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Designing a Cost-Effective In-Situ Digital Power Measurement System

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Power meter manufacturers have responded to the need for instruments that measure power with the complex RF waveforms of digital wireless systems and digital broadcasting

Complex RF waveforms used in CDMA, DAB, DMB, DTV and HDTV systems require the use of products that employ square-law detection circuits, unlike those used for simple CW, AM or FM modulated power measurement. This application note is a design guide for incorporating precision power measurement components into digital transmission systems.

Multi-octave RF directional couplers that sample signals at a reduced level suitable for laboratory grade power meters with thermal sensors tend to be cost prohibitive for large system designs. They usually have greater uncertainties because of the mix and match of vendor equipment, are typically less rugged, and take up greater space. In addition, interfacing the output of the sensor or display unit to the transmitter's internal firmware can prove to be a challenge. Also, a display unit will require an additional mains power source.

A simpler, less costly approach is to utilize a system that is "all in one." In other words, the directional couplers and sensors are provided as a single module, ready to install within the transmitter or at any suitable point along the transmission system, such as the output of the combiners.

One system to consider for ease of interface and lower cost of implementation has already been employed by many manufacturers and operators around the world. This application note describes how to utilize the benefits of this system's Digital Wattmeters and Digital Wattchman® monitoring system.

Figure 1 · Line sections and sensors are shown here, along with optional analog display meters and alarm panel.

Description

The directional coupler and sensor functions are incorporated into one small assembly. Figure 1 illustrates a typical example with one of many metering possibilities.

The "line sections" are available with either one or two "sockets" for coupler/sensors. A dual socket design allows for both forward and reflected power measurement, while a single socket would allow for one or the other. Normally, the forward power measurement range is 10 times the reflected power, such as 500 watts forward and 50 watts reflected. This range accommodates the expected maximum levels of reflected power. Within the sockets are inserted the sensors (Fig. 2), typically called "elements," that are tuned for a specific power range, and a frequency band—such as 1000 watts, 500 watts, etc., at 470 to 608 MHz, 614 to 806 MHz, and so forth. The optimized power levels and frequency bands contribute

to a greater overall accuracy compared to broadband measurement systems. Also, there is no separate directional coupler to add to the calibration process, cost or procurement logistics.

Interfacing Requirements

The only power requirement for this measurement system is 5 VDC at about 2 milliamps per element, which typically is provided via one of the many metering options available, or may be obtained easily from transmitter modules or other accessories. Additional AC power is not required. The power connector is a SMA female coaxial connector. The shielding provided by a coaxial power connection minimizes any chance of unwanted RF feedback into the unit.

The output of the power measurement system (single or dual) is via coaxial connectors, also for improved shielding, and is ready for both analog metering and translation by existing data I/O ports that accept current sensing (analog meter) inputs. The standard outputs are 30 microamps for a full scale reading into a resistive load of 1400 ohms. Other outputs are available for special applications that are not set up to use standard metering products.

Figure 2 · RF power sensors, or "elements" are provided with precision calibration for various ranges of power and frequency.

If this type of standard I/O is not available, any A/D input can be utilized. For example, the sensors will provide approximately 0.1 VDC full-scale output when terminated into a 5k ohm resistive load. The digitized measurement can then be translated via a look-up table for an accurate power measurement with the user's own digital monitoring system.

Summary

Integrated power measurement systems for digital transmission can be installed simply, with no need to obtain and calibrate couplers, detectors and metering from different vendors. Systems like the one described here are available with the proper square-law detectors required for fast response to complex RF waveforms of digital wireless and broadcast signals.

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The Coaxial Dynamics Family of Digital Power Meters

First, it should be noted that this line of power meters is not the same as older CW-only designs. These high power, remote wattmeters are designed for accurate measurement of CDMA, DAB, DTV and HDTV digital transmissions, and will accommodate standard CW, AM and FM signals as well. The units are sold with a single sensor input or with two switched inputs for Forward-Reverse power models. The two-input unit requires a dual element line section for the sensor/detector elements. In turn, both styles are offered with either 5/10/25 full-scale readings, or with a 15/30/60 scale. One of these two scale numberings will result in a "normal" reading of the user's equipment in the center portion of the meter, where it is easiest to read. Models include:

98952-A	5/10/25 scales, single reading
98954-A	5/10/25 scales, FWD/RFL switch
98958-A	15/30/60 scales, single reading
98959-A	15/30/60 scales, FWD/RFL switch

Digital Wattchman® Station Monitor/Alarm

This rack mounted monitoring unit (pictured at the top of Fig. 1) incorporates the same digital power metering capability of the wattmeters, along with monitoring and alarm circuitry to alert personnel and/or automatically shut down equipment when out-of-tolerance conditions are encountered—such as over-power or excessive reflected power due to high VSWR. The alarms include relay contacts, indicator light and audible signal. The response time from fault to alarm is 15 ms.

Elements and Line Sections

The above units require the user's choice of line section and element. For broadcast use, typical line section choices are standard 50 ohm rigid coaxial line sizes from 1-5/8" to 6-1/8". The line sections can be provided with standard EIA flanges, as an unflanged flush section, or unflanged recessed section.

Elements are available for power levels from 100 watts (1-5/8" line section) to 100,000 watts (4-1/16" and 6-1/8" line sections). Four frequency ranges cover FM and TV bands: 54-108 MHz, 100-216 MHz, 470-608 MHz and 614-806 MHz.

Other sizes and power ranges are available for other digital wireless services. Standard products cover frequencies up to 1800 MHz.