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RF Peak Power Measurement Is Now A Necessary Technique for Communication Signals

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The developments that have occurred in wireless communications in the past decade have changed test and measurement practice in a dramatic way. This is especially so because test and measurement techniques are developed over long years of experience. This gives confidence that the methods are valid and repeatable and rapid change is naturally suspect. No area of electronic measurement is more conservative than the measurement of RF power. Until the 1990s it had barely changed in thirty years. The basic thermoelectric type RF power meter of 1990 was hardly distinguishable from that of 1960. Along the way diode type sensors had appeared on the scene, and in the 1980s the possibility of wider bandwidth RF power measurements was realized by instrument manufacturers. Still, the applications seemed to be limited and most engineers saw no reason to move beyond the tried and true.

The first hint that things were going to change came with the prospect of digital television broadcasting. The HDTV Grand Alliance planned field tests in 1995 and they needed to measure the peak to average ratio and cumulative distribution function of the power of an HDTV signal. Only two peak power meters were available at the time that could do this and both were used in the tests. Unfortunately, as everyone now knows, HDTV did not catch on with the public and still has an uncertain future. But, all was not lost. There was something else coming along called the cellular telephone and the public was fascinated with the idea. There were two general types of systems; one based on time division multiplex called Time Division Multiple Access (TDMA) and a newer type based on noise-like orthogonal encoding called Code Division Multiple Access (CDMA). Both of these were a peak power engineer's dream come true. Neither of these RF signal types can be adequately measured with a conventional RF power meter.

RF engineers are used to challenging measurement problems and develop into very resourceful people. Many felt that the spectrum analyzer would be able to meet all of the measurement needs for complex modulated signals; but wideband power and peak power measurements are beyond its reach. Some were determined to measure power the same way they always had in spite of the fancy new modulation methods. "We only need to measure average power" was a very familiar comment in the mid 1990s. Even if this were so, there are some problems with the pulse based systems, including the Global System Mobile (GSM) along with TDMA. An average responding power meter can't deal with pulses unless you know the pulse duty cycle. If the duty cycle is unknown or variable, you have a problem getting meaningful results. Engineers tried to devise charts of "correction factors," just as we used to do for amplitude modulation, for various pulse patterns to convert the average power reading to pulse power. This method is not only inaccurate but also slow. Long settling times are needed to smooth out and average the pulsed input to a nearly constant value. The desire to reduce testing time, and therefore cost, did not allow for much of this. It is no wonder that early cell phone handsets had such unreliable power output control.

Today's RF peak power meter with a flexible time base and triggering system as well as data capture can measure the power of particular pulses and even accumulated successive pulse readings to form a complete picture of handset stepped power control in one sweep. It is both fast and accurate. Newer systems require more information about the "pulses" which may actually be bursts of complex modulation. A portion of the beginning and end of the "pulse" may be excluded or the peak to average ratio within a "pulse" may be needed. The legacy style power measurement can do nothing with these requirements.

When CDMA systems came into the widespread use the vintage thermoelectric sensor and power meter could again play a role. It could accurately measure the average power of the noise-like CDMA signal. But, the CDMA signal had a new and disturbing characteristic, a large peak to average ratio that could not be ignored. We were familiar with AM where the peak carrier power at 100 percent modulation is 6 dB above the unmodulated carrier power. If a non-linear component clipped off a little of the peak only some audio distortion was introduced. The CDMA signal often had a 13 dB peak to average ratio, and clipping a little of the peak caused bit errors which degraded the performance of the system. Statistical RF power measurements had first been used with the HDTV tests. Now, they were needed for CDMA. Although statistical power measurement has been around for nearly a decade, it is still a deep mystery to many engineers who need to know about it. Perhaps engineers are wary of anything "statistical". If so, they are needlessly missing a powerful technique. The instantaneous power values are sorted by their size rather than their relative time of occurrence, and they are counted rather than averaged. This process can run for a very long time, limited only by available memory, or can run indefinitely if decimation is applied. It is invaluable for characterizing infrequent events, such as the maximum peak power of a CDMA signal which occurs only once in an hour. Looking at pulses using this method provides additional insights not observed in the time domain.

As with any new measurement technique, standard practices are still undecided and not all of the questions have yet been answered. What exactly does it mean to measure the rise time of a power waveform? Can a certifiable reference standard source for a 16 dB peak to average ratio signal be developed?

Looking ahead there is no longer any way to avoid RF peak power measurements. The more advanced communication systems will require the detailed power analysis made possible by this technique.

