



MULTITONE SIGNAL GENERATORS FOR CELLULAR AND PCS HPA EVALUATION

Today's multicarrier wireless communications systems require sophisticated test equipment to analyze and verify performance levels. Spread spectrum systems are prone to generating intermodulation products due to the nonlinearity of system components such as high power amplifiers (HPA). These multichannel HPAs must be tested using a signal source capable of generating multiple simultaneous signals that are stable and precise

and feature very low and controlled intermodulation levels.

The MTG-2000 series multitone signal generators provide up to 16 CW signal outputs simultaneously and have been designed specifically to test the intermodulation performance of base station HPAs. Each tone is generated by a frequency synthesizer that features 10 Hz frequency resolution, and the multitone models can be outfitted with up to 16 synthesizers (instead of the typical eight-tone configuration). **Table 1** lists the generators' key operating specifications.

TABLE 1
PERFORMANCE SPECIFICATIONS

Channels	8 and 16
Frequency range (MHz)	800 to 1000 1700 to 2200
RF power output (dBm)	-63 to +4 programmable
Phase control (°)	0 to 359
IMD products (dBc) (phase aligned)	< -85
Spurious and harmonics (dBc)	< -85
Phase noise (dBc/Hz)	-80 (1 kHz offset) -110 (100 kHz offset)
Reference output (dBm)	0 ±1.5 dB
Reference input (dBm)	-3 to +10
RF output connector	N-type female
Size (H × W × D)	7.0" × 17.5" × 22.0"

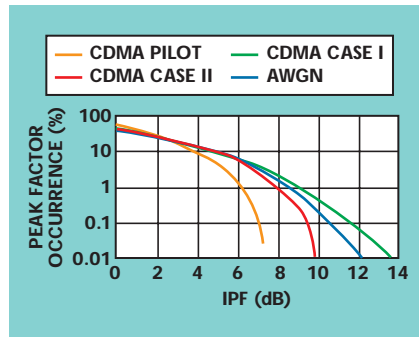
FEATURES

The signal generators permit frequency modules for both cellular and PCS applications to be installed in the same signal generator, offering a cost-effective method to simulate a typical base station input to the output HPA. In addition, a wireless base station can generate a set of carriers that may phase align and increase the peak power output to very high levels. The phase-control capabilities of these multitone signal generators provide a means to simulate these signal conditions as well. The units also feature an automatic phase-alignment (phase peaking) subroutine

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PRODUCT FEATURE

Fig. 1 Peak factor CCDFs for four signal types.

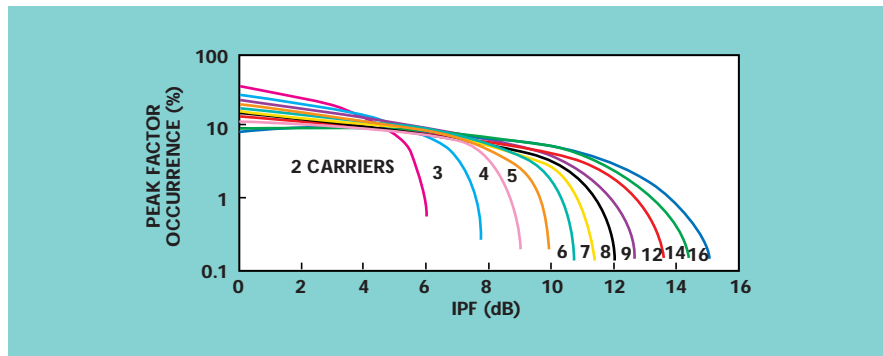


that permits the user to simulate a signal that tests to controlled and repeatable peak power conditions.

A continuous random phase mode is provided to verify that a linearized amplifier can respond properly to the varying peak power conditions presented in actual base station use. This function moves the phase of each channel randomly at a controlled rate and generates a signal of varying peak power similar to the conditions found in an actual base station. (It has been determined that 16 tones operated in this fashion properly simulate the signal presented to both cellular and PCS HPAs.) Most HPAs are tested in both the phase-peaked and continuous random phase modes to verify that the amplifier can respond safely to the highest peak power conditions and operate in a more real-world condition where the peak power varies over a 6 to 10 dB range as a result of normal modulation and phase drift.

The multitone signal generators feature calibrated output levels to within 0.1 dB resolution. Tone-to-tone variation can be as high as 10 dB to simulate tilt or compensate for signal path variations. In addition, each generated tone is available as an output on the rear panel for use in testing devices that require higher power levels than those available at the generator's combined output port.

Fig. 2 CCDFs created by a number of phase-aligned carriers.



A Labview™ driver that permits easy incorporation in automatic test equipment applications will be available for controlling the generators. Users of the model IMD multitone generator can easily convert to the MTG-2000 units using the IMD emulation IEEE bus command set.

CDMA CAPABILITIES

The signal generators also can be used to generate simulated CDMA and wideband CDMA signals. The units incorporate subroutines that allow the signals to be spread uniformly over any frequency range and the actual peak power can be controlled by phase aligning a user-defined set of tones (up to 16 using one generator and 32 using two). The available multitone test signal is somewhat more stringent than the actual CDMA signal. However, users have determined an intermodulation level that assures an amplifier's performance is sufficient to meet the CDMA requirements.

A common tool for evaluating a signal's peak factor characteristics is the complementary cumulative density function (CCDF). The CCDF reveals not only the signal's peak factor, but also the probability of occurrence of different power levels with respect to time. **Figure 1** shows CCDFs of four signals: a CDMA pilot signal, ad-

ditive white Gaussian noise (AWGN) signal and two CDMA signals with different traffic loads. A CCDF plot is useful because it conveys the probability of all observable power levels from which envelope peak factor or instantaneous peak factor (IPF) are determined easily.

Multicarrier phase-aligned signals can be used to simulate a range of peak factors and CCDFs. Different CCDFs can be created by adding more carriers. **Figure 2** shows a range of CCDFs attained by using two to 16 phase-aligned carriers that are equally spaced over the band of interest.

CONCLUSION

A series of multitone signal generators are available for evaluating the intermodulation and linearity performance of today's wireless base station HPAs. The generators provide up to 16 simultaneous output signals and feature synthesized frequency control and low internal intermodulation. The new generators represent a cost-effective way to simulate the conditions presented by a base station to the output HPA.

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