Measuring TDMA Signals

A common question received about applications using a TDMA signal is that True Average Power Measurement devices like an APM-16 or a 5010B do not provide accurate readings. In these cases, the problem most likely isn't from a malfunctioning device. The problem is with the measurement itself. Sometimes, average power isn't the most appropriate measurement for the job.

Time-Division Multiple Access (TDMA) signals are common in communications today. They carry multiple data streams on one signal without stacking the signals on top of one another. Instead, each data stream gets a time slot, and the signal cycles through all the time slots before going back to the first. In this fashion, the combined signal is essentially many pulsed data streams, with each having a time-shift to prevent any two from transmitting at the same time. The benefit of these TDMA radios this is that the amplifier doesn't need to handle high peaks, because the signals cannot stack on top of each other causing high peaks. The power envelope remains constant in each slot when data is transmitting.

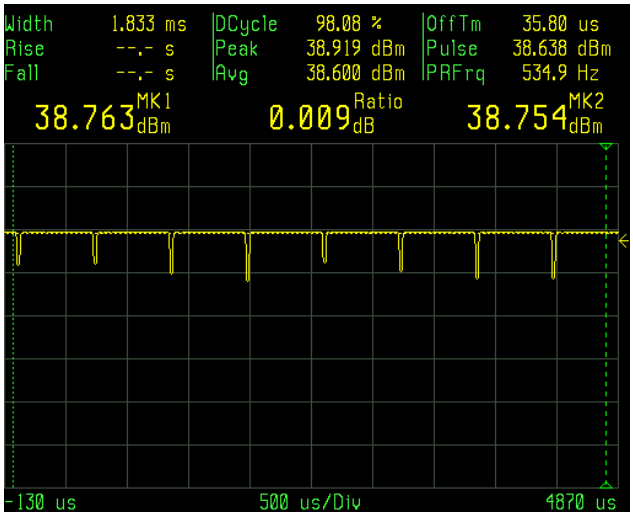

Figure 1: GSM Waveform with All Time Slots Open

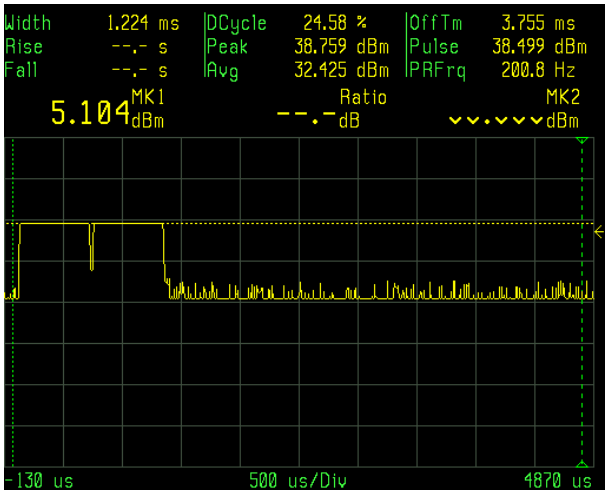

Figure 2: GSM Waveform with 2 Time Slots Open

Figure 1 is an example of a GSM waveform, a common TDMA signal, as captured on a Boonton 4500B. In that picture, all 8 slots are transmitting information, so the signal appears to be operating close to continuous (>96% duty cycle). A true average power measurement in this case would be reading slightly lower than the power of the radio, because of the transition time between pulses.

Figure 2 is an example of the same GSM system, where only two slots are transmitting data. As you can see, the signal has the same power in the first two slots, but no power is present on the other six slots. While this radio is fully functioning, the same true average power measurement would read only 24% of the rated power on the radio. This may appear as either the radio or power meter malfunctioning.

So what can be done? There are three ways to make these power measurements accurately.

1) Measure the true average power and convert it back to full scale based on how many slots are active.

While this solution might be applicable for a pass/fail test, it provides the least amount of diagnostic information about the radio. In addition, this cannot be done "live" while slots are turning on and off, because the readings will be fluctuating too much to make an accurate measurement.

2) Measure the peak power

Since the TDMA signal is comprised of time-shifted pulses, the peak envelope of the signal remains largely constant. Peak power measurements should give you the same power whether one or eight slots are in use. The downside is that it cannot determine if there's any kind of decay over the duration of the pulse, and will only show you the highest peak of the signal.

3) Measure the burst average power and the duty cycle

The best solution for measuring TDMA signals is to measure burst average power with the duty cycle. Burst average power will give you the average power of all the active slots and duty cycle will tell you how many slots are active. This measurement would be able to flag any kind of decay in pulse power, inactive slots, and misalignment of signals that might occur. This measurement can also be made on a "live" signal without affecting the accuracy.

While square law and thermal power measurement solutions will give true average power, that average power measurement is not always the most appropriate diagnostic tool for a system. TDMA signals' pulsed nature can cause confusion depending on the number of time slots active at any given time. For the best results, use a power measurement solution capable of measuring peak or burst average power, like Bird Technologies Group's Wideband Power Sensor Series.