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Broadband linear high power amplifier for base station

Pengcheng Jia, Lee-Yin Chen, Robert A. York
E.C.E. Dept., University of California, Santa Barbara, CA 93106

The emerging broadband wireless and satellite communication systems call for linear, broadband and high power amplifier module for base stations. Power combining techniques are widely used to increase the power level much higher than a single solid-state device. But when a large number of devices are required, the corporate combining network will consume more surface area and become more lossy which leads to a much lowered combining efficiency. When the new communication standard is moving to higher band, the problem will become more severe.

Spatial combining technique has shown constant combining efficiency over frequency due to its spatial parallel combining structure. As shown in Figure 1, UCSB has demonstrated a broadband spatial power combining technique for integrating 32 GaAs MMIC amplifiers using oversized coaxial waveguide. An oversized waveguide is divided into 16 identical trays with 2 MMIC amplifiers on each circuit tray. When the trays are stacked together, a coaxial waveguide opening will be formed with 32 parallel amplifier channels inside. A broadband slotline antenna array is used to couple the energy efficiently from the waveguide space to the input and output of the MMIC amplifiers. TEM mode is the dominant in the loaded oversized waveguide. Due to the symmetric illumination of 32 channels, each MMIC amplifier will receive same amount of power and avoid the unequally drive problem in rectangular waveguide combiner.

The passive combining circuit has shown better than 70% combining efficiency over the 6-18 GHz bandwidth. With GaAs MMIC amplifiers integrated, a maximum power of 50 watt was achieved with bandwidth from 6 to 17 GHz as shown in Figure 2. The fluctuation of the gain curve is due to the broadband MMIC amplifier. Stabilization circuit are also integrated before the input of the MMIC amplifiers.

The UCSB "tray" approach spatial power combining design has unique heat transfer advantage over other spatial combining schemes. The MMIC amplifiers are mounted to the copper tray through a Cu/Mo subcarrier, which has similar thermal expansion coefficient as GaAs. The heat generated by the MMIC amplifiers is effectively conducted from the metal tray to the outer surface and cooled by forced air convection. Fins are machined on the outside surface of the waveguide to increase heat dissipation area.

Due to the equally drive of 32 MMICs, the amplifier has shown good linearity with an OIP3 of 52 dBm, which is a 14 dB improvement over the OIP3 of a single MMIC amplifier. The comparison of OIP3 is shown in Figure 3. The spatial combining technique has the same noise figure as a single MMIC amplifier. The dynamic range of the amplifier will also increase by 14 dB. Due to the irrelevance of the phase noise from each channel, the overall phase noise is also improved as shown in Figure 4. The design can also be applied in lower frequency band and also Ka Band. All these features enable the design a good candidate for power amplifiers in wireless communication base station.

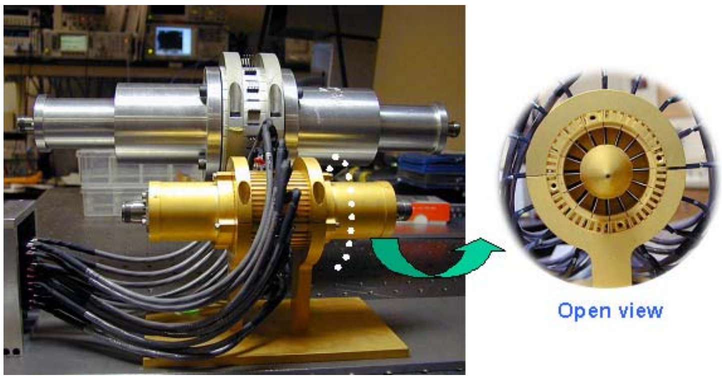

Figure 1 Broadband amplifiers using coaxial waveguide combining technique

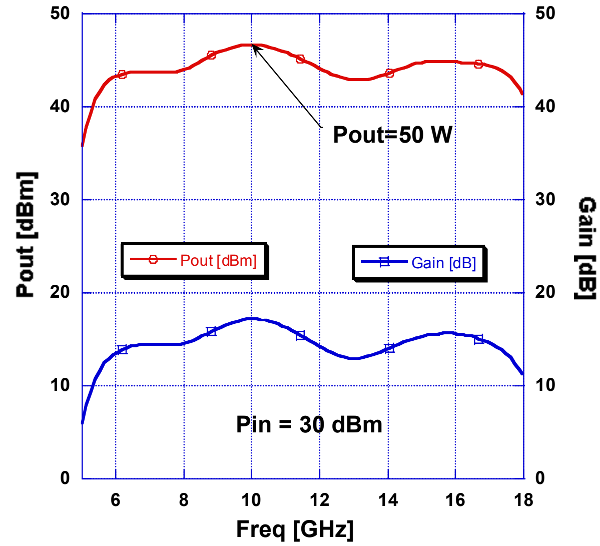

Figure 2 Pout and Gain of the broadband amplifier

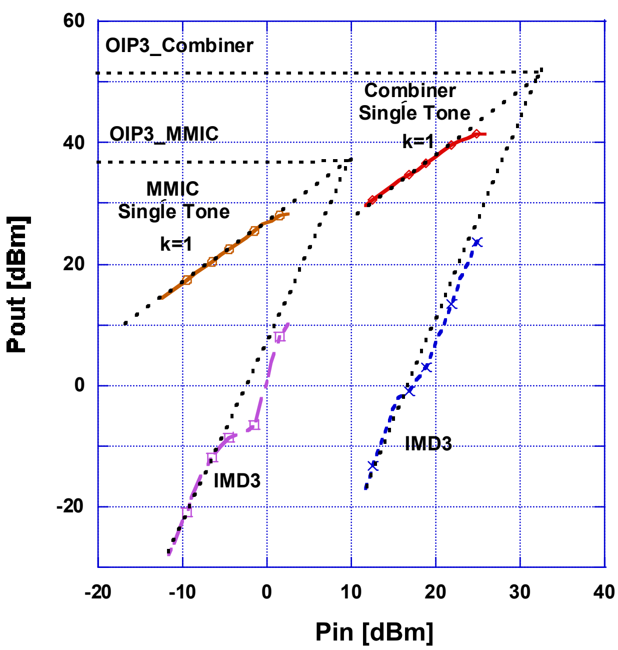

Figure 3 Improvement of OIP3 of the amplifier over single MMIC

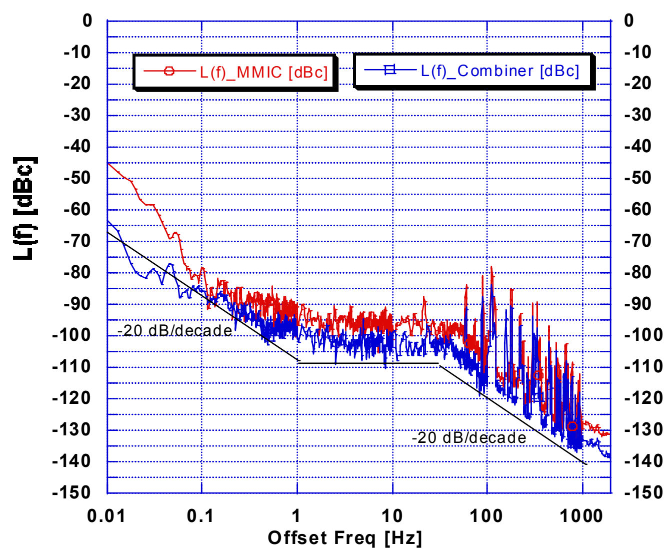

Figure 2 Phase noise reduction of the amplifier