

## PA Linearization for Modern Communication Systems

In third generation (3G) mobile communication systems, ultra linear amplification is required for complex modulation formats. Nonlinear amplification yields inter-modulation distortion (IMD) products and results in unacceptable spectral regrowth in the adjacent channels. To achieve ultra linear amplification, special linearization techniques are usually employed. Various techniques have been developed to reduce IMD products in high power amplifiers and generally, three main linearization methods are used. They are the predistortion method, the feedback method and the feedforward method.

AR Modular RF located in Bothell, Washington designs and manufactures high power amplifiers using traditional backoff plus the linearization techniques mentioned above for different applications in the communications and wireless industry. Further more, we have developed a combination of “Doherty technique” along with analog predistortion techniques in the traditional feedforward method to further improve our goal of **“HIGH EFFICIENCY AND HIGH LINEARITY”**

### Analog Predistortion Technique

It is well known that analog predistortion is a widely used linearization method in power amplifier (PA) designs. AR uses this technique in certain applications in order to improve the linearity to a certain level while increasing the efficiency and yet keeping the build costs low.

A typical analog predistortion PA at AR is shown in figure 1. The backoff of the output stage is typically 6 or 7 dB (2 or 3 dB less than the normal HPA), thus, improving the efficiency and the linearity of the amplifier. Our analog predistortion can improve the IMD3 by 6 to 10dB for an amplifier in the band 450 MHz to 2.2 GHz.

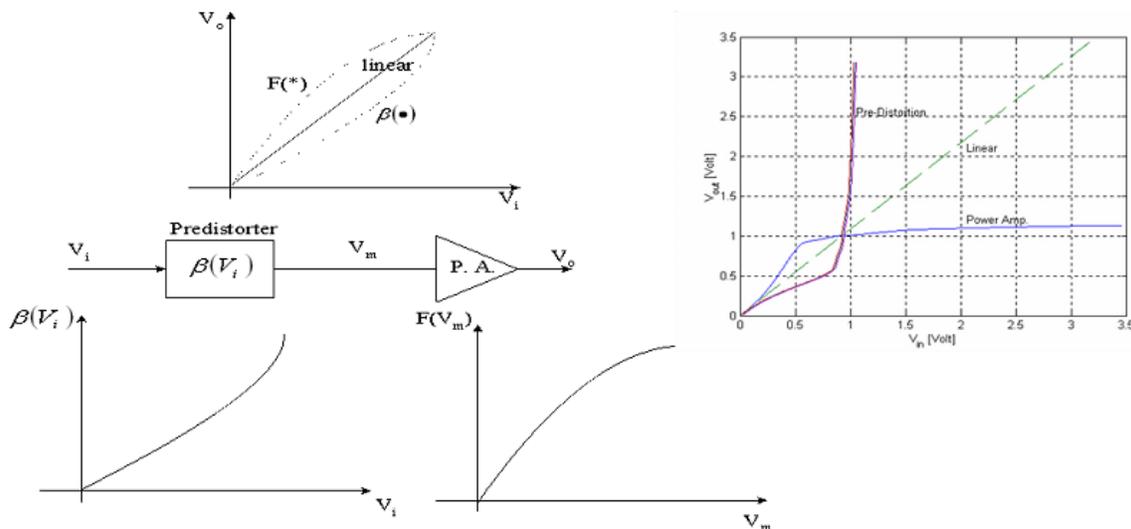


Figure 1: Analog predistortion



The feedforward structure is very complicated but it is still widely used in the narrow band wireless market because of its dramatic improvement on the linearity of the amplifier. The normal improvement on the IMD of 2-tones and ACPR for the CDMA or WCDMA application is better than 20dB.

However, this structure has a very negative affect on the efficiency since there are essentially two PAs in it and also because of the additional insertion loss of the delay lines especially the 2<sup>nd</sup> (main) delay. Due to these effects, the efficiency of the normal feedforward structure is only about 6% to 7%.

In order to improve the efficiency of the structure, our engineers have combined the technique of analog predistortion with the Doherty technique in the main PA as shown in figure 4. Our new design of the feedforward LPA has a much improved efficiency of around 10% to 13%.

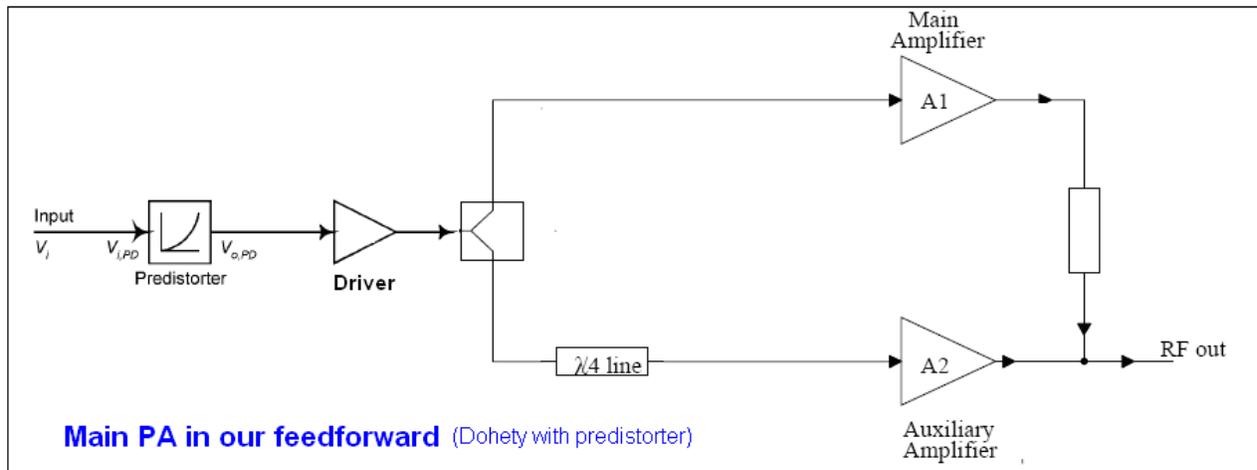


Figure 4: New main PA in the feedforward structure

We have the ability to design the feedforward PA for operation from 450 MHz to 2100 MHz, and with output powers ranging from 10W to 60W for 2-tone CW, CDMA and WCDMA modulations for single or multi-carrier PAs to meet the demanding needs of the wireless communication market. Typical output plots of the feedforward PA showing the improvement effects are shown in figure 5.

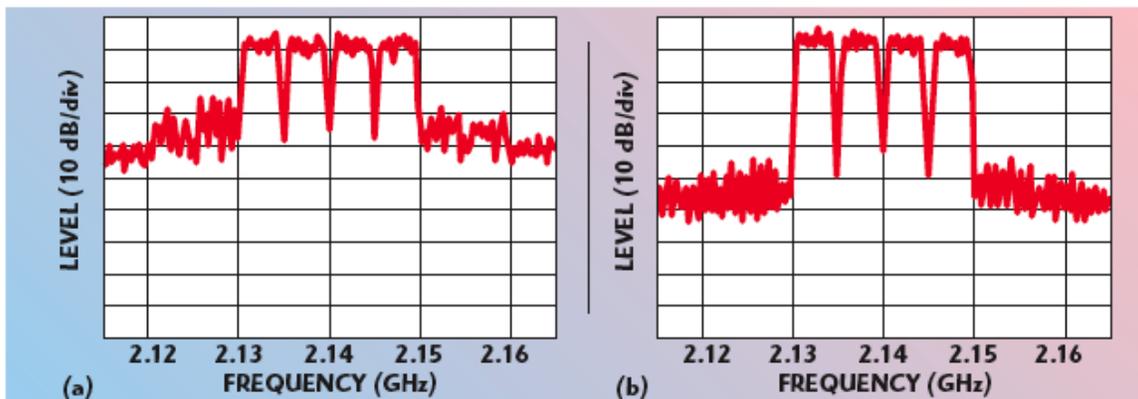


Figure 5: Typical spectrum plots of the output from the feedforward