



Application Note:  
**Tuning an RF Combiner using a Tracking Generator**

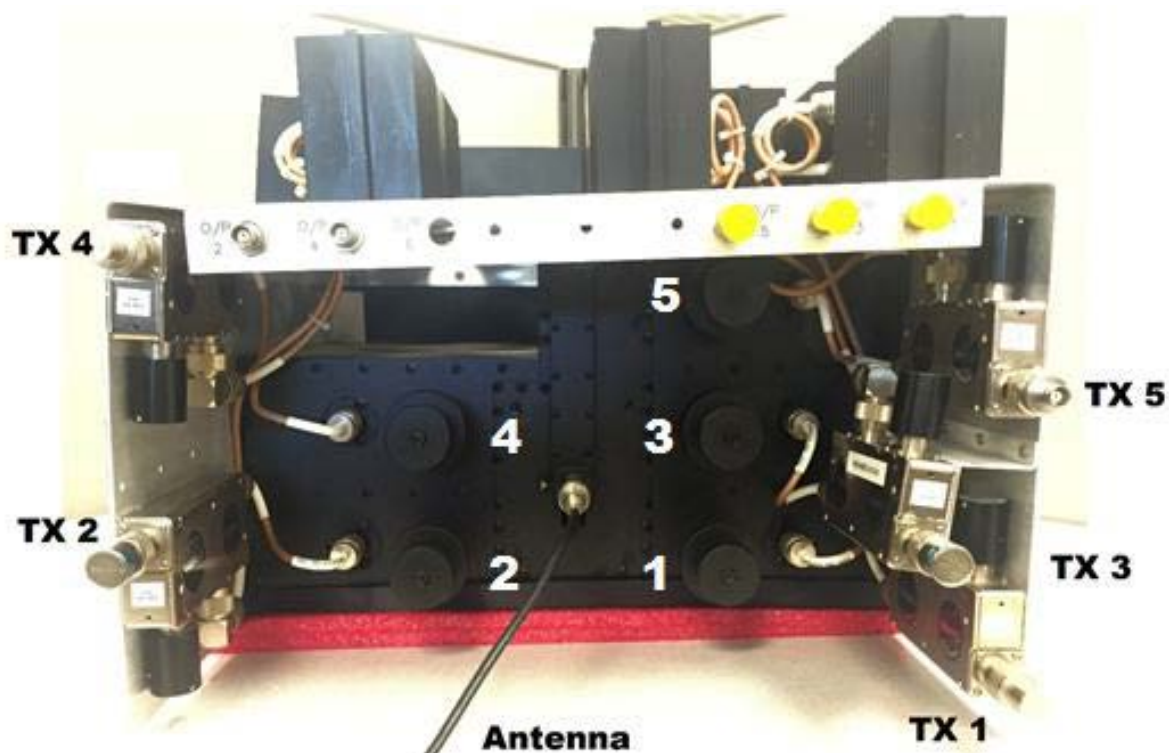


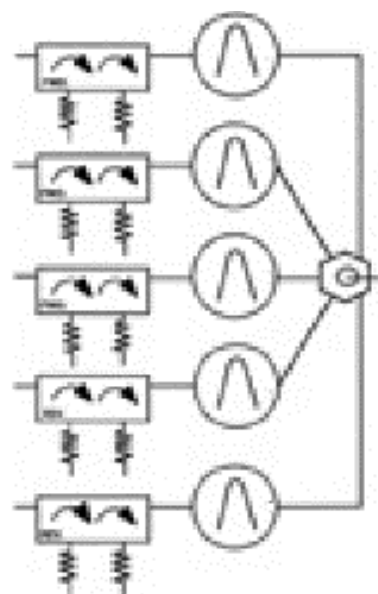
Figure 1: CellWave WIJD860-5S 5-port Transmitter Combiner in the 800 MHz range.

In this example, the desired tuning starts on port 1 @ 856.6625 MHz and increases in 1 MHz increments resulting in Port 5 centered on 860.6625 MHz. The input ports are labeled TX1 through TX5 in the figure above.

This RF combiner utilizes a two-stage, 2-port isolator to prevent RF signals from traveling back into the transmitters. The output stage sends reverse power to the high wattage attenuators on the top of the chassis. The output of these attenuators is routed to BNC sample ports on the rear of the unit. The input stage is terminated with a 15W load to dissipate any remaining reverse power.

The output of each of the 5 isolators is fed into its own bandpass cavity filter. Tuning of these cavities is accomplished using the tuning and lock knobs (labeled 1 through 5).

The output of the 5 cavities are combined into a single output located between the two rows of tuning knobs.



**NOTE:**

Terminate all ports not connected to the Service Monitor. Use high quality cable and adapters.



### Using the Tracking Generator instrument mode

This functionality is accessed by pressing the “Instruments” button on the front panel and selecting it from the vertical soft keys. A tracking generator operates in duplex and sweeps generate and monitor frequencies over a selected frequency range and displays the received signal level. This type of instrument is extremely useful for tuning RF components such as filters, duplexers, and combiners.

In this case we will output a signal from the Gen Out port into each of the transmitter port in turn and receive the signal on the Antenna port from the common antenna output on the combiner.

You can either enter a start and stop frequency, or center frequency and span. In this case we will center on 858.6625 MHz with a span of 10 MHz to start.

Attenuation should be set to zero. Output power should be set as high as possible without producing a receiver overload message. If the occurs, you will see the top of the signal clipped and noisy.

You should see a peak corresponding to the frequency of the port you are connected to. You should also see slight dips corresponding to the frequencies of the other ports.





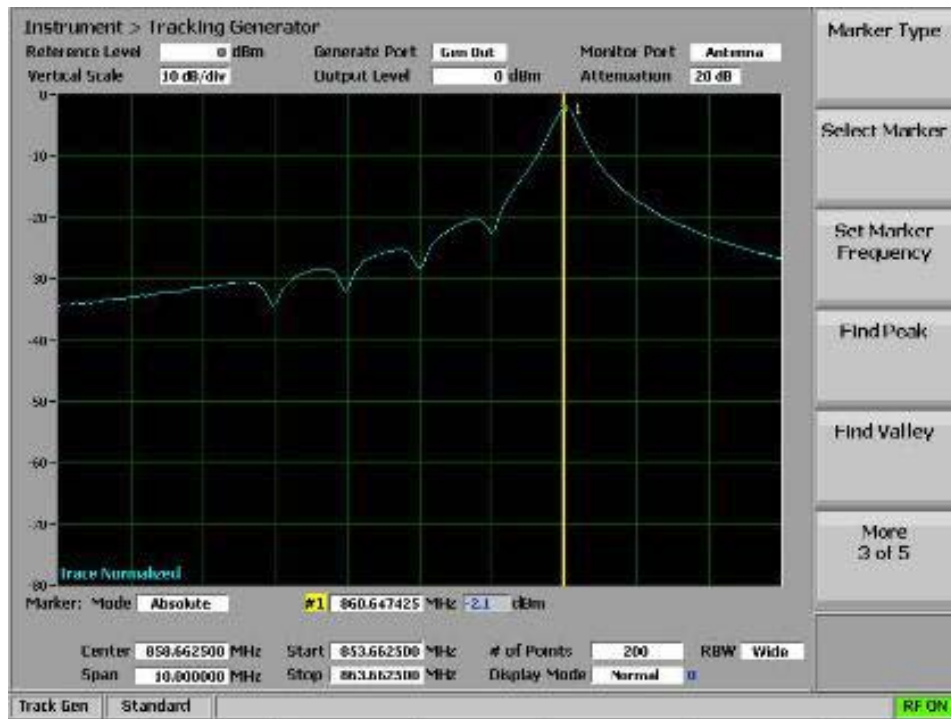
Normalize: calibrate out cable and adapter losses using a barrel connector

Before tuning you should normalize the tracking generator trace to calibrate out the cable and adapter losses. This is accomplished by disconnecting

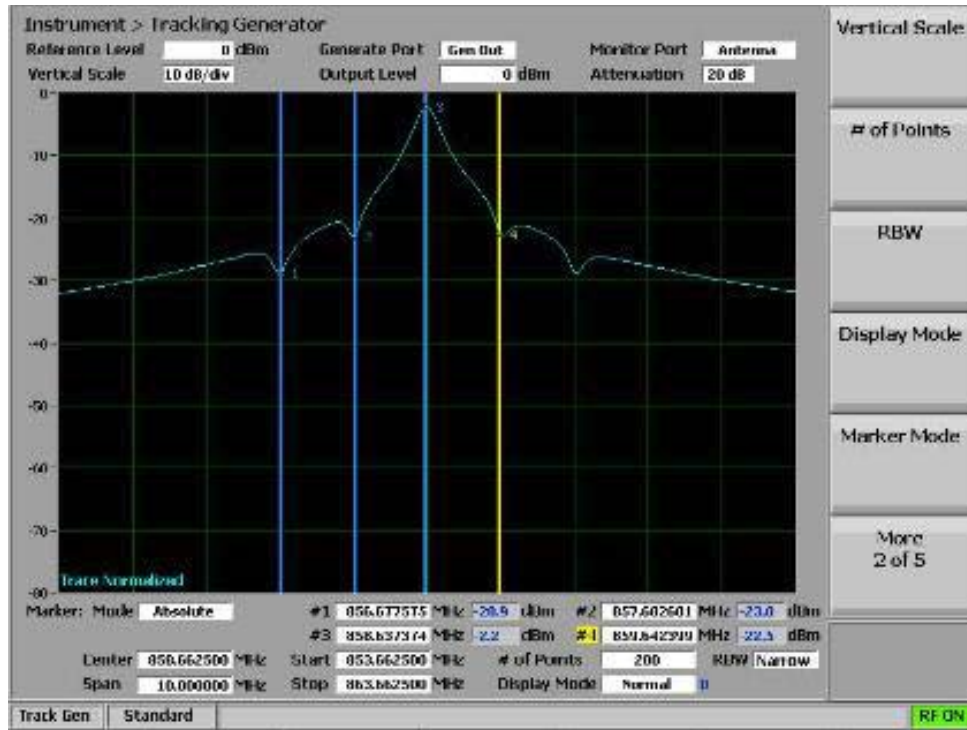
### COARSE TUNING

Using Markers: First set “Marker Mode” to “Absolute”. Use “Set Marker Frequency” to set the frequency. Use “Select Marker” to add additional markers. You can use “Marker Type: to change the appearance of the markers.

Place a marker at the highest frequency (Ch 5 @ 860 MHz). Unlock and adjust the tuning knob for the corresponding cavity until the peak is center on the marker. Do not lock the knob at this time.



Repeat the process, switching the port connection each time, for each transmitter port. You may need take multiple passes to retune the higher frequency ports, as the cavity tunings with affect each other.



You can use up to 4 markers if you find these useful

## FINE TUNING

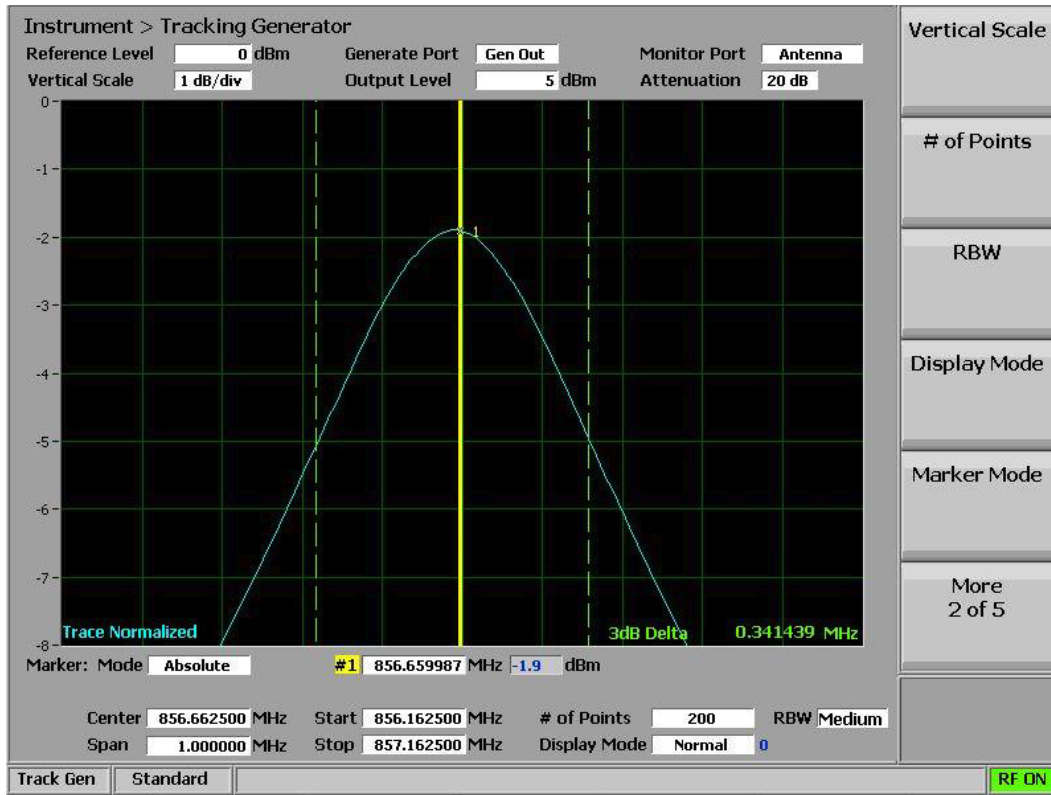
Once the cavities are aligned to the new frequencies, it's time to zoom in and make sure we minimize the insert loss to avoid losing too much power when the signal goes through the combiner.

Set the center frequency to the first channel frequency and the span to a value of the channel spacing (in this case 1 MHz). If this doesn't give you the resolution you need, you can decrease the span. You will also want to reduce the vertical scale to provide a sharper peak. In this case, the lowest setting is used: 1dB/Div.

For each port you will need to repeat the following steps:

1. Connect your test cables to the barrel and Normalize your trace.
2. Set your marker frequency to the desired channel frequency.
3. Adjust the cavity to center the peak on the marker, noting the marker value below the display is the insertion loss for this channel.
4. As you tightened the lock on the cavity knob, you will notice the peak shifting. You will need to compensate by holding or adjusting the knob until the knob is locked and secured.
5. Make a note of the insertion loss or use the screenshot functionality to save an image of the screen.
6. Turn on the 3dB markers to see the measured bandwidth of the cavity. Note this value if it differs significantly from the manufacturers specifications. In this example, the bandwidth is measured as 341 kHz which is relatively close to the specified 250 kHz bandwidth.

Once all the channels are tuned, you may want to return to the wider span view to confirm that all the channels are in their intended tunings. You should also capture a screenshot to a USB thumb drive for documentation purposes.



### Insertion Loss

When the trace has been properly normalized, the value of the marker at the desired frequency indicates the amount of signal lost while traveling through the combiner. In the previous figure, this value is -1.9 dB. This should fall within the specifications of the manufacturer. If a port shows excessive insertion loss, see the bottom of this document for help in diagnosis a possible fault.

### Bandwidth

Filter bandwidth is defined at the span between the two frequencies at which the signal is attenuated by 3 dB (half of the power in Watts). This parameter is a function of the design of the combiner and is not adjustable. It limits the closest channel spacing that can be functionally achieve. Minimum channel spacing is half of the 3 dB bandwidth. This value must be wide enough to pass the full modulated signal through the combiner without allowing adjacent signals to interfere.

### Troubleshooting excessive Insertion Loss

If you discover that one or more of the ports are suffering from excessive insertion loss, you will need to diagnose the source of the problem and make repairs.

- STEP 1: Bypass the Circulator/Isolator to check the cavity directly (Gen Out directly at cavity input)
- STEP 2: Test the circulator/isolator
- STEP 3: Repairing a damaged circulator/isolator



Broken solder joint at output connector caused arcing