



## **FMi 703 / 1405 Transmitter**

**Tuning for Best HD Spectrum**

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# 1 FM HD Spectral Measurements

The following document describes the technique for accurately tuning and measuring the FM HD Radio™ Spectrum of an FMi 703 or FMi 1405 Transmitter.

## 1.1 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.

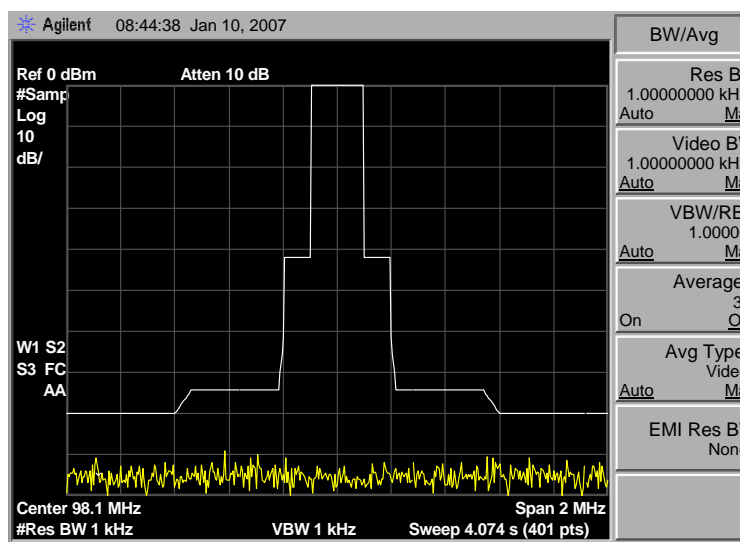


Figure 2 - FM HD Radio™ Spectral Emissions Limits Mask in Graphical Form

## 1.2 Setting up the Spectrum Analyzer

### 1.2.1 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). Set the resolution bandwidth to 1MHz.

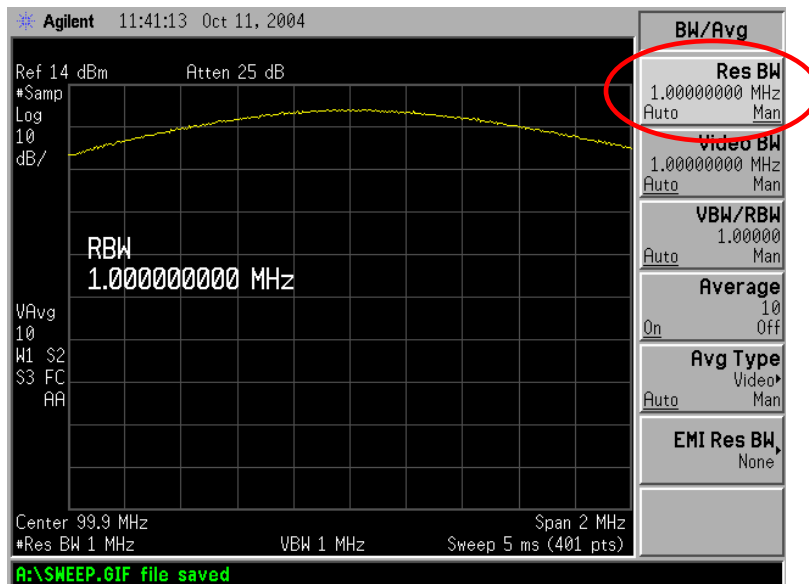


Figure 3 – Setting the top reference at 1MHz RBW.

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.

- 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 1.2.2.

### 1.2.2 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  $\leq 80$  dB down as shown below.

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

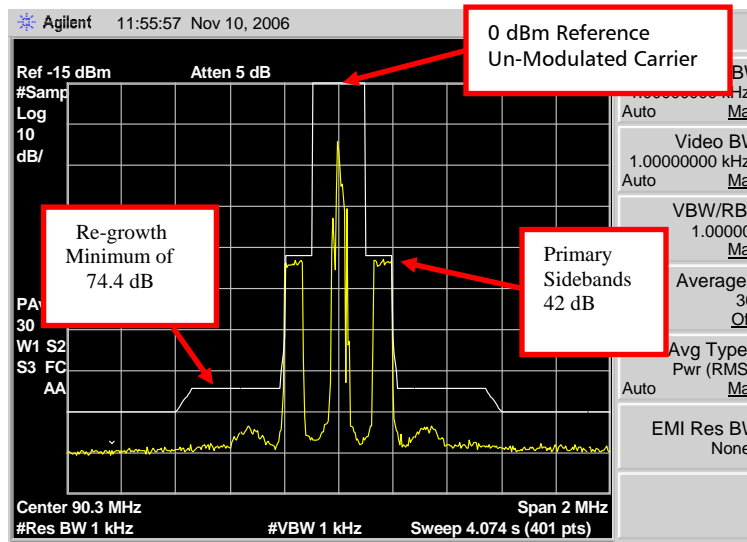


Figure 4 – Properly Aligned FM HD Radio™ Spectrum

## 2 FMi 703 and FMi 1405 Spectral Adjustments

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

There are (3) points of adjustment when tuning an FMi 703 or FMi 1405 Transmitter for best spectrum. Please NOTE that all three of these adjustments interact with each other. If one is adjusted then the others will be affected too. It will be necessary to go back and forth between the three until the best spectrum is achieved.

In the Transmitter:

- 1) PA Bias Level
- 2) IPA Bias Level

In the Exciter:

- 3) Distortion Null

## 3 Set the PA Bias Level

**Step 1** – Establish HyperTerminal communication with the Transmitter using a Null Modem Cable @ 9600, N, 8, 1 and connect to the d-sub connector on the front of the transmitter.

**Step 2** – Verify communication by pressing <enter> on the keyboard. Text should appear in the HyperTerminal window.

**Step 3** – Ensure that BOTH the Transmitter and Exciter are in the desired mode of operation (IBOC ONLY or FM+IBOC).

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

**Step 5** – Using a Voltmeter, probe TP8 (PA Bias) as shown.



**Figure 5 – TP8 (PA Bias Voltage)**

< proceed to the next page >

**Step 6** – See Figures 5 and 6 below. Press “**B**” on the keyboard and follow the on screen instructions for raising / lowering the PA Bias Voltage. The PA Bias Voltage should be adjusted to the approximate values using the Standby Exciter button to lower the value and Standby IPA to raise the value. When the desired value is reached press the ON button.

IBOC Only = approximate average 2.71V (min. 2.65 and max. 2.80)

FM + IBOC = approximate average 2.69V (min. 2.67 and max. 2.73)



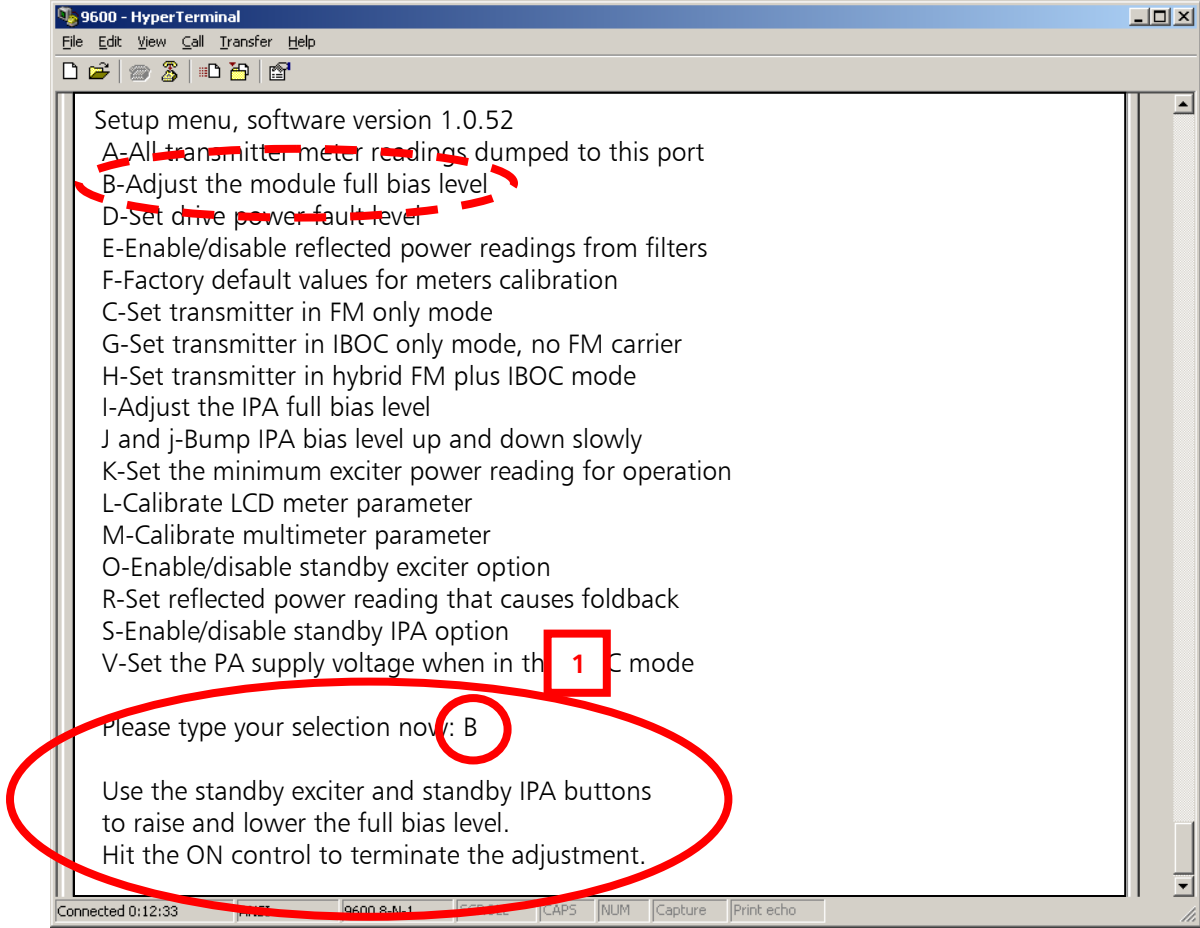


Figure 6 – PA Bias Voltage Adjustment

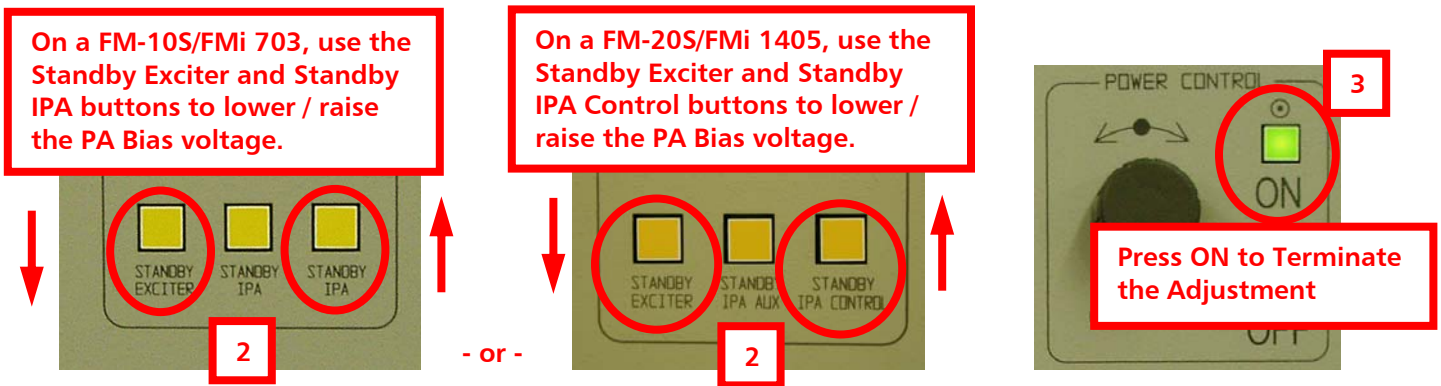
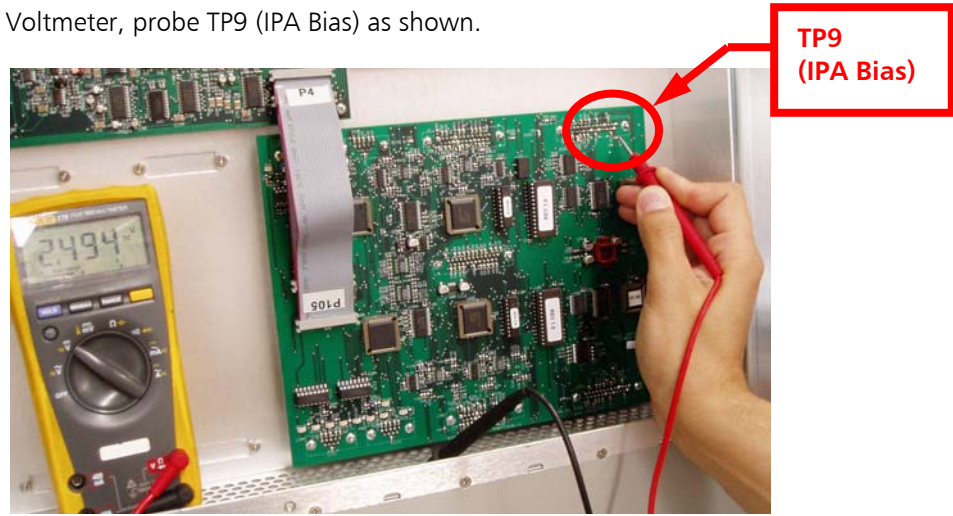


Figure 7 – PA Bias Voltage Adjustment



## 4 Set the IPA Bias Level

**Step 1** – Using a Voltmeter, probe TP9 (IPA Bias) as shown.



**Figure 8 – TP9 (IPA Bias Voltage)**

**Step 2** – See Figures 8 & 9 below. Press “I” and follow the on screen instructions for raising / lowering the IPA Bias Voltage. The IPA Bias Voltage should be adjusted to the approximate values using the Standby Exciter button to lower the value and Standby IPA to raise the value. When the desired value is reached press the ON button.

IBOC Only = approximate average 2.60 (min. 2.47 and max. 2.79)

FM + IBOC = approximate average 2.59 (min. 2.33 and max. 2.91)

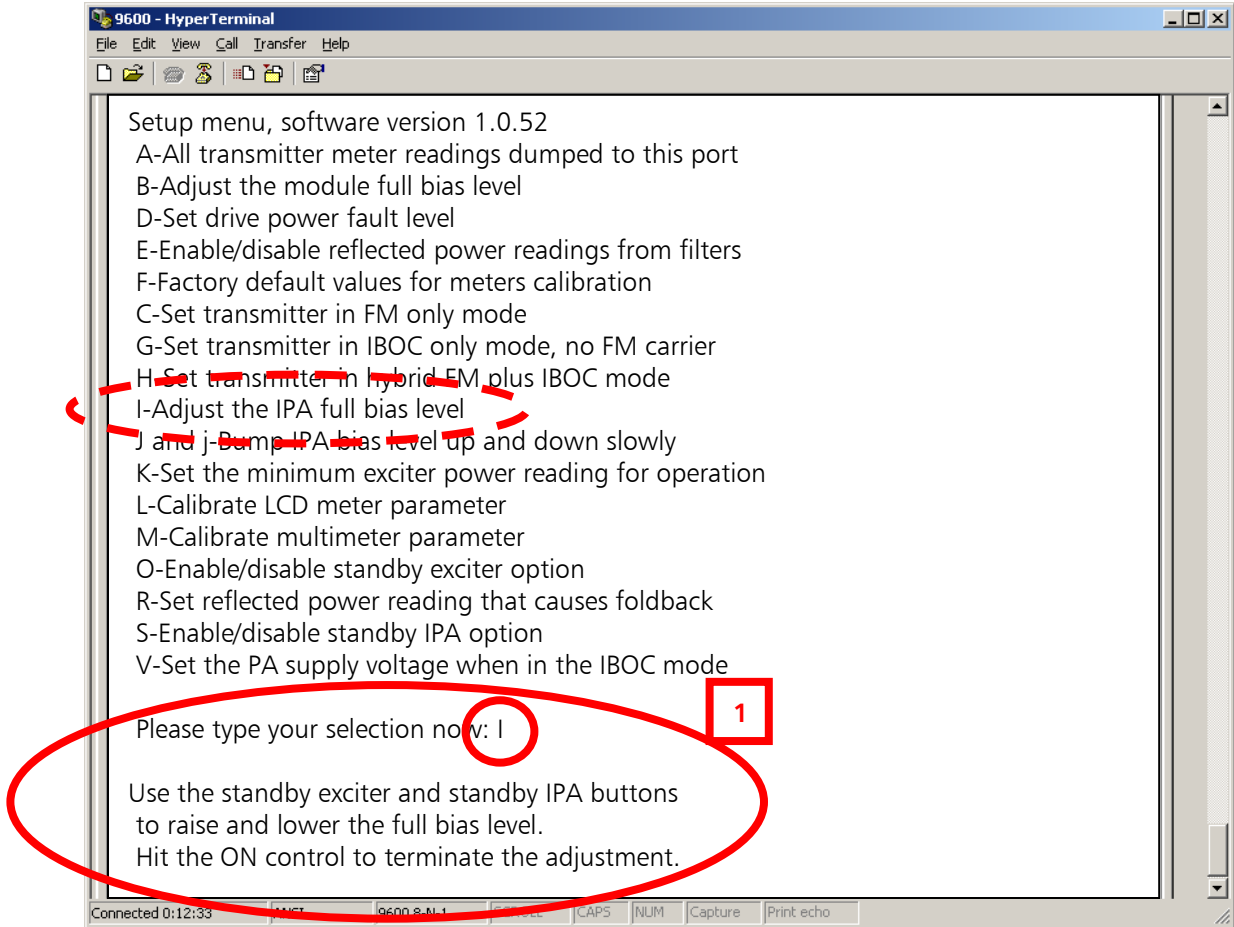


Figure 9 – IPA Bias Voltage

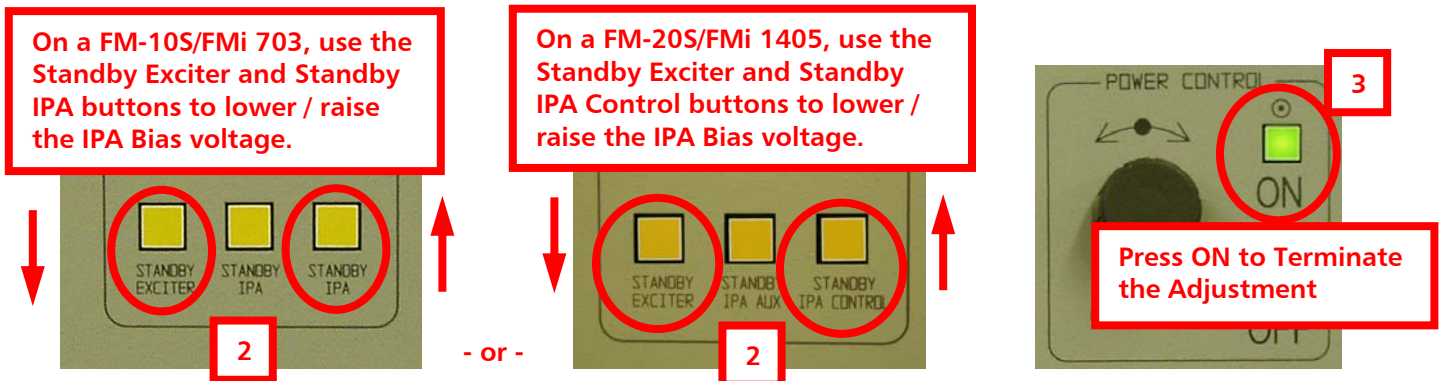


Figure 10 – IPA Bias Voltage Adjustment

## 5 Distortion Null Adjustment

Adjust the distortion Null Potentiometer on the rear of the Exciter until the AGC Scale is set to approximately 14,500 for HD Only (or 10,500 for FM + HD). This can be monitored on the Front Panel GUI of the FXi under the Operating Mode -> IBOC Menu (see Figure 11 below).

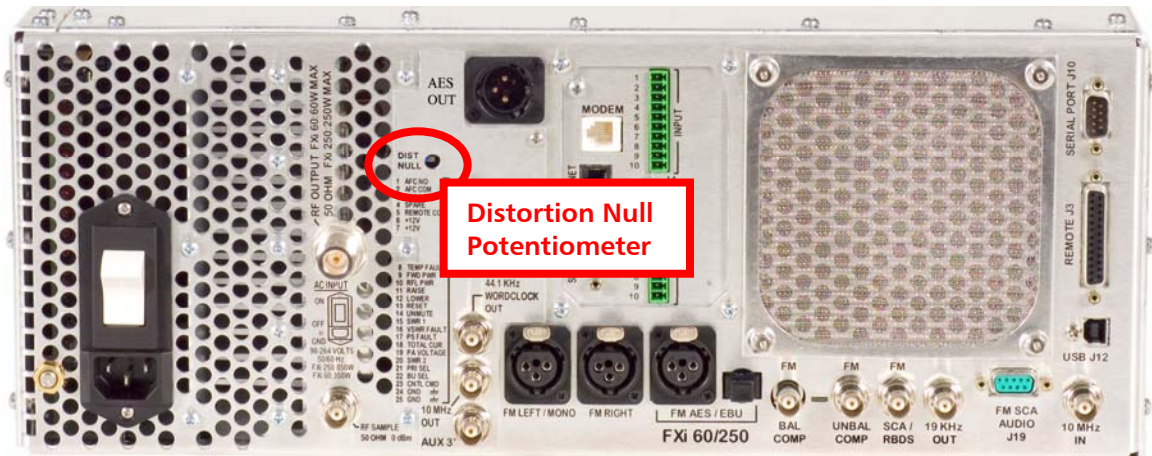


Figure 11 – Distortion Null Adjustment

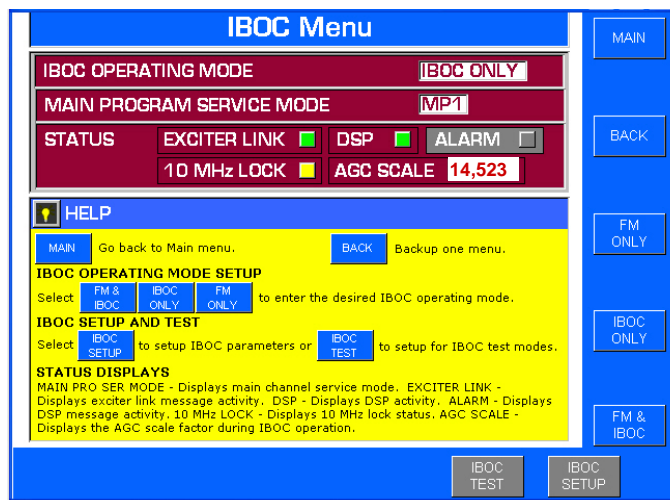


Figure 12 – AGC Scale Factor

## 6 Review and Adjust for Best Spectrum

While monitoring the spectrum on the Spectrum Analyzer adjust the Distortion Null above and below the nominal value to obtain optimum performance. Normally, you should only have to adjust this +/- 2000. IPA Bias may also need to be adjusted again for best results. Go back and forth between the Distortion Null and IPA Bias adjustments until best performance is met.



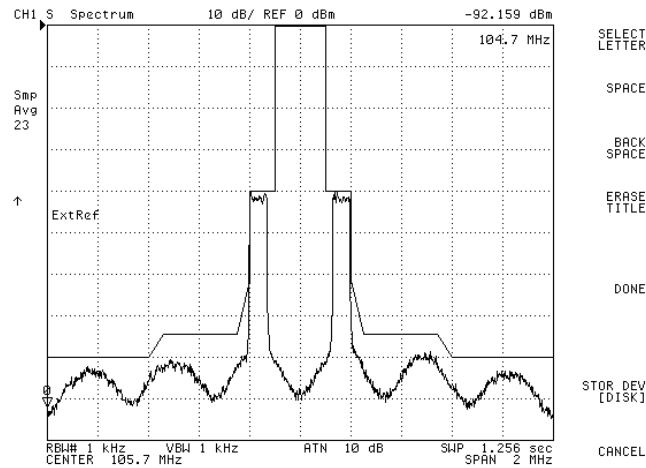


Figure 13 – Typical Properly Aligned HD Only Spectrum

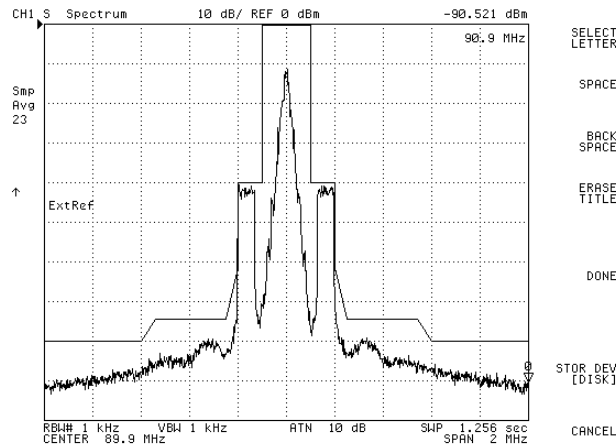


Figure 14 – Typical Properly Aligned FM+HD (Hybrid) Spectrum

## 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
- FXi Exciter HD Injection Level Adjustment; 597-0541-010

## 8 RF Technical Services Contact Information

RF Technical Services -

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