Counter Intelligence

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One of the favorite tools of the trade for any serious scanning enthusiasts is the frequency counter. It can be the key to unlocking some of the most interesting and exciting scanning action as it unfolds. However, for those who don't understand the fundamentals of how a counter works, it can be an endless source of disappointment and frustration. In this article, we'll attempt to shed some light on the capabilities and limitations of frequency counters. And for those who've been using their counter for awhile, we'll include some tips to hopefully increase your success.

First, let's start with a short discussion of frequency counter fundamentals. Briefly stated, a frequency counter is an electronic device used to measure the frequency of a nearby transmitter. The counter will only acquire an accurate reading when the signal from source is relatively close by (referred to as "near field") and is approximately fifteen to twenty decibels stronger than the ambient signal level for a period long enough to acquire a reliable reading.

Some counters today employ one or more filter circuits to reduce false readings. The most elementary of these filters simply ensure that a consistent signal is present for a sustained duration (approximately six milliseconds) before indicating a reading. More sophisticated filters, such as those found on the Optoelectronics Scout, use a microprocessor to all but eliminate false readings.

Another desirable feature to look for in a counter is an electronic memory to store the frequency readings which it has obtained. Typically from one to three frequencies may be stored, then reviewed at a later time and entered into a scanner. Other counters, such as the Scout, can store up to four hundred frequencies, as well as the number of times a signal was received at each frequency. The Scout also offers an ICOM CI-V interface, which enables it to automatically tune a CI-V controlled scanner (such as the AOR 8000) to the same frequency that the Scout intercepts.

To better understand how a frequency counter works, we'll try to use a simple analogy. Let's say that you're in a gymnasium with only one other person who is at the far opposite end of the gym from you. As this person begins to speak softly, you can hear the sound of their voice, but cannot discern what's being said. Now let's assume that the person speaking represents the signal source (transmitter) and you represent the frequency counter. Just as you are unable to hear what is being spoken, the counter is unable to acquire the frequency of a signal that is too far away. In our gymnasium scenario, you would have to move close to the other person, or the other person would have to speak louder for you to understand what was being said. Correspondingly, with a frequency counter attempting to receive a weak signal, the signal source would either have to increase its power, or more likely, you would have to move closer to the signal before you could obtain a reading.

To understand another dilemma when using a frequency counter, let's again use our gym analogy. However, this time you're surrounded by a circle of people, all at an equal distance, and all talking at the same time at approximately the same volume. All you can make out is a jumble of voices, a low roar, but no single one discernible. This is analogous to what happens when you try to use a frequency counter in an environment where you're surrounded by a number of strong signals. This condition, known as a high ambient noise floor, occurs when multiple transmitters in the same vicinity are all emitting signals at roughly the same level.

A typical example of what can occur is when an inexperienced counter user positions themselves at the base of a radio tower with fifteen or twenty antennas clearly in view, yet they can't seem to get a single good reading. On a typical day, there's a pretty high probability that many of the transmitters are active simultaneously. This is particularly true if one or more of those antennas are attached to a pager transmitter or cell phone transceiver, both of which transmit almost ceaselessly. All of these simultaneous signals creates RF chaos that simply overloads the counter and renders it useless. The counter can't clearly discern one signal from the other, and therefor, cannot provide an accurate reading from any single transmitter. Again, for you to obtain an accurate reading, one single transmitter must be substantially stronger than the others. Unfortunately, since they antennas are all so close together, moving closer to the tower usually won't help. To further complicate matters, the base of an antenna tower is usually where the weakest emission of the signal is found.

This is also why it is so difficult to obtain a good reading from a weak signal source in an urban environment which is saturated with high levels of RF energy. One only has to look at the tops of the many buildings in the area to understand why. Within one thousand feet from my office in downtown Houston, Texas are at least three hundred antennas, some transmitting at more than four hundred watts! Consequently, a frequency counter has very little chance of locking onto any single signal long enough to acquire a reading unless the signal is either very strong or very close.

However, there are a few tricks you can use to raise the odds a bit in your favor. First, it helps considerably if you know a bit about the signal you're trying to measure. As a rule of thumb, the longer the antenna, the lower the frequency of the transmitter. For example, a quarter-wave antenna for a Citizen's Band radio, which operates at about 27 MHz, is approximately 102 inches in length. A quarter wave antenna for a two-meter and seventy-centimeter ham radio is approximately nineteen inches and six inches, respectively. A quarter-wave cell phone antenna is a scant three inches in length.

So how does knowing the approximate frequency of the target help? Well, if you can get your counter antenna as close to resonant as possible with the target transmitter's antenna, or at least within the same band, the efficiency of your counter will go up substantially. This may mean carrying several different antennas in your equipment bag. Then, for example, when you see the local volunteer fire department using radios with inordinately long antennas, your best bet is to use the longest antenna available. Conversely, when trying to capture a signal up in the 800 MHz range, a small stub of an antenna will actually work better than a long one.

If you don't want to carry around several antennas with you, it might be wise to invest in a collapsible antenna with a BNC connector (which is the style of connector found on most counters). To calculate how far to extend the antenna, divide the target transmitter's frequency by 2808 and the result is the approximate best antenna length in inches. For example if you were trying to capture a business radio in the 460 MHz range, 2808 / 460 would yield 6.1, or approximately six inches. Now, with your antenna adjusted to that length, you stand a much better chance of success!

Another trick of the trade is to employ a filter, which is inserted between the counter and the antenna, to help isolate the target frequency. A filter basically attenuates unwanted signals while allowing those in the target range to pass through to the counter. Subsequently, the counter then does not have to contend with as many conflicting signals as it attempts to lock onto the target.

There are three types of filters commonly used: low pass, high pass and notch. The characteristics of the filter, which frequencies it will pass and which it will attenuate, are shown on the filter's specifications. For example, a 50 MHz low pass filter would only pass frequencies from 50 MHz downward, and would greatly attenuate anything above that range. An 800 MHz high pass filter will attenuate everything below, while passing those frequencies above 800 MHz. A notch filter is designed to attenuate a certain frequency range, such as the FM broadcast band from 88 MHz to 108 MHz, but allow everything to pass above and below that range. The combination of the right antenna and a good filter can do wonders to increase the range and efficiency of your counter.

One common mistake you should avoid is the use of a broad-band preamplifier between the counter and antenna. It seems to make sense that if you amplify the incoming signal, you should be able to increase the range of the counter. However, not only are you amplifying the signal of the intended target, but those of all the competing signals, as well as introducing RF noise, to the counter. Besides, most modern counters already have a preamplifier as part of their circuitry.

Finally, don't be afraid to experiment with different antennas and filters. With a bit of practice and experience, you'll be able to employ these techniques with ease to obtain those interesting frequencies that have eluded you for so long!

The Scout mentioned in this article is available from Optoelectronics, 5821 NE 14th Avenue, Ft. Lauderdale, FL 33334. They can be reached at 800-327-5912 or 954-771-2050.