APPLICATIONS & BENEFITS

Bird 7022

Statistical RF Power Sensor

Bird 7022, Statistical RF Power Sensor

Multi-function RF power meters have been completely transformed since they first appeared in the early 1990's. What once were benchtop instruments that incorporated power sensing instrumentation and components such as directional couplers and detectors along with a display in a single enclosure, today the RF power sensor itself incorporates complete power meter functionality, requiring only a laptop or other computer for analysis and display.

The **Bird Model 7022 Statistical RF Power Sensor** (Figure 1) is currently the only field measurement device that provides the statistical measurement capability required to accurately characterize modern communications system waveforms independent of the modulation technique or channel access method used in the system.

Figure 1 –Model 7022 RF Power Sensor

Digital Modulation and Measuring RF Power

RF power meters with statistical analysis capability have been available for use in laboratory environments for more than ten years but none are well suited for portable use in field environments. About seven years ago, a class of in-line power meters were introduced that provide more advanced capability for systems involving complex modulation, but these instruments provided only limited information with regard to modulation schemes that employ time-based channel access methods. To accurately measure peak and burst average power of time slots associated with TDMA-based channel access methods, the sensor must provide results independent of modulation format.

The Bird Model 7022 Statistical Power Sensor is such an instrument and provides three distinct operating modes:

- **Conventional Mode:** Measures forward and reflected average power as well as VSWR and return loss like traditional RF power meters.

- **Time-Domain Mode:** Displays time-domain waveform characteristics and provides markers to determine average burst power, peak power, and other pulse-related parameters.

- **Statistical Mode:** Displays peak/average power ratio versus the time in percent that the waveform is at or exceeds a specific peak/average power ratio.

Conventional Mode

The Bird Model 7022 provides highly accurate average power measurements from 350 MHz to 6 GHz across a power range from 250 mW to 500 W (33 dB dynamic range). This average power mode also provides for measurements of antenna and transmission system performance such as VSWR and return loss.

All measurements are conveniently displayed using Bird's VPM3 Windows-based Virtual Power Meter software, which is supplied with the sensor. In all measurement modes, directional coupler frequency response characteristics are corrected through automatic frequency measurement and correction techniques.

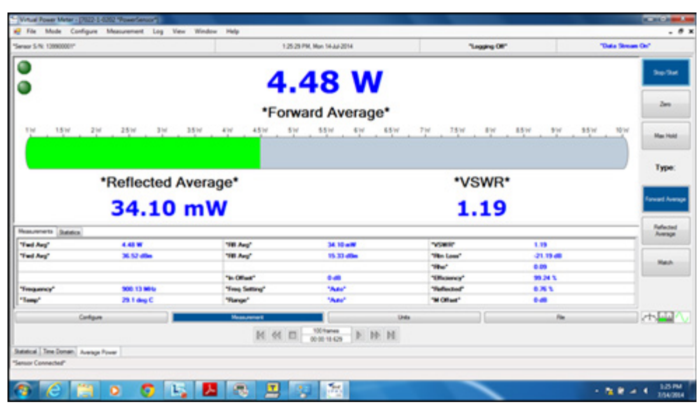

Figure 2- Conventional Power Measurement Mode

Time Domain Mode

As the Model 7022 can measure the power-versus-time characteristics of waveforms, parameters such as average burst power and peak power may be determined and displayed either automatically or by placing markers on the waveform displayed on the screen. Internal and external trigger options are also available, with trigger hold-off, level, and delay settings available as well.

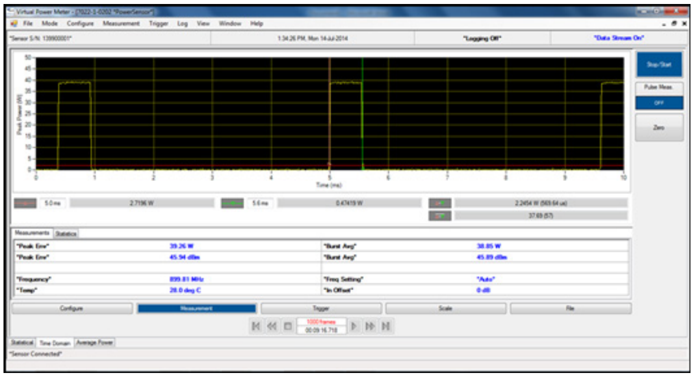

Figure 3 - Time Domain Mode

The time domain mode is extremely useful for time-varying waveforms such as TDMA-based channel access methods or Time Division Duplex (TDD) formats. A good example of a system employing this technology is a Digital Mobile Radio (DMR) subscriber unit. DMR is an open-standard communications format used primarily in land mobile radio systems with Mototrbo being its most prolific implementation. Other formats well suited to this mode are TETRA and TETRAPOL, APCO Project 25 Phase 1 and Phase 2, GSM–GSM-R, and LTE-TDD.

The analysis of time-domain-based waveforms such as TDMA may require measurement of the peak or burst average power of a single time slot within the TDMA frame. This measurement is easily performed on the VPM3 software by placing movable cursors on either side of the specific time slot to be measured and simply reading the power characteristics from the table. More advanced pulse power parameters such as top-level power, minimum power, and other measurements are available by enabling the pulse measurement mode, available on the right side of the display. Several video filter settings (4.5 kHz, 400 kHz, 5 MHz, 20 MHz) are available in the Model 7022 in order to tailor the instrument response to the signal being measured. Several video smoothing settings are available as well.

Statistical Mode

Before the transition from analog to digital modulation schemes, information was encoded via amplitude, frequency, or phase modulation using linear modulators. Measuring the envelope power of these signals is straightforward and produces repeatable and predictable results. In contrast, most modern wireless communication systems employ complex modulation and channel access methods like Orthogonal Frequency Division Multiplexing (OFDM) or Code Division Multiple Access (CDMA). These methods use a combination of amplitude and phase modulation to create symbol-based multichannel or multicarrier systems that result in pseudorandom or noise-like power envelopes. As a result, modulation parameters such as AM depth or FM modulation index are not useful because the peak-to-average power ratio of the modulated carrier is a complex function of the data stream content rather than just amplitude, and is not constant with time.

While the average power of the above waveforms can be easily measured, this measurement yields only limited information about the performance of the transmitter system such as parameters that are ratiometric in nature (antenna VSWR or return loss). The development of these new waveforms required the use of more advanced instruments.

A more universal power measurement approach uses statistics to provide a display of the percentage of time that a particular waveform exists at a specific value of peak-to-average power. Figure 4 illustrates this concept as applied to an LTE-TDD waveform. The horizontal axis in the figure represents the peak-to-average power ratio of the waveform being measured and vertical axis represents time in percent. Reading a specific point on the graph provides information about the percentage of time that the signal being measured exhibits a specific peak-to-average power ratio characteristic.

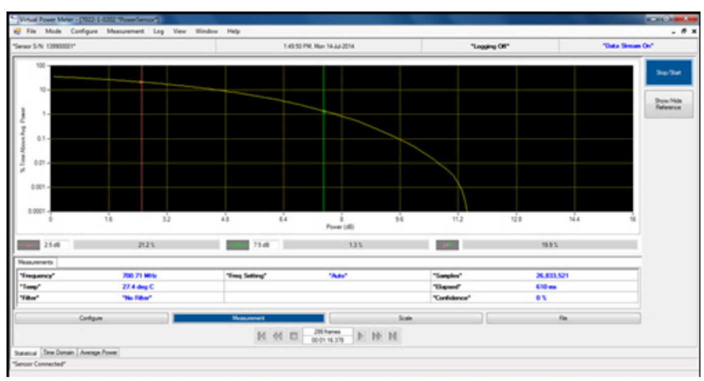

Figure 4 – Statistical Power Display

Table 1 lists in numeric format a few of the statistical curve data points shown in Figure 4. The maximum peak-to-average power ratio of the waveform being measured in Figure 4 is at the point where the curve intersects the horizontal axis. This corresponds to a value of 11.5 dB. Two movable cursors are available within the VPM3 display that can be placed at any point on the curve in order to determine specific values of the waveform peak-to-average ratio and corresponding time.

Table 1 – Numeric Format

Time (%)	Peak-to-Average Ratio (dB)
10	4.8
1	7.5
0.1	9.6
0.01	10.6

Interpreting Statistical Data

There are many factors that influence the performance of modern communications systems, including:

- ***The presence of interfering signals within the operating bandwidth of the system.***
- ***Transmission line discontinuities resulting in multiple reflection within the transmission system.***
- ***Poor amplifier linearity caused by amplifier compression resulting in nonlinear distortion and poor fidelity of the transmitted waveforms.***
- ***Antenna damage or degradation resulting in high transmission system reflection (high VSWR and return loss).***
- ***Issues with transmitter modulator performance resulting in high Error Vector Magnitude (EVM).***

Many of these issues may be identified through the use of the statistical techniques described above. For example, if an LTE radio system is known to be dropping calls at a higher rate than expected, a service technician must know whether the problem is within the radio itself, with some element of the transmission system, or with the air interface. Measuring the waveform statistics of the base station radio while terminated with a high-quality, 50-ohm termination and then again with the radio connected to the transmission and antenna system will provide clues as to where the issues may originate.

In addition to the LTE formats referenced above, Wi-Fi, WiMAX, Next Generation Public Safety Communications (APCO Project 25 Phase 2 and LTE), GSM-R, and tactical military waveforms employing complex modulation schemes are also good examples in which the Statistical Analysis Mode can be used.

Summary

Wireless telecommunications is rapidly approaching the day when digital modulation schemes will be universally employed. Over the last 15 years or so, this has transformed not just the transmission systems themselves but the instruments employed to commission and maintain them. Measurement of RF power is a classic example of the transformation, as conventional RF power measurements are no longer useful for characterizing time-based signals characteristic of higher-order modulation schemes. The Bird Model 7022 RF Power Sensor with statistical analysis functions is designed to provide the ability to measure digital waveforms as well as all conventional measurements, in a rugged, compact package well suited for use in the field.

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