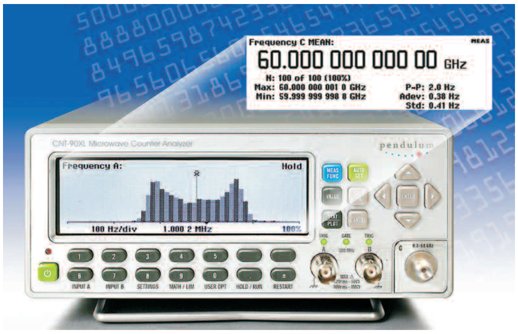

A NEW GENERATION OF MICROWAVE COUNTERS

Traditionally frequency counters have fallen into two main categories—general-purpose counters/timers and microwave counters. The former typically measure frequency from parts of a hertz to 200 to 300 MHz and can display frequency, time interval and period. Some general-purpose counters also provide ratio, phase comparison and low frequency burst measurement capabilities. Microwave counters typically measure frequency from 10 Hz to the end of their specified upper frequency, which can be anywhere from 3 to over 100 GHz. Some microwave counters can also measure power, either internally at the coax connector, or through a separate input, using external power sensors. Traditional counter designs use one or more versions of direct, reciprocal (with or without interpolation), or heterodyne mixer counting methods. These methods all have a defined start and stop period, plus some dead time between measurements, during which calculation and interpolation is done. Then the measurement is read out, registers are cleared, and the instrument is prepared and reset for the next measurement.

Such procedures are now a thing of the past with the new CNT-90XL microwave counter, which is a fundamental design departure from both general-purpose and microwave counters. It incorporates a unique counter/timer/analyzer with a sophisticated microwave counter/power meter. This new generation of instrument is a 'zero dead-time' microwave counter that uses a graphic display to show numeric and statistical data of measurement results. The instrument can display measurement data in a statistical format, including a graphic display of trend line and histogram distributions, and a numeric format of mean, min/max, peak-to-peak, Allan Deviation and standard deviation of the frequency or power of a microwave signal.

THE DESIGN

The CNT-90XL uses a unique time stamping method of measurement that allows for continuous event counting (no dead time between counts). With time stamping, the input events and the clock cycles are continuously counted, without being reset or interrupted. At regular intervals, pacing intervals, the momentary contents of the event count register and the time

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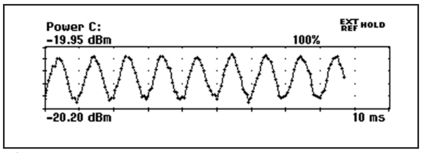
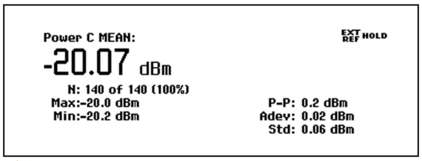
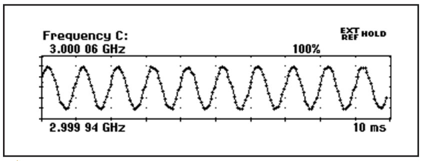


▲ *Fig. 1 Small amount of AM carrier shown on the CNT-90XL counter's front panel display.*



▲ *Fig. 2 Numerical statistics of the AM signal shown in Figure 1.*

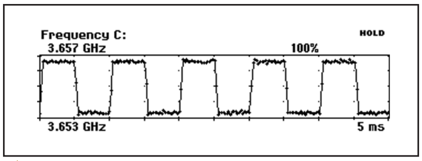


▲ *Fig. 3 1 kHz FM with a 12 ppm modulation depth.*

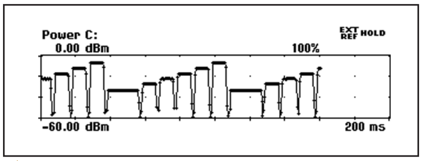
count register are transferred to memory. The read-out of the register contents is always synchronized to the input trigger, so it is the event trigger that is time stamped. Each stored time stamp is also interpolated 'on the fly' for improved resolution. The contents in the memory are thereafter post-processed.

Because the instrument can make and store hundreds of thousands of measurements per second without dead time, it can use a linear regression least squares line-fitting method to further improve measurement accuracy. The main advantage of linear regression is to reduce the influence of noise from the measurement process as well as superimposed random noise on the test signal, thus increasing frequency resolution.

The microwave input of the CNT-90XL uses a broadband hybrid superheterodyne sampling mixer with power measurement capability. Supporting circuitry (LO, synthesizer, etc.) delivers signal data to the counter for memory storage and display of both frequency and power. Once the microwave signal is acquired, which takes approximately 25 ms, measurements are made without dead time. Up to 250,000 measurements per second can be made and processed without dead time in the count chain, providing for advanced statistical analysis. The benefits of this kind of measurement process, which can be



▲ *Fig. 4 Pulse modulated frequency.*



▲ *Fig. 5 Generator power steps with signal off-time.*

applied to frequency as well as power, are numerous. Data on frequency and power stability over very short times can be analyzed, providing an insight into circuit function that is not available with other counters.

MEASUREMENT CHALLENGES

The instrument's design, fast measurement speed, and high resolution provide measurement and analysis of signals that could not be achieved previously. For example, short-term clock frequency variations over a given period of time (1 sec., 10 sec., 100 sec., etc.) are often expressed using Allan Variance, an estimate of the clock stability over a given period of time, from one averaging period to the next. Statistical Allan Deviation requires that there be no dead time between measured samples, with a minimum of 100 samples used for the calculation. Because of its fast zero dead-time measurement capability, the CNT-90XL can display Allan Deviation simultaneously with mean, min/max, peak-to-peak and standard deviation. Both frequency and power stability can be measured and displayed.

An example of a very small amount of AM on a carrier is shown in ***Figures 1*** (graphically) and ***2*** (numerically) on the instrument's front panel display. Other examples of the ability of the CNT-90XL to capture and display challenging measurements are shown in ***Figures 3*** and ***4***, while ***Figure 5*** shows the power steps from a generator (–30 to –5 dBm, in 5 dB steps), with a measurable off-time between power steps.

Real-world signals do not have constant stable frequencies or power, with modulated, frequency hopping, swept frequency or power, and burst signals being examples. Also, the concept of a mean frequency may be useless for these types of signals. The average frequency over 80-channels of WLAN using FHSS, or the average of several burst cycles containing chirp radar, is not meaningful.

Instead, the challenge is to closely follow and represent the actual frequency over time inside the burst, or alternatively, to see the statistical distribution of the WLAN channels. These types of signals require a very fast high resolution measurement and the new CNT-90XL meets these requirements.

Applications for this new counter include microwave link carrier calibration, satellite communication equipment testing, YIG and VCO testing, RF and microwave instrumentation calibration, and microwave frequency and power stability testing.

The CNT-90XL counter family includes four models that measure frequency from 0.001 Hz to 27, 40, 46 and 60 GHz (model dependant). The instruments feature 14 digits of numeric display, are capable of CW and burst measurement of frequency and power, and include both USB and GPIB connection as standard. Resolution is 12 digits/s (frequency), 0.01 dBm (power), 100 ps (time) and 0.001° (phase). Frequency measurement ranges from 0.001 Hz to the top of the instrument's range. Period measurements are available on A & B inputs (single or average) range from 3.3 ns to 1000 s, and 4 ns down to 17 ps (average) on the microwave input (model dependant). Ratio measurements between any two of the three inputs are included and power (dBm) on the microwave input is also provided.

CONCLUSION

The challenges of a fast-growing microwave product world and the applications provided by these new technologies are challenging test instrument manufacturers to keep pace with new test solutions to meet this changing environment. The CNT-90XL has answered the challenge.

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