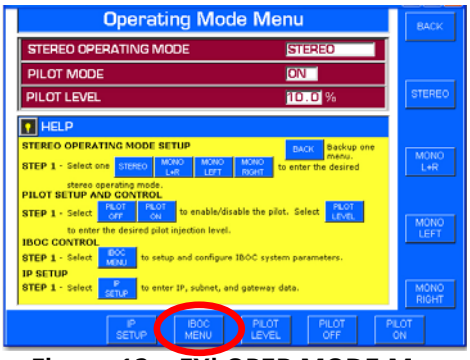

Figure 12 – FXi OPER MODE Menu

Step 3 – Select **IBOC ONLY**.

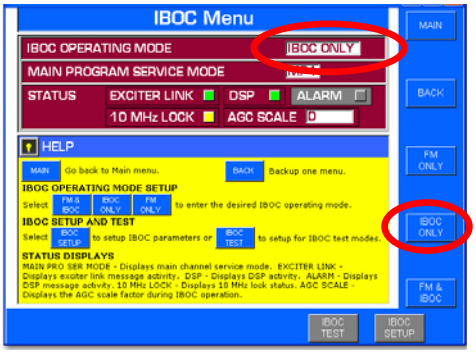

Figure 13 – FXi IBOC Menu

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Step 4 – Adjust the distortion Null Potentiometer on the rear of the Exciter for a minimum sideband reading on the Spectrum Analyzer.

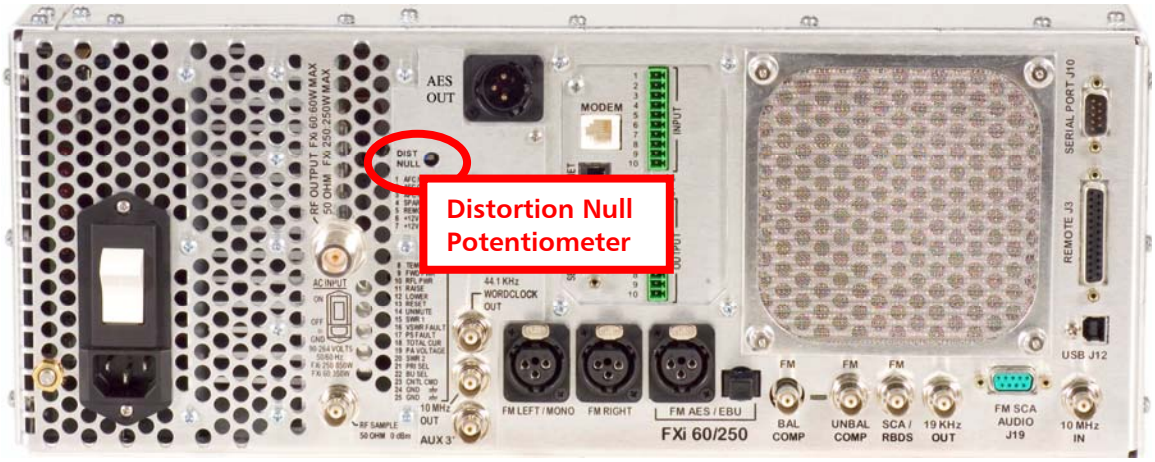

Figure 14 – Distortion Null Adjustment

Step 5 – 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 15 below when properly aligned.

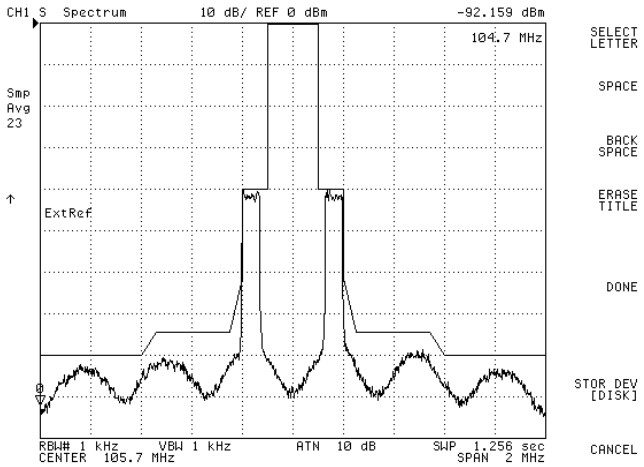

Figure 15 – Typical Properly Aligned HD Only Spectrum

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8 Tuning for Best FM + HD Spectrum

Step 1 – Go to the FXi Exciter GUI and select **OPER MODE** from the Main Menu.

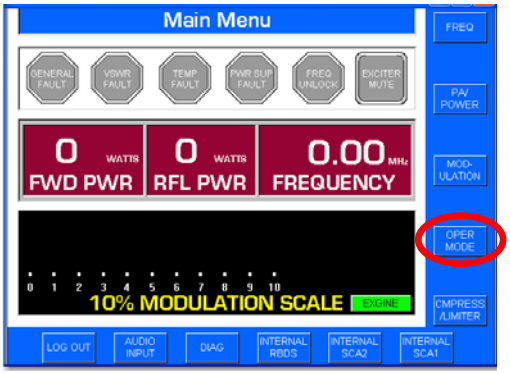

Figure 16 – FXi Main Menu

Step 2 – Select **IBOC MENU**.

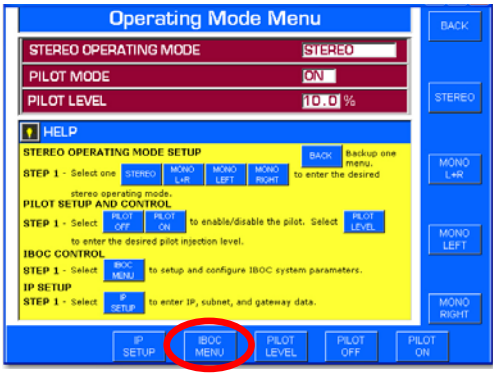

Figure 17 – FXi OPER MODE Menu

Step 3 – Select **FM + IBOC**.

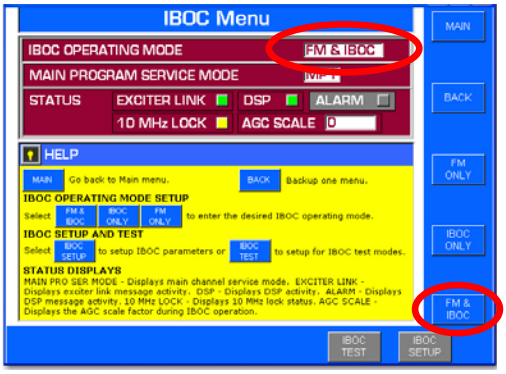

Figure 18 – FXi IBOC Menu

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Step 4 – Ensure the Transmitter's RF Output to ON.

Step 5 – Apply normal program Audio.

Step 6 – Adjust the distortion Null Potentiometer on the rear of the Exciter for a minimum sideband reading on the Spectrum Analyzer.

Figure 19 – Distortion Null Adjustment

Step 7 – 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 20 below when properly aligned.

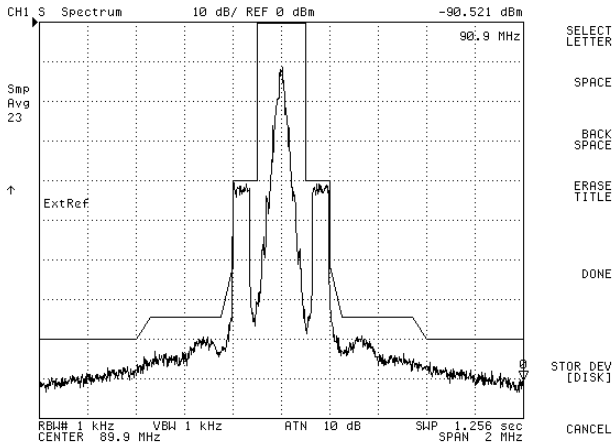

Figure 20 – Typical Properly Aligned FM+HD (Hybrid) Spectrum

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9 Set the AGC Scale Factor in the FXi 60/250 Exciter

Step 1 – Ensure that your Transmitter is currently operating in either **IBOC ONLY** or **FM + IBOC** mode.

Step 2 – Ensure that the Transmitter is operating at the Transmitter's RF Power Output (TPO) level that you would normally operate it at.

Step 3 – Next, go to the FXi Exciter GUI Main Menu and select **OPER MODE**.

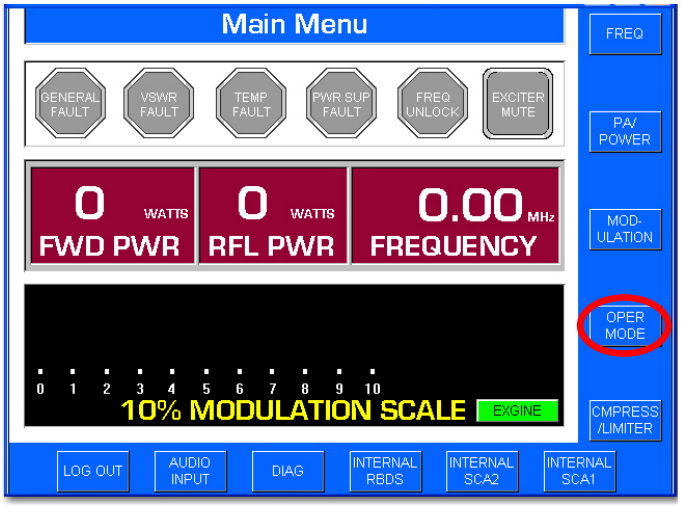

Figure 21 – FXi Main Menu

Step 4 – Select **IBOC MENU**.

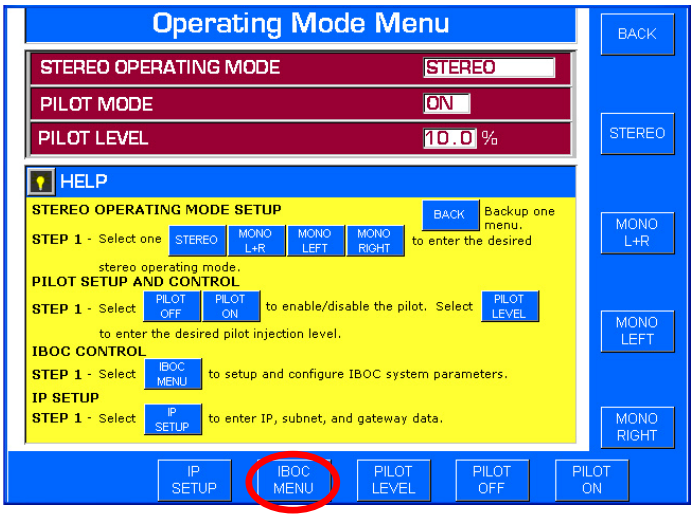

Figure 22 – Operating Mode Menu

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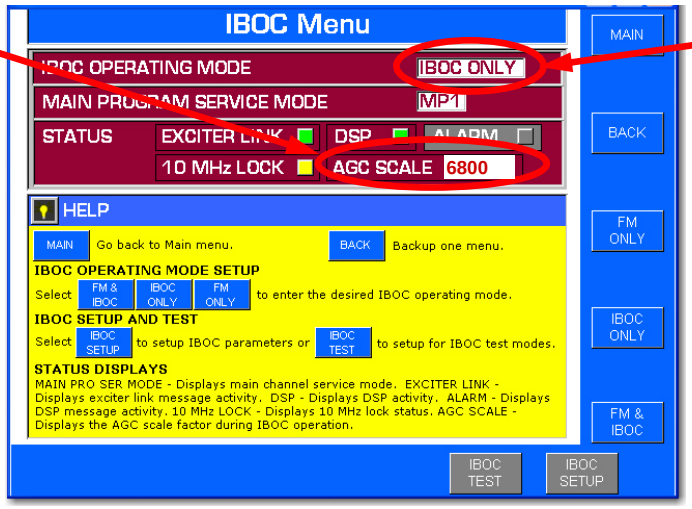
Step 5 – Record the **IBOC OPERATING MODE** and the present **AGC SCALE** reading.

Remember, the Transmitter must be operating at the TPO level that you would normally operate it at!

Record the present AGC Scale reading.

Note: The present AGC Scale reading will appear here if the FXi 60/250 Exciter is running software v2.0.35 or newer.

If running an older version, you will need to use Hyperterminal's "e" command to see the present Scale Factor reading.



Note the present IBOC Operating Mode

Figure 23 – Record the AGC SCALE at Normal Operating RF Output Power

Step 6 – Increase the RF output of the transmitter in the range of 5% (minimum) to 15% (maximum) above the current TPO level of your transmitter.

Note that the smaller the increase, such as 5%, may ultimately inhibit the transmitter's ability to automatically compensate for environmental temperature variations. If your transmitter is subject to outside variations in ambient room temperature, then this may require a setting near the upper end, such as 15%, of the range.

Units shipped from the BE factory now are preset with a Max scale factor 15% above the TPO on your order. This is set at an ambient room temperature of 21C.

Step 7 – Go back to the FXi Exciter GUI Main Menu and select **OPER MODE**.

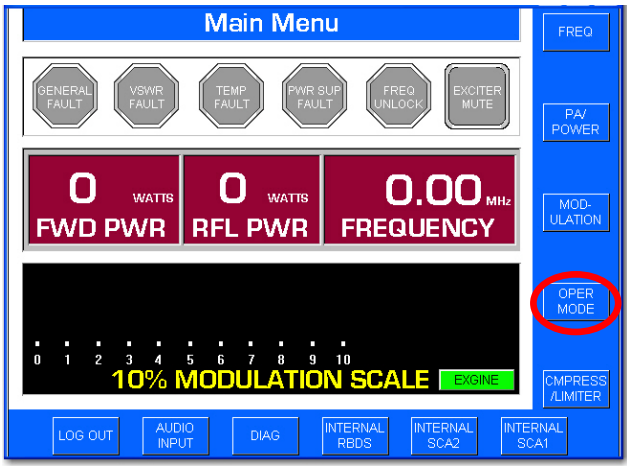


Figure 24 – FXi Main Menu

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Step 8 – Select **IBOC MENU**.

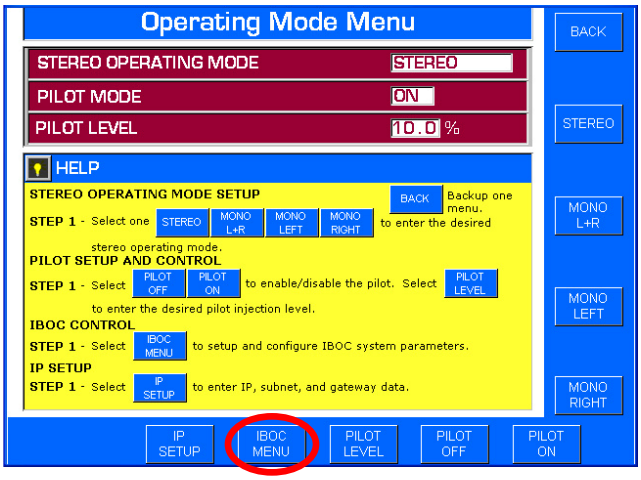
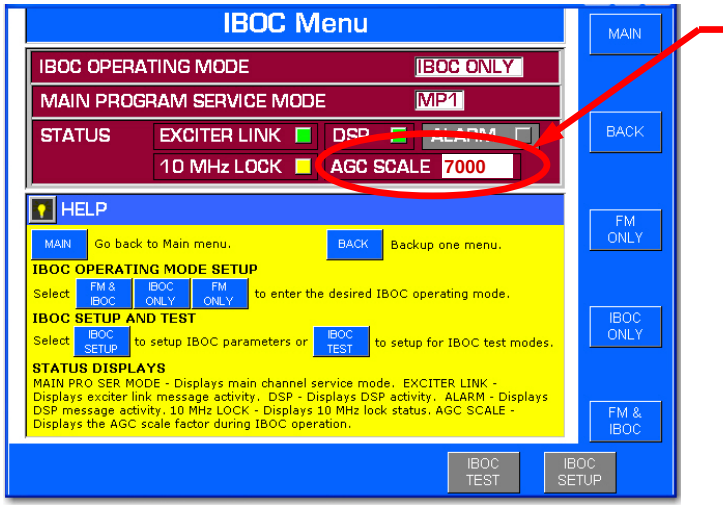


Figure 25 – Operating Mode Menu

Step 9 – Record the present **AGC SCALE** reading.

Remember, the transmitter must now be operating in the range of 5 - 15% above the TPO level that you would normally operate it at!



Record the present AGC Scale reading (this number should be slightly larger than the number recorded in Step 5 at Normal TPO)

Note: The present AGC Scale reading will appear here if the FXi 60/250 Exciter is running software v2.0.35 or newer.

If running an older version, you will need to use Hyperterminal's "e" command to see the present Scale Factor reading.

Figure 26 – Record the AGC SCALE at "5 -15% above" Normal Operating RF Output Power

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Step 10 – Press "**i**" (lower case) on the keyboard of the PC to change the scale factor of the "current" IBOC Operating Mode.

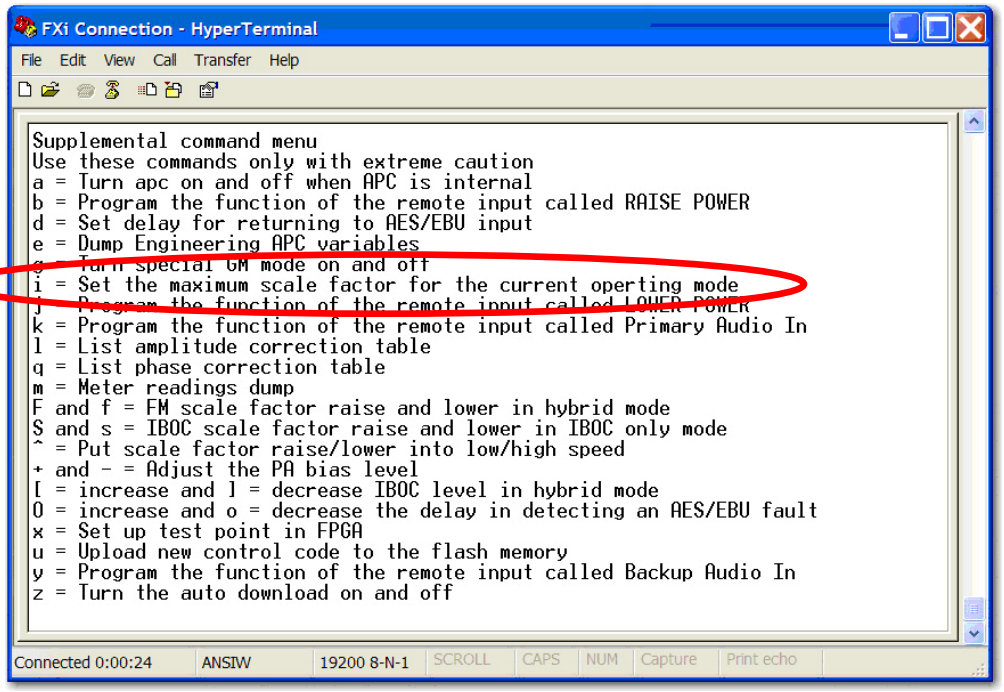

Figure 27 – HyperTerminal Supplemental Command Menu

Step 11 – After pressing "**i**", the following command prompt will appear. Enter the AGC Scale setting recorded in **Step 9** (7000 for this example) and press **Enter.**

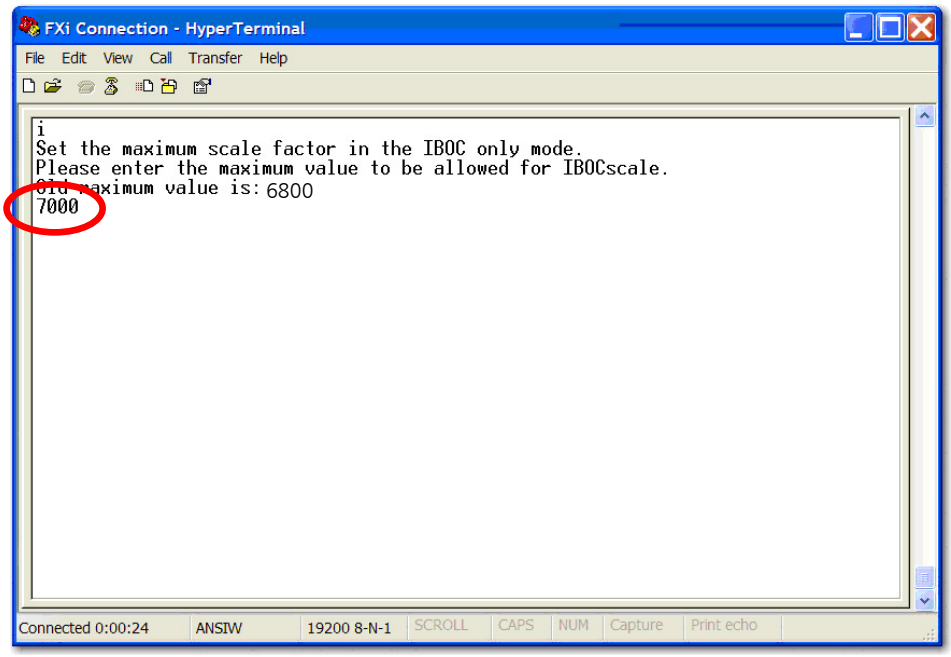

Figure 28 – "i" Command to Change Maximum Scale Factor

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Step 12 – Lower the transmitter's RF Output Power level back to where you would normally operate it at.

Step 13 – To verify that the scale factor was changed, press "**e**" (lower case) on the keyboard.

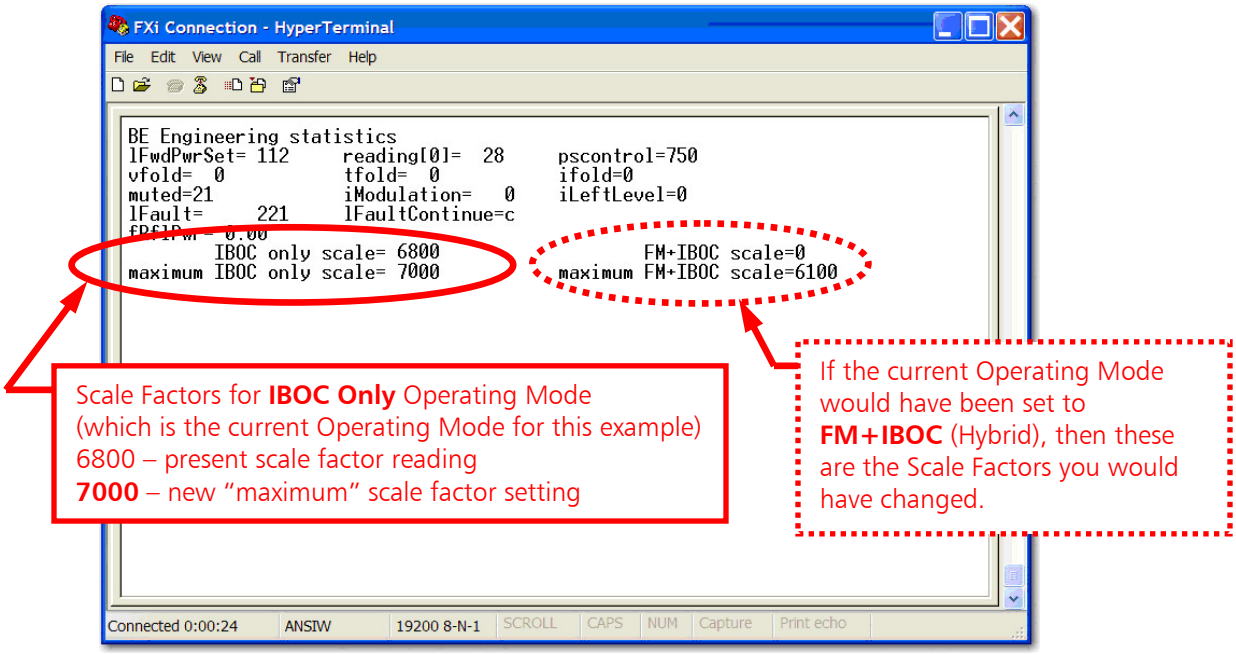

Figure 29 – "e" Command to Review Engineering Statistics

10 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 703/1405 HD Spectrum Tuning Application Guide; 597-1012-009
- FXi Exciter HD Injection Level Adjustment; 597-0541-010

11 RF Technical Services Contact Information

RF Technical Services -

Telephone: (217) 224-9617
E-Mail: rfservice@bdcast.com
Fax: (217) 224-6258
web: www.bdcast.com

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