BDA Test Procedure

This document describes how to test the BDA / Signal Booster using DSA815 Spectrum Analyzer. After all other testing has been performed (Donor, DAS, DAS/Donor Isolation) and the isolation value has been identified and sent to the RSI Project manager, the prescribed gain value will be determined and set within the BDA. This procedure will demonstrate how to take the following measurements:

- Downlink Gain
- Uplink Gain
- Uplink Maximum Power
- Downlink Maximum Power

There are two purposes for BDA testing, the first is to verify that the BDA is outputting the desired level of gain. And the second purpose is to the confirm that the BDA's maximum power feature is working. The maximum power feature is crucial to the operation of the BDA System. Due to legislation, the max output of a BDA can be 30 dBm, by measuring the maximum uplink and downlink power one can confirm that the BDA is within code and specification.

Sample Units:

- 800MHz Public Safety Band
- Downlink (DL): 851MHz - 860MHz
- Uplink (UL): 806 - 815MHz

Sub-Procedures:

1. Set the Spectrum Analyzer – Frequency Span
2. Set the Spectrum Analyzer - Markers
3. Set the Spectrum Analyzer - Resolution Bandwidth
4. Set the Spectrum Analyzer - Tracking Generator
5. Check the Test Cables
6. Measure the Downlink Gain
7. Measure the Uplink Gain
8. Measure the Uplink Maximum Power
9. Measure the Downlink Maximum Power

Requirements:

- Radio Solutions, Inc. (RSI) Test Accessory Kit
- Rigol DSA-815 Spectrum Analyzer with Tracking Generator (TG)

Note: **Bold, green text** indicates a selection on the Spectrum Analyzer
Bold, orange text indicates a selection of Power on the BDA

1. Set the Spectrum Analyzer – Frequency Span

Set the spectrum analyzer to show the full frequency span as to include both the uplink and downlink bands, +/- 10MHz. Adding the 10MHz will show the passband cut-off / roll-off, verifying that there are no unwanted emissions coming from the BDA.

Procedure:

An 800MHz band (UL: 806-815 and DL: 851MHz-860MHz) requires a span with a 796MHz start frequency and 870MHz stop frequency:

1. Power up the Spectrum Analyzer, which will default to factory settings

2. Set the Start Frequency:
   FREQ > Start Freq > 796 > MHz

3. Set the Stop Frequency:
   Stop Freq > 870 > MHz

2. Set the Spectrum Analyzer – Markers

A "Marker" is a Point-of-Interest that show measurements taken on a specific frequency. The spectrum analyzer can display up to four (4) markers on the screen. For example: to derive the signal level of 850MHz, one must set the marker to 850MHz and then see its corresponding marker measurement value.

The four (4) markers need to be set to the following frequencies:

- Median frequency of the Downlink Passband; the passband frequency range is labeled on the BDA module (e.g. the median frequency between 851MHz and 860MHz is 855.5MHz)

- Downlink user-specific frequency (i.e. Fire Radio Channel Downlink)

- Median frequency of the Uplink Passband; the passband frequency range is labeled on the BDA module (e.g. the median frequency between 806MHz and 815MHz is 810.5MHz)

- Uplink user-specific frequency (i.e. Fire Radio Channel Uplink)

Confirm the proper markers with the Project Manager.

When markers are set, one can measure and verify the gain and power values for both the frequency of interest (i.e. the actual user frequency), as well as the median frequency of the passband (i.e. the reference value on the BDA control panel display).

Procedure:

Using the spectrum analyzer, configure the following frequencies to prompt the Marker Table (see Figure 1.1):

1. **Mkr > 855.5 > MHz**
(sets the first marker to the median frequency of the downlink passband)

2. **Mkr > Normal > 857 > MHz**
(sets the second marker to the downlink user-specific frequency)

3. **Mkr > Normal > 810.5 > MHz**
(sets the third marker to the median frequency of the uplink passband)

4. **Mkr > Normal > 812 > MHz**
(sets the fourth marker to the uplink user-specific frequency)

5. Scroll Down to **"1/2" > Mkr Table**
(will display the marker table that consists of all four (4) markers)

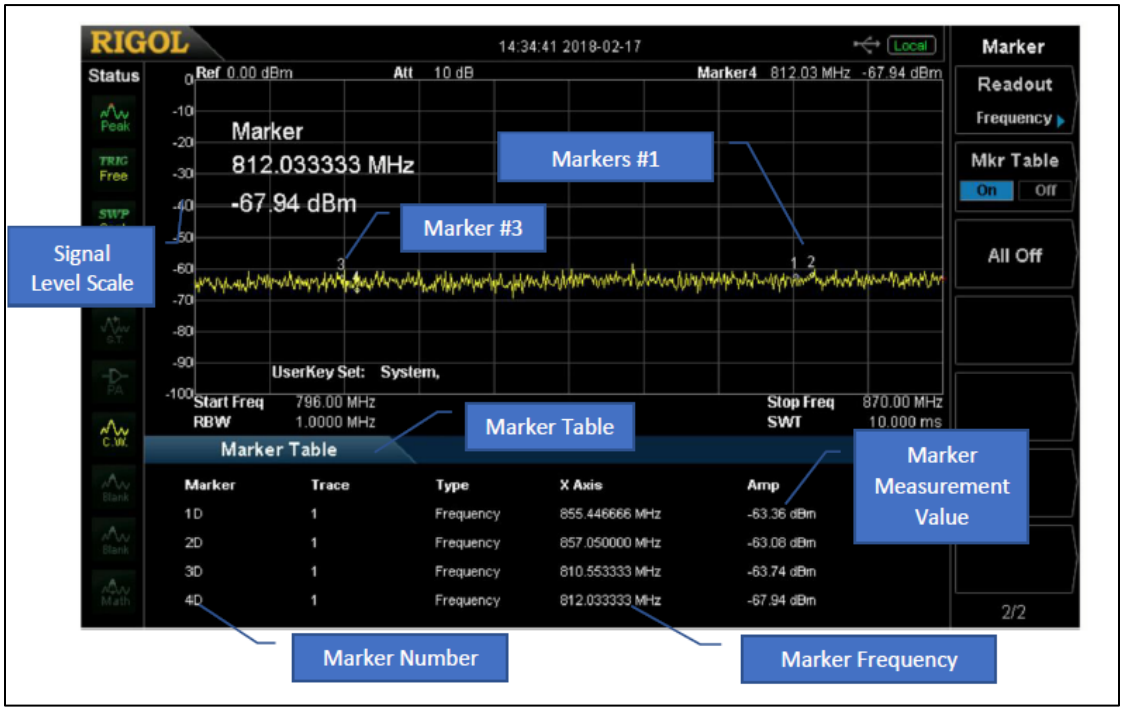


Figure 1.1

3. Set the Spectrum Analyzer – Resolutions Bandwidth

Procedure:

1. **BW / Det > RBW**

2. Use the rotary knob to adjust the RBW value to **10KHz** (see Figure 1.2)

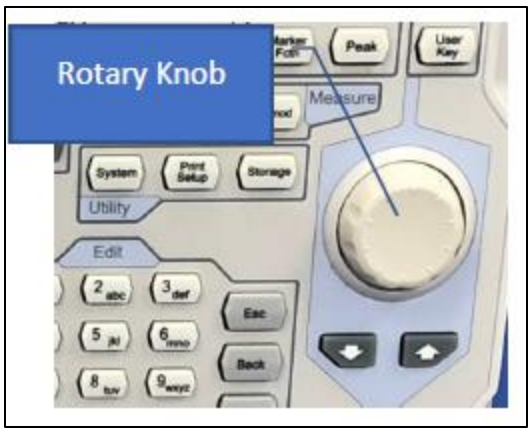


Figure 1.2

4. Set the Spectrum Analyzer – Tracking Generator

The Tracking Generator ("TG") is a signal producer that creates a radio signal on the same frequency as the one received by the spectrum analyzer.

Procedure:

1. **TG > TG Level**

2. Use the rotary knob to adjust the desired level to **0dBm**

5. Check the Test Cables

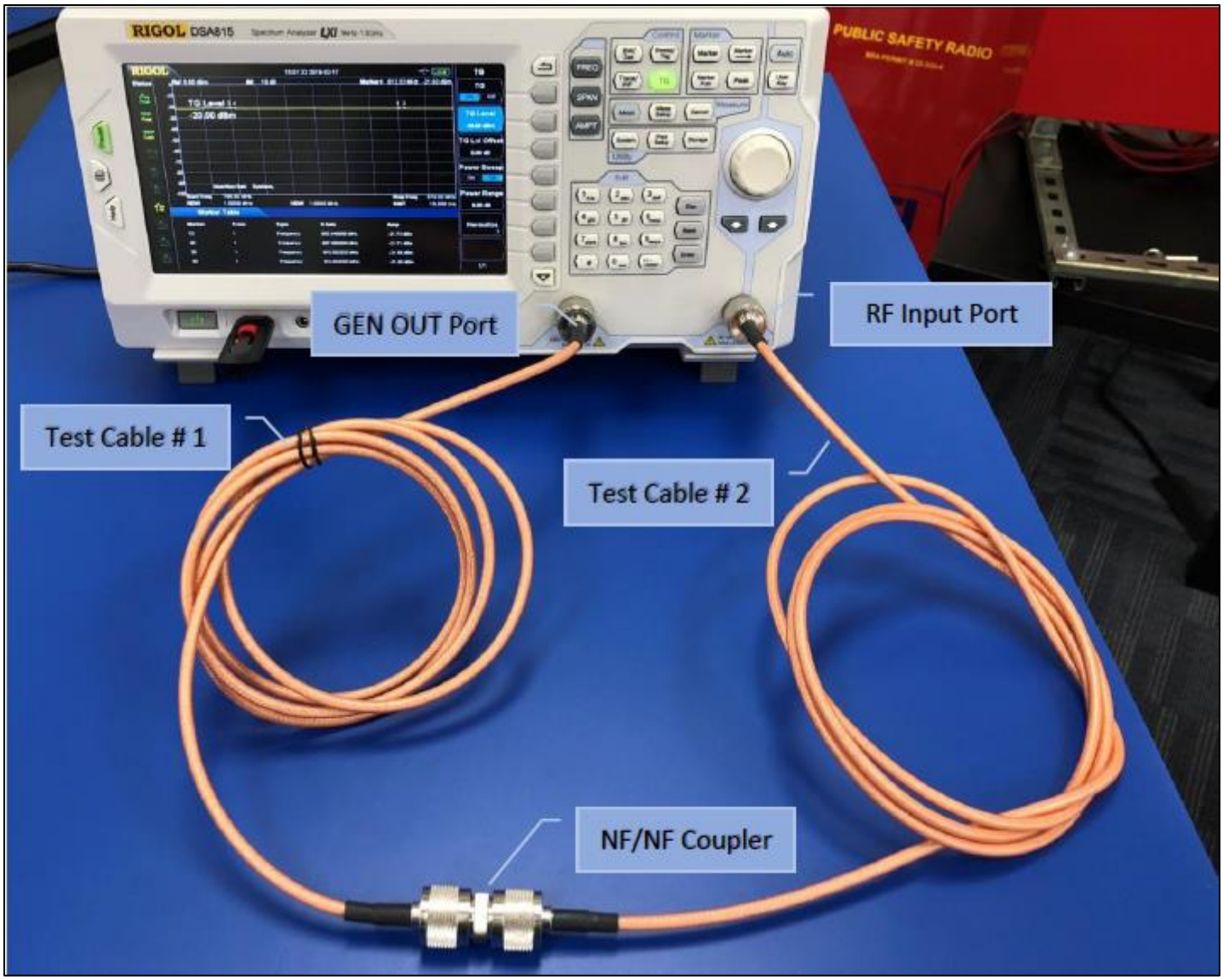
One must measure the insertion loss to test the two (2) test cables as to:

- Ensure the cables are not broken
- Verify the cable loss

Only use the RSI-specified RG142 test cables. Do *not* use RG58, RG8 or similar.

Procedure:

1. Connect the two test cables to “Gen Output” and “RF Input” ports on the spectrum analyzer
2. Connect the two cables together using the N-Female to N-Female coupler



3. **TG On**

4. The marker table will display the total cable loss on marker 1D (See Figure 1.3):

0dBm + -2.12dBm = 2.12dB loss

Signal level from the generator + Measurement by the spectrum analyzer = Total cable loss

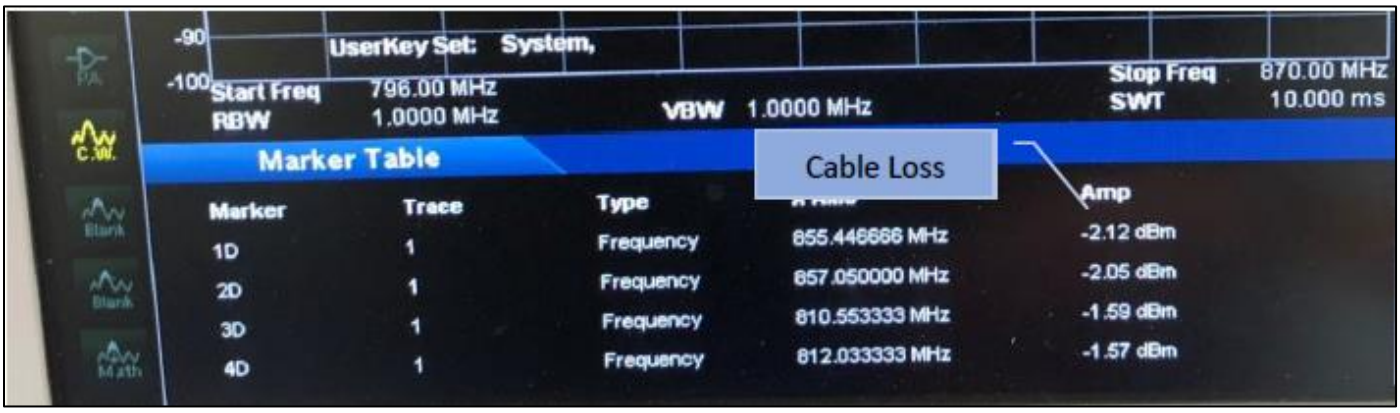


Figure 1.3

The cable loss of each standard RG142 test cable is ~1dB. The lower the frequency, the lower cable loss; please verify before each test.

The screen above shows that 2.12dB is for both cables, which equals 1.06dB cable loss per cable.

5. **TG Off**

6. Disconnect the test cable from "Gen Output" port and remove the N-Female to N-Female Coupler from the test cables.

6. Measure Downlink Gain

Procedure:

1. Set the "Maximum Hold" to show both uplink and downlink measurements on the same screen: **Trace / P/F > Trace Type > Max Hold**

2. Insert the 20dB attenuator to the "Gen Output" port on the spectrum analyzer

3. Attach the test cable to the opposite end of the 20dB attenuator now attached to the "Gen Output" port

30dB Attenuators must always be connected for all testing. Do NOT connect the BDA directly to the spectrum analyzer without attenuators on both ports or else damage and/or possible destruction may occur.

4. Connect a 30dB attenuator to the Donor Antenna port and another 30dB attenuator to the DAS port of the BDA.

Please make sure that the BDA is always powered OFF before disconnecting or connecting the donor antenna and DAS ports on the BDA. Signal spikes and fast transients are created while connecting and reconnecting the antenna ports and may damage the power amplifier.

5. Ensure the BDA power is set to OFF. Attach the test cable to the "Gen Output" port of the Spectrum Analyzer (i.e. the 20dB attenuator) to the Donor Antenna port of the BDA (i.e. the 30dB attenuator).

6. Attach the test cable to the "RF Input" port of the Spectrum Analyzer (no attenuator should be attached to this port) to the DAS port of the BDA (i.e. the 30dB attenuator).

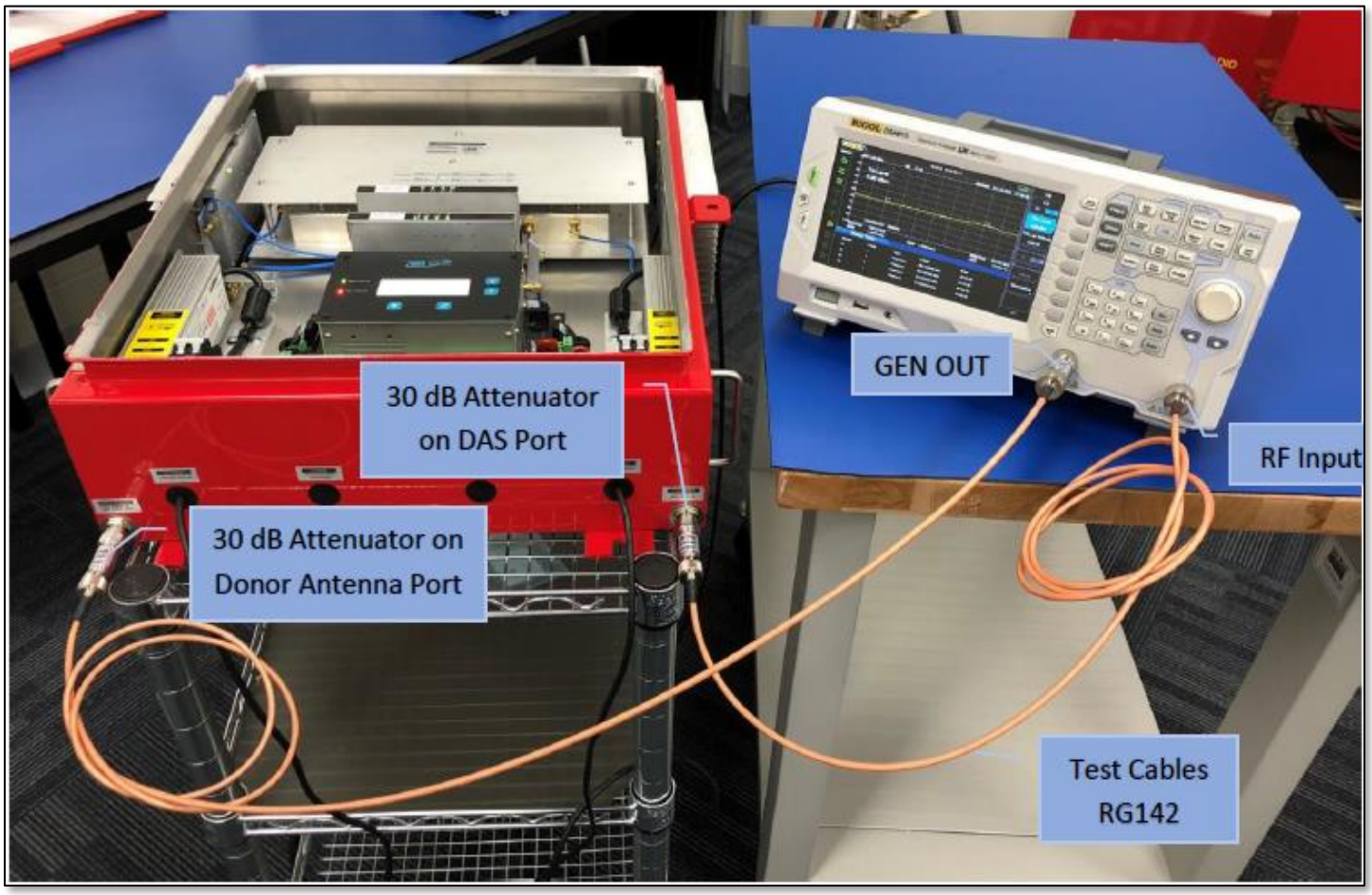


Figure 1.4

7. **Turn BDA power to ON**.

After the power-up, the increased noise floor will be displayed within the passband of the downlink amplifier (See Figure 1.5). The noise floor is simply the sum of all external noise sources and unwanted signals that the donor antenna receives but may not necessarily monitor.

As a general rule of thumb, the noise level for an 80dB amplifier should be no more than -45dBm. When setting a 95dB "high-gain" amplifier, the noise level should be no more than -30dBm.

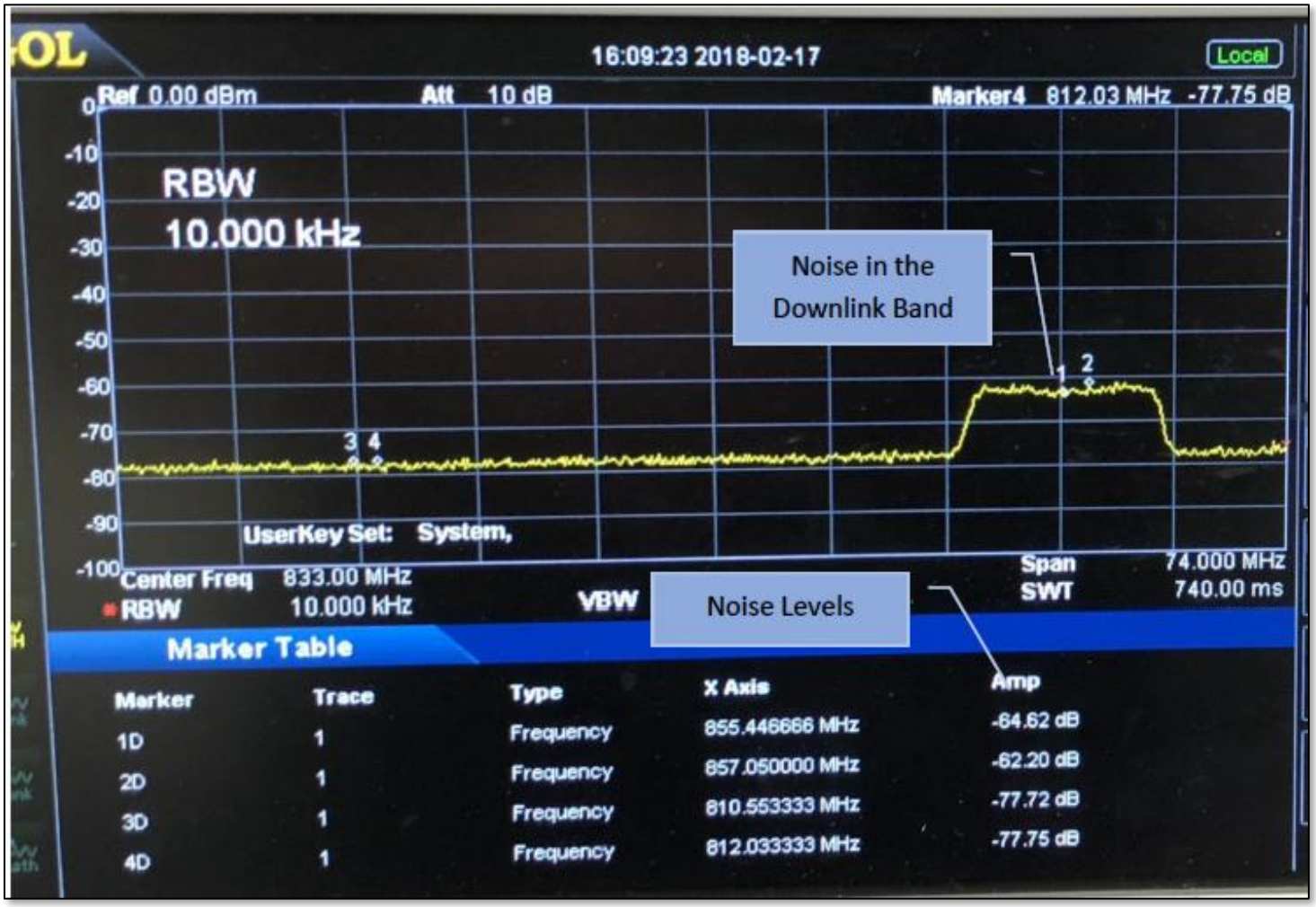


Figure 1.5

8. **TG > TG Level**

9. Use the rotary knob to adjust the Tracking Generator (TG) **-20 dBm**

10. **TG on**. Verify the spectrum analyzer shows a similar display reading (See Figure 1.6).

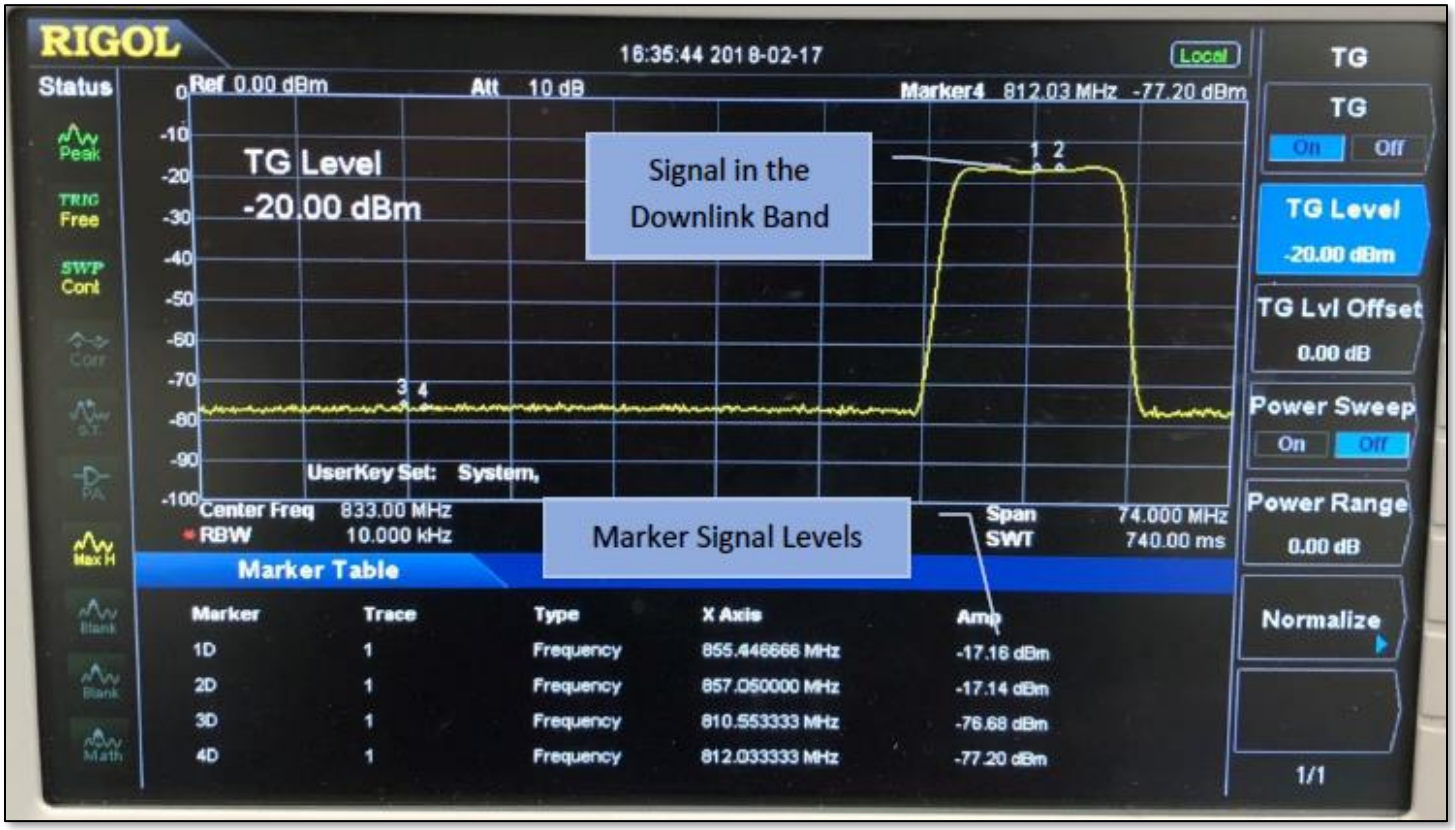


Figure 1.6

11. Calculate the actual gain value:

The calculated actual gain value should be within +/- 2 dB of the expected gain value set on the BDA. If there any discrepancies be sure to share results with the Project Manager.

Value	Reference
(-20dBm)	The generated TG level of the spectrum analyzer (step #9)
+ (-20dB)	The value of the attenuator on the "Gen Output" port of the spectrum analyzer (step #3)
+ (-1dB)	The cable loss from the "Gen Output" port of the spectrum analyzer to the donor antenna port of the BDA (step #5)
+ (-30dB)	The value of the attenuator on the donor antenna port of the BDA (step #4)
+ (-30dB)	The value of the attenuator on the DAS port of the BDA (step #4)
+ (-1dB)	The cable loss from the DAS port of the BDA to the "RF Input" of the spectrum analyzer (step #6)
= (-102dBm)	The summed losses amongst testing equipment
- (-17.16dBm)	The amp value or signal level of Marker 1D (Figure 1.6)
= (-84.84dBm)	The calculated downlink gain value, which should be consistent to the expected gain value set on the BDA

12. **TG OFF**

13. **Turn the BDA power to OFF**

14. Detach the cable from the Donor Antenna port of the BDA (i.e. the 30dB attenuator).

15. Detach the cable from the DAS port of the BDA (i.e. the 30dB attenuator).

7. Measure the Uplink Gain

Procedure:

1. Make sure the 20dB attenuator is attached to the "Gen Output" port on the spectrum analyzer

30dB Attenuators must always be connected for all testing. Do NOT connect the BDA directly to the spectrum analyzer without attenuators on both ports or else damage and/or possible destruction may occur.

2. Confirm a 30dB attenuator is attached to the Donor Antenna port and another 30dB attenuator is attached to the DAS port of the BDA.

Please make sure that the BDA is always powered OFF before disconnecting or connecting the donor antenna and DAS ports on the BDA. Signal spikes and fast transients are created while connecting and reconnecting the antenna ports and may damage the power amplifier.

3. Ensure the BDA power is set to OFF. Attach the test cable to the "Gen Output" port of the Spectrum Analyzer (i.e. the 20dB attenuator) to the DAS port of the BDA (i.e. the 30dB attenuator).

4. Attach the test cable to the "RF Input" port of the Spectrum Analyzer (no attenuator should be attached to this port) to the Donor Antenna port of the BDA (i.e. the 30dB attenuator) (See Figure 1.7).

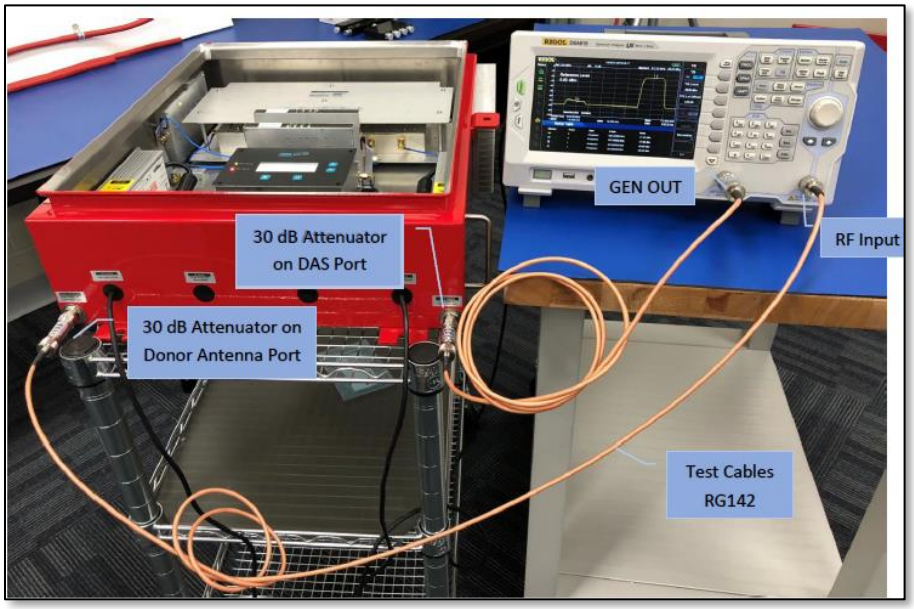


Figure 1.7

5. **Turn the BDA power to ON.**
You will now see the uplink noise floor on Markers 3 and 4 (See figure 1.8).

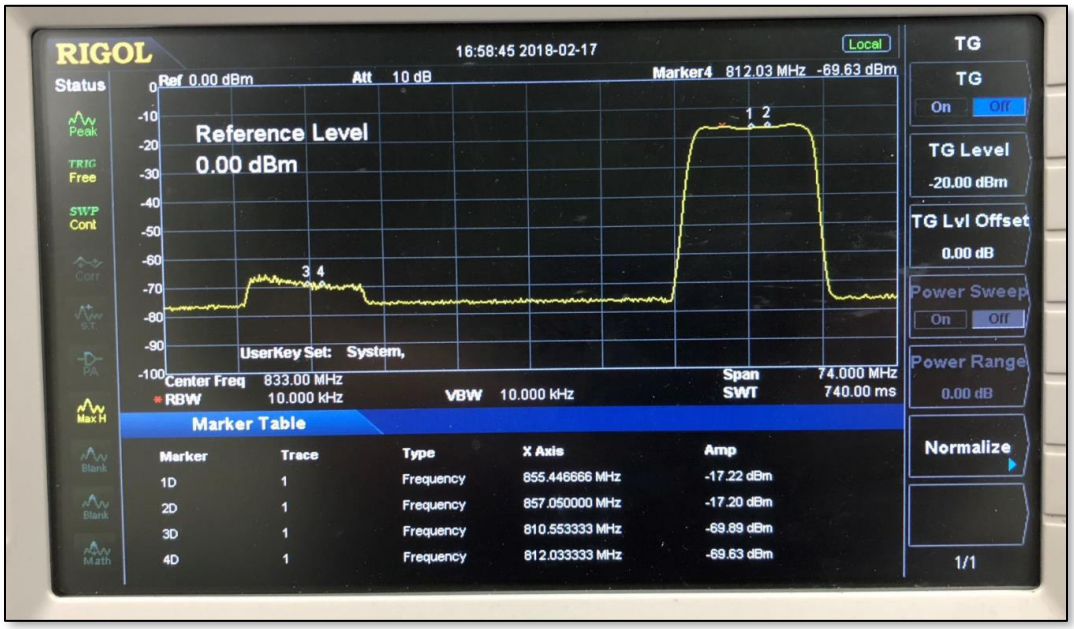


Figure 1.8

6. Confirm that the Tracking Generator (TG) Level is set at **-20dBm**.

7. **TG On.**

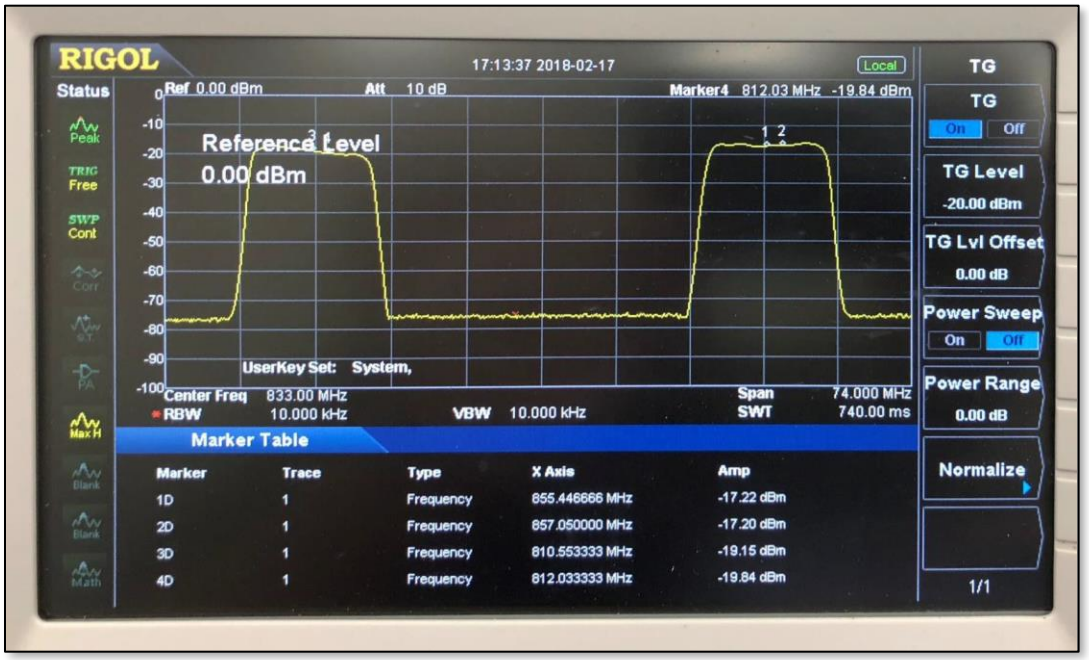


Figure 1.9

8. Calculate the Actual Gain

Value	Reference
(-20dBm)	The generated TG level of the spectrum analyzer (step #7)
+ (-20dB)	The value of the attenuator on the "Gen Output" port of the spectrum analyzer (step #2)
+ (-1dB)	The cable loss from the "Gen Output" port of the spectrum analyzer to the DAS port of the BDA (step #4)
+ (-30dB)	The value of the attenuator on the DAS port of the BDA (step #3)
+ (-30dB)	The value of the attenuator on the donor antenna port of the BDA (step #3)
+ (-1dB)	The cable loss from the Donor Antenna port of the BDA to the "RF Input" of the spectrum analyzer (step #5)
= (-102dBm)	The summed losses amongst testing equipment
- (-19.15dBm)	The amp value or signal level of Marker 3D (Figure 1.9)
= (-82.85dBm)	The calculated uplink gain value, which should be consistent to the expected gain value set on the BDA

The calculated actual gain value should be within +/- 2 dB of the expected gain value set on the BDA. If there any discrepancies be sure to share results with the Project Manager.

9. Send a screen shot of the two tests' display (see Figure 1.9) to the Project Manager.

10. **TG OFF**

11. **Turn the BDA power to OFF**

12. Remove the 20dB attenuator from the "Gen Output" port of the spectrum analyzer.

8. Measure Uplink Maximum Power

Procedure:

Please make sure that the BDA is always powered OFF before disconnecting or connecting the donor antenna and DAS ports on the BDA. Signal spikes and fast transients are created while connecting and reconnecting the antenna ports and may damage the power amplifier.

1. Make sure the BDA power is set to OFF
2. Make sure the 20dB attenuator is removed from the "Gen Output" port of the spectrum analyzer.

30dB Attenuators must always be connected for all testing. Do NOT connect the BDA directly to the spectrum analyzer without attenuators on both ports or else damage and/or possible destruction may occur.

3. Confirm a 30dB attenuator is attached to the Donor Antenna port and another 30dB attenuator is attached to the DAS port of the BDA.
4. Connect the cable from the DAS port of the BDA (i.e. the 30dB attenuator) to the "Gen Output" port of the spectrum analyzer.
5. Clear the Trace from any previous testing: **Trace / P/F > Trace Type > Max Hold**
6. **TG > TG Level**
7. Use the rotary knob to adjust the Tracking Generator (TG) **-0 dBm**
8. **Turn the BDA power to ON**
9. **TG On**

It is important to note, when the TG is turned on, the two lights labeled “AGCA Level” and “LNA Level” on the BDA Uplink module should be blinking (see Figure 1.10). This means the BDA is properly functioning.

Figure 1.10

10. Calculate the Uplink Maximum Power.

Figure 1.11

Value	Reference
(0dB)	The generated TG level of the spectrum analyzer
+ (-30dB)	The value of the attenuator on the donor antenna port of the BDA (step #3)
+ (-1dB)	The cable loss from the Donor Antenna port of the BDA to the "RF Input" of the spectrum analyzer (step #5)
= (-31dBm)	The summed losses amongst the Uplink testing equipment
- (-0.51dBm)	The amp value or signal level of Marker 3D (Figure 1.11)
= (-30.5dBm)	The calculated uplink maximum power, which should be consistent to the expected Maximum gain set at 30dBm

11. **TG OFF**

12. **Turn the Power of the BDA OFF**

13. Detach the test cable from the "Gen Output" port of the spectrum analyzer and detach the test cable from the "RF Input" port of the spectrum analyzer.

9. Measure Downlink Maximum Power

Please make sure that the BDA is always powered OFF before disconnecting or connecting the donor antenna and DAS ports on the BDA. Signal spikes and fast transients are created while connecting and reconnecting the antenna ports and may damage the power amplifier.

1. Make sure the BDA power is set to OFF

2. Make sure the 20dB attenuator is removed from the "Gen Output" port of the spectrum analyzer.

30dB Attenuators must always be connected for all testing. Do NOT connect the BDA directly to the spectrum analyzer without attenuators on both ports or else damage and/or possible destruction may occur.

3. Confirm a 30dB attenuator is attached to the Donor Antenna port and another 30dB attenuator is attached to the DAS port of the BDA.

4. Connect the cable from the DAS port of the BDA (i.e. the 30dB attenuator) to the "RF Input" port of the spectrum analyzer.

5. Connect the cable from the Donor Antenna port of the BDA (i.e. the 30dB attenuator) to the "Gen Output" port of the spectrum analyzer.

6. Confirm the **TG Level** is set to **-0dBm**

7. **Turn the BDA power to ON**

8. **TG On**

9. Calculate the Uplink Maximum Power.

Value	**Reference**
(0dB)	The generated TG level of the spectrum analyzer
+ (-30dB)	The value of the attenuator on the DAS port of the BDA (step #3)
+ (-1dB)	The cable loss from the DAS port of the BDA to the "RF Input" of the spectrum analyzer (step #5)
= (-31dBm)	The summed losses amongst the Uplink testing equipment
- (-0.36dBm)	The amp value or signal level of Marker 1D (Figure 1.12)
= (-30.64dBm)	The calculated downlink maximum power, which should be consistent to the expected Maximum gain set at 30dBm

10. Send a screen shot of the two tests' display (see Figure 1.12) to the Project Manager.

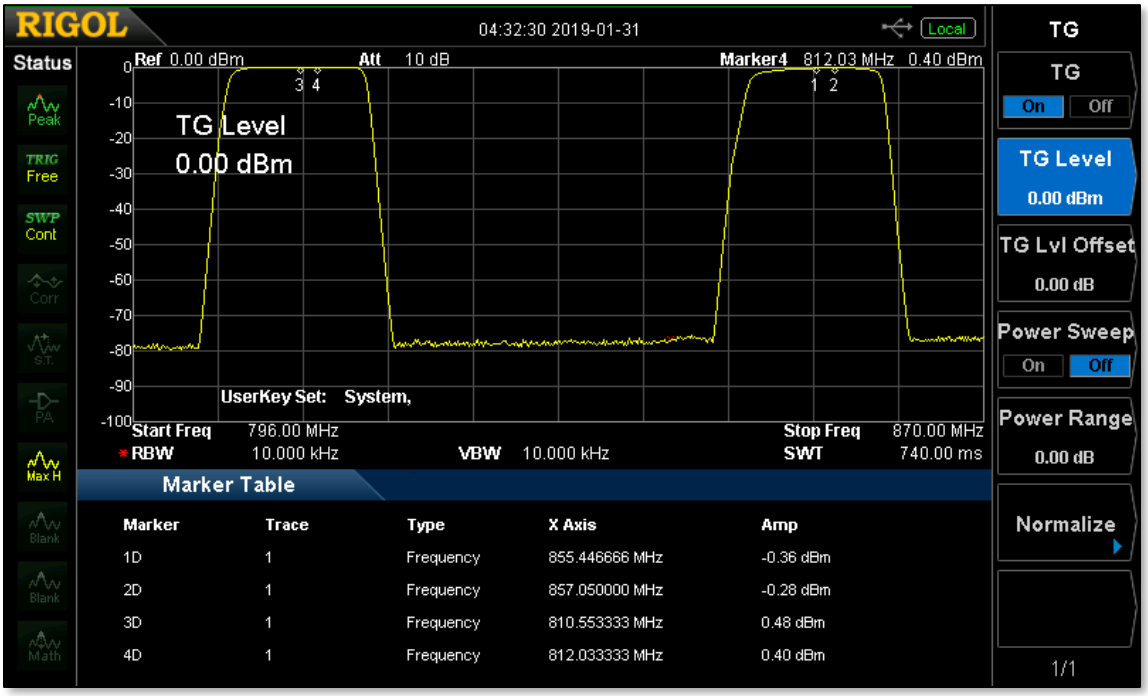


Figure 1.12

It is important to note, when the TG is turned on, the two lights labeled "AGCA Level" and "LNA Level" on the BDA Downlink module should be blinking (see Figure 1.13). This means the BDA is properly functioning.

Figure 1.13

11. **TG OFF**

12. **Turn the BDA power to OFF**

13. Remove the 30dB attenuators from the DAS port and Donor Antenna port of the BDA.

14. Reconnect the Donor Antenna cable head-end to the Donor Antenna port BDA and reconnect the DAS cable head-end to the DAS port of the BDA.