IMD ELIMINATION AND ACPR IMPROVEMENT FOR AN 800 MHZ HBT MMIC POWER AMPLIFIER

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Abstract

This paper describes a novel technique for reducing the third order intermodulation (IMD) product and ACPR levels in HBT power amplifiers. This technique is based on the dynamic control of the injection/feedback of the second harmonic frequency signal to the amplifier. For a cellular frequency HBT MMIC power amplifier, a reduction of 44 dB in the 3rd order IMD level is measured at 28 dBm output power. By controlling the phase and amplitude of the injected/fedback second harmonic, <u>a total rejection of IMD products over a wide dynamic range of input power is achieved</u> without any change in the fundamental signal levels. The ACPR for CDMA system (IS-98 standard) over a 30 KHz bandwidth with ±900 KHz offset shows a 6 dB improvement. No degradation in the CDMA signal quality factor (ρ) and PAE (40%) are observed. To the best of our knowledge this is the first application of this technique to HBT power amplifiers.

Introduction

A common performance parameter of amplifiers used in communication systems, is the effect of non linearity on the amplifier performance. The intermodulation (IM) products are regarded as the most troublesome in communication system amplifiers. The conventional feedback technique for reducing the IM distortion in non-linear amplifiers causes a reduction in the amplifier gain and needs additional complicated circuitry. Its' alternative, the feedforward technique requires a second high performance amplifier closely matched to the main amplifier and additional extra bulky components. The latter technique also consumes more DC current due to the need for the second amplifier which does not contribute to the total RF power[1,2].

Description and experimental results

The technique described in this paper is based on using non-linearity of the HBT amplifier to cancel out the 3rd order IM product. In this technique the second order harmonics of the source signals are injected into the amplifier as well as the fundamental signals similar to the method described in Ref.[3] for a MESFET amplifier. In the MESFET amplifier case, a 20 dB IMD improvement at low output power level was achieved. Applying this approach to an HBT amplifier, a complete elimination of IMD levels at high power levels in CW mode was obtained. Also, noticeable improvements on ACPR for a CDMA digital signal was observed.

In our present approach, the non-linearity of the HBT amplifier causes interaction between the source signals and their injected second order harmonics. This interaction results in additional signals at the output of the amplifier at the 3rd order

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intermodulation frequencies. On the other hand there are components of the 3rd order intermodulation products due to the interaction between the fundamental signals. By proper selection of phase and amplitude of the injected second harmonics, it is possible to make the 3rd order intermodulation product produced by the second harmonics and the original 3rd order products to be out of phase and equal in amplitude. As a consequence the 3rd order intermodulation distortion is totally eliminated, in principle without compromising the amplifier's gain and the fundamental signal levels.

The measured results on a commercially available 800 MHz HBT MMIC power amplifier is plotted and shown in Figures 1 and 2.

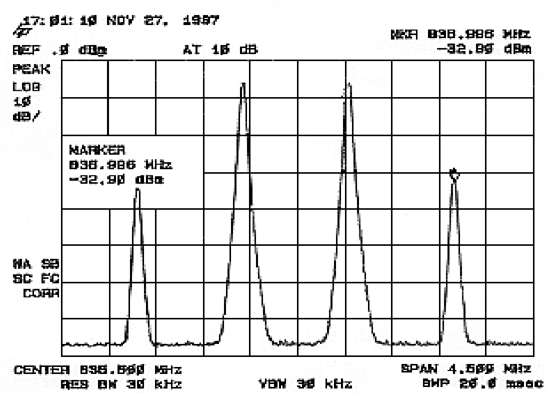

Fig. 1: Output Spectrum of the HBT PA at 28 dBm before applying the technique.

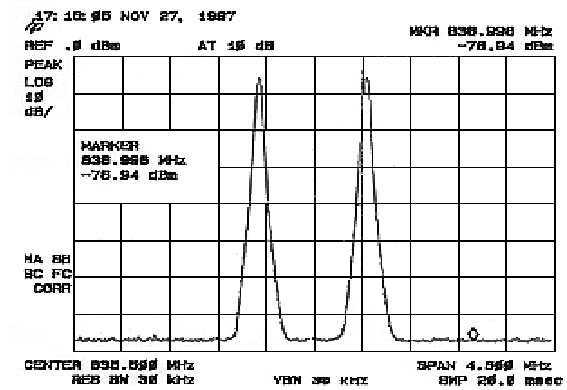

Fig. 2: Output Spectrum of the HBT PA at 28 dBm after applying the technique.

Figure 1 is a plot of the spectrum analyzer display showing the output of the amplifier prior to the application of the technique. In this figure the fundamental signals are at 835 and 836 MHz and the third order intermodulation products are at 834 and 837 MHz. Figure 2 shows the corresponding outputs with the second harmonic injected and adjusted to minimize the intermodulation. Comparison of the figures shows that the third order IM products have been attenuated to the noise floor level. It should be noted that there is no change in the fundamental powers. The total power of the signals are 28 dBm Similar results were observed at other power levels (Figures 3 and 4).

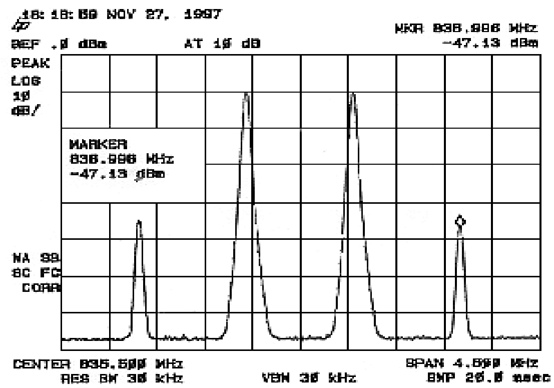

Fig. 3: Output Spectrum of the HBT PA at lower output power before applying the technique.

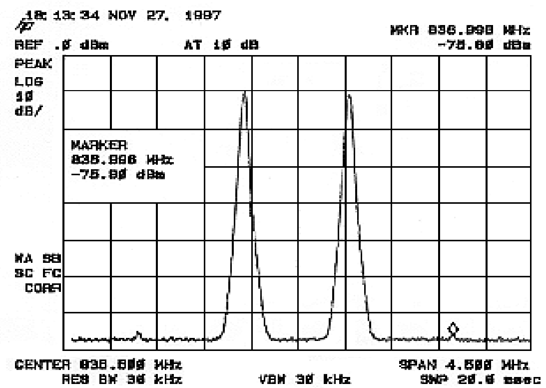

Fig. 4: Ouput Spectrum of the HBT PA at lower output power before applying the technique.

The adjacent channel power ratio (ACPR) was also measured with a CDMA signal for a 30 KHz bandwidth with a +/- 900 KHz offset at 835.5 MHz. A 6 dB improvement in ACPR was observed. Further improvements of ACPR is under investigation. The CDMA signal quality factor (ρ) which is a measure of the power correlated with the ideal transmission code over the total power did not deteriorate using this technique.

Conclusion

The second harmonics of the fundamental signals in a CW mode can be applied together with the fundamental ones into a non-linear amplifier in order to attenuate the third order IM products. Experimental results measured a 44 dB third order IMD reduction (down to the noise floor) in an HBT MMIC power amplifier. This was achieved with no change in the power levels of the fundamental signals. The technique was also successfully applied to the HBT PA using digital CDMA signals.

References:

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[2]- H. Seidel, "A feedforward experiment applied to an L-4 carrier system amplifier", IEEE Trans. On Commun. Technol., Vol. Com-19, no. 3, pp. 320-325, June 1971.

[3]- M.R. Moazzam and C.S. Aitchison. "A low third order intermodulation amplifier with harmonic feedback circuitry", 1996 IEEE MTTS Dig., 1996, pp. 827-830.