THERE IS NOW A STRONGER CASE FOR USING THE GENUINE DIGITALLY MODULATED SIGNAL AS A STIMULUS.

Test Stimulus For Power Amplifiers Gains In Cellular/PCS Designs

CODE-division-multiple-access (CDMA) systems are placing new demands on component manufacturers, test equipment, and measurement techniques. Requirements for the suppression of adjacent-channel power (ACP) have become more stringent than those required by the older analog systems. Global System for Mobile Communications (GSM) systems (IS-54 or IS-136) use constant modulation envelope formats, and the digital time-division-multiple-access (TDMA) and CDMA standards in North America use quadrature-phase-shift-keying (QPSK) formats.

While QPSK formats have greater spectral efficiency, they are non-constant-envelope signals and are subject to spectrum regeneration from nonlinearity in the transmit systems.

CDMA, as implemented in IS-95, has increased the capacity of wireless networks due to its code-division multiplexing and frequency reuse. In order to reduce possible capacity degradation, digital cellular and personal communications services (PCS) place high demands on power-amplifier (PA) nonlinear effects. Since the CDMA system relies on orthogonal codes that are not pseudorandom in nature, the additive summation of the combined traffic channels will not have Gaussian distribution of amplitudes.

The cumulative distribution function (CDF) of the IS-97 CDMA base-station signal depends on the Walsh-code values selected for transmission. As a result, mobile-phone amplifiers will now need to contend with CDFs that are more challenging than those of AWGN stimulus. Since IS-95 measurements are intended to predict performance in an operating network, it is necessary to provide the device under test (DUT) with signals that have similar amplitude distributions to the system signal. There is a now a stronger case for using the genuine digitally modulated signal as a stimulus.

QPSK formats offer greater spectral efficiency, but they are non-constant-envelope signals. The non-constant envelopes are subjected to spectrum regeneration from nonlinearities in the transmit systems. This regeneration of power outside the transmit channel gives rise to interfering signals in other channels, or ACP. This same phenomenon creates in-band interference that causes errors in the symbol vectors. The root-mean-square (RMS) sum of these errors is referred to as error vector magnitude (EVM). The EVM is usually calculated on the full Nyquist filtered envelope.

The challenge to the PA designer is to design a low-distortion amplifier with a higher efficiency.

There are simulation techniques at the system level which concentrate only on the envelope distortion and have been successful in predicting intermodulation distortion (IMD) in multicarrier systems. These methods have also been applied to spectral-regrowth simulation of QPSK signals for idealized amplifier characteristics. Software packages are available that implement this method using power-series representation of the nonlinear amplifier characteristics. More accurate and robust methods than the traditional power-series curve fitting have been proposed by using bounded and orthogonal basis functions. Inferences in PA design are formulated based on the predictions made on various measured characteristics and nonlinear circuit models. Zebra enables the PA manufacturer to add measured ACP and EVM characteristics with real stimulus.

EVM is calculated by summing in RMS error vectors of the output constellation. The output constellation is usually obtained by applying the radio-common-carrier (RCC) filter and sampling the envelope waveform. In the cellular band, the ACP ratio is defined as the ratio of channel power in the operating bandwidth (1.23 MHz) to an adjacent channel, measured in a 30-KHz bandwidth.

Measurements of the probabilities of exceeding a particular peak-to-average ratio can vary by a factor of 100:1 between noise (AWGN) and a Walsh-coded CDMA channel. Experiments have shown that the peak-to-average ratio of Walsh-coded signals can depend not only on the number of codes used, but also on the actual choice of codes. This, in turn, leads to variations in ACP results due to the dependency of peak amplitude on the code selection used.

Walsh codes 0, 4, 8, 16, 24, 32, 40, 48, and 56 have greatest similarity. Use of these channels will create RF envelopes with higher probability of large peak-to-average ratios. The wrong choice of Walsh codes can result in an error in ACP-ratio (ACPR) measurements up to 13 dBc.

The CDMA source that exists in the market is an integrated part of an expensive phone-testing equipment or tied as an option to an expensive AWGN signal generator. In most of the phone-testing equipment there is not any access to baseband in-phase (I) and quadrature (Q) signals. Zebra is a simple multiple CDMA channel source with a built-in IS-95 filter. The CDMA channels are precisely combined using a digital combiner. The Zebra is available with up to 16 code channels. Zebra provides independent control of the gain and Walsh-code spreading for each channel. As the channels are digitally combined a stimulus—well-defined RF envelopes per IS-97—can be generated. In addition, the output of Zebra can be combined with an external noise signal. This enables greater system-loading simulation while respecting worst-case modulation peaks by choosing adverse Walsh mixing with AWGN. Zebra also has options to modulate actual data packets. **WSD**

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