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PRODUCT TECHNOLOGY

Noise Modules Track Receiver Fidelity

These custom noise modules can monitor antenna matching and receiver integrity over the full wireless and PCS bands.

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BROADBAND noise is an ideal signal source for assessing the performance of virtually any electronic device or system that involves detection or processing of a signal. These include platforms such as wireless and land mobile communications systems, cellular-phone networks, satellite receivers for cable television (CATV), and even home-entertainment systems. Sources designed specifically to generate precise excess noise ratios (ENRs), such as the MicroCal™ line of noise sources from Micronetics Wireless (Hudson, NH), are ideal tools for characterizing and validating system performance.

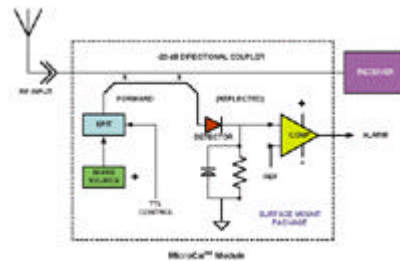
For example, MicroCal noise sources with integral VSWR monitors can be used to provide remote readings of a cellular or personal-communications-services (PCS) site antenna's performance levels. Inserted between the site's receiving antenna and its interconnecting cables, a MicroCal noise generator is ideal for remote monitoring of the antenna match to the receiver. Beyond the antenna, the MicroCal noise generators can be used as built-in-test (BIT) sources for tracking the performance profile of the active and passive components in a receiver channel.

The MicroCal generators represent the cumulative experience of a company involved in pioneering noise technology more than 25 years ago. The technology has evolved to its current generation of miniature surface-mount-technology (SMT) noise modules that are ideal for integration into active and passive components and subsystems. The compact size of the MicroCal modules makes them suitable for integration into a wide range of components, including amplifiers, antennas, cable connectors, and filters--especially in components where the physical location can make access impractical or impossible, such as mounted near antennas on communications towers. The MicroCal modules are well- suited for end-to-end system tracking of cellular and PCS base-station performance.

The MicroCal noise modules provide the predictable and repeatable performance needed for gauging component and system performance levels. For example, the noise sources have a flat power-density output versus frequency and only exhibit a small change in reflection coefficient

(>0.01) when switching from the off to on states.

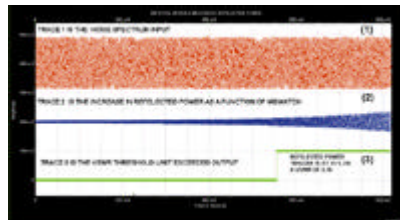
One way where a MicroCal noise source can be used for cellular or PCS base-station monitoring is when it is integrated with a dual directional coupler (**Fig. 1**).



[Click to see enlarged image](#)

Fig 1. This block diagram shows an example of a MicroCal noise module integrated with a SPST switch and dual directional coupler.

The design actually consists of an SMT noise source coupled to a single-pole, single-throw (SPST) nonreflective switch driving the forward path of the dual directional coupler. When inserted between a base-station antenna and the receiver input cable, this noise source can be used to actively monitor the antenna-to-receiver impedance match and to track any change in component characteristics through the receiver chain. The coupler is designed to mechanically match the antenna to the receiver-cable interface. The SPST switch can be controlled through transistor-transistor-logic (TTL) signals to form a continuous-wave (CW) or modulated noise source. The SystemView system-level simulation software from Elanix, Inc. (Westlake Village, CA) was used to model and predict the degradation of the antenna-to-receive input-port impedance matching, and simulate an alarm threshold function for monitoring purposes (**Fig. 2**).



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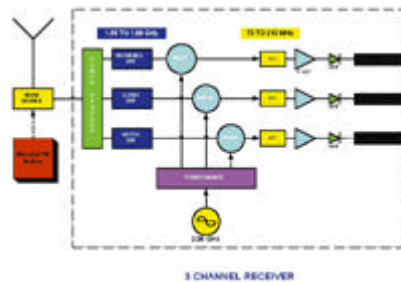
Fig 2. These three traces show the noise input spectrum (top), the increase in reflected noise power from a power impedance match (middle), and the VSWR threshold trigger (bottom).

In this simulation, a diode detector senses the reflection of noise energy in the return path of the coupler. A terminating resistor provides a matched load for the detector. A capacitor integrates and stores the detected noise as a DC voltage. A comparator is used to compare the reflected DC level to a user-specified reference. An alarm is provided when the reference level is exceeded by the reflected noise.

The first trace in the plot represents the through-path noise level at the output of the MicroCal noise source. The second trace shows the change in reflected power as a function of load mismatch. The third trace shows the alarm trigger when the reflected power exceeds a preset reference level. For this example, the alarm is activated when the VSWR exceeds a value of 2.15:1. The time base has been intentionally set for a short duration for this simulation. In a real-world application, the

duration could be set for weeks, months, or years, depending on the monitoring and calibration requirements. Once a receiver has been characterized with the help of the noise source, future measurements can be compared with the original baseline value. Any change in the receiver chain will be revealed when new measurements are compared with the reference values.

Figure 3 is the block diagram of a three-channel receiver modeled with the aid of the SystemView. All channels operate over the frequency band of 1.85 to 1.99 GHz. The local-oscillator (LO) frequency for each channel is 2.060 GHz. Each channel has an intermediate-frequency (IF) bandwidth of 140 MHz, spanning a total IF bandwidth of 70 to 210 MHz.



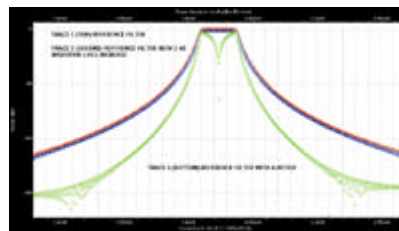
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Fig 3. This three-channel receiver was simulated with SystemView software to demonstrate the effectiveness of the MicroCal noise modules.

The IF amplifier gains, detector parameters, and resistor-capacitor (RC) filter networks are identical for all three receiver channels. The top channel is considered the reference channel. The center-channel RF filter has been modeled with insertion loss that is 2 dB higher than that of the reference channel. The bottom channel has a notch filter centered in the passband of the RF filter. A compact noise module is used as the signal source to characterize each channel.

MODELING FACTORS

The filter response was modeled for each channel prior to downconversion to IF. The top trace of **Fig. 4** shows the response of a good filter.

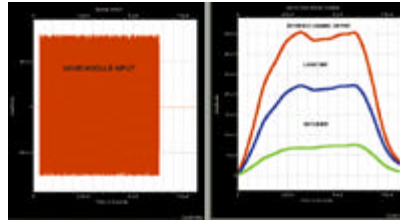


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Fig 4. These three simulated filter responses are for the reference channel (top trace), the channel with 2-dB higher insertion loss than the reference (middle trace), and the channel with a passband notch (bottom trace).

The second trace is the response of the same type of filter with a 2 dB higher insertion loss. The third trace is the same filter with a notch at the center frequency. Although the amplitudes of each case are similar, detected excess noise from the three filters will clearly show the ability of the noise module's BIT function to identify each of the three conditions.

The left-hand side of **Fig. 5** shows the modulated noise signal used to evaluate the three bandpass filters while the right-hand side shows the response of the three receiver channels.



[Click to see enlarged image](#)

Fig 5. This modulated noise signal (left) was used to generate the simulated responses shown at the right for the three receiver channels.

The plot on the left-hand side of Fig. 5 is the modulated noise input. The right graph shows the reference channel response to the modulated noise input at a level of 40 mV. The middle trace is the channel with an increase of 2 dB in insertion loss (compared to the reference channel) at a level of 25 mV. The bottom trace is the output of the channel with the notch in the passband at a level of 8 mV.

Since noise sources have a uniform distribution of random power, all of the filters appear to have the same response shape, however, they differ in detected amplitude due to the difference in detected noise power. This example shows the simplicity of using precision noise sources as a tool for tracking a receiver's performance characteristic. By distributing the MicroCal noise modules within all of a system's critical components, the fault or source of the system's performance degradation can be traced to the offending component or components with minimal effort and time.

Additional information on the topic of noise is available on the Micronetics Wireless website. In particular, there is an application note entitled "Understanding noise" (which can be accessed at the company's site at www.micronetics.com/products/understa.htm). The note defines the five parameters commonly used to specify noise--output level, output characteristics, noise characteristics, input power, and accuracy/stability. For example, noise characteristics such as peak factor (crest factor) and symmetry are defined, along with accuracy factors such as temperature coefficient and long-term drift. The application note also covers common noise-source conversions, such as effective noise ratio (ENR) to noise figure. **Micronetics Wireless, 26 Hampshire Dr., Hudson, NH 03051; (603) 883-2900, FAX: (603) 882-8987, Internet: <http://www.micronetics.com>.**