

# History and Future Trends in RF Power Amplifier Linearization

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**Abstract**—Since the earliest days of broadcast radio, minimization of distortion has been an important factor in RF power amplifier (PA) design because of the use of amplitude modulation (AM). With the advent of vacuum tube technology, it became well understood that linearity must necessarily be compromised to achieve high efficiency in the conversion of DC power to RF power. As radio evolved, methods of modulation that avoided amplitude modulation, such as FM, were developed to alleviate some linearity requirements so as to achieve higher efficiency. This breakthrough gave birth to the development of mobile radios, which by nature had finite energy supplies. However, as radio spectrum became an increasingly scarce resource, system designers were forced to use spectrally efficient modulation schemes that necessarily employ both amplitude and phase modulation. With the introduction of the Internet, and its subsequent migration to mobile platforms, the demand for high data rates over increasingly crowded radio bands has driven linearity standards to extremes that are well beyond the capabilities of any known RF PA technology.

Methods to linearize RF PAs have been known since the 1930s. Feed-forward (FF) linearization, one of the earliest techniques, is still widely employed in cellular basestations and digital television transmitters today. However, because of complexity of the technique, the efficiency of FF linearized PAs rarely exceeds 10%. However, the importance of DC conversion efficiency has been considered secondary to that of linearity for these fixed site transmitters. But this was never true for the mobile platforms, and is becoming more important as operating expenses for cellular basestations increase in direct proportion to energy costs. As such, methods of linearization, such as digital predistortion (DPD) have become increasingly popular due to their improved efficiency over feed-forward techniques. Furthermore, crest factor reduction (CFR) used in conjunction with DPD have pushed DC-to-RF conversion efficiencies well into the double digits. This paper will discuss the development of PA linearization technology, and will discuss recent advances that may allow further improvements in PA distortion and higher efficiencies.