Chapter 5

GaAs Solid State Broadband Power Amplifier for L and S Bands Applications

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ABSTRACT

This chapter provides an insight view of the Broadband Power Amplifier (BPA) design. Basically, the aim of the BPA is to increase the power level of the signal present at its input terminal up to a prefixed power level at its output terminal in the operating frequency band. The research of a GaAs single stage solid state broadband power amplifier based of ATF13876 which operates in the frequency band ranging from 1.17 GHz to 3 GHz is presented in this chapter. The wider bandwidth circuits are designed by using transmission lines which are intrinsically wideband circuits. With carefully designed biasing and broadband matching networks, unconditionally stability and excellent matching performance are fulfilled over the overall operating bandwidth with a maximum power gain of 17.34 dB and a saturated output power of 17 dBm. Considering the wider bandwidth of the proposed BPA, the latter compares favorably with the contemporary state-of-the-art.

INTRODUCTION

Today, every person of us uses communication systems at home, on the moving or anywhere. We re-DOI: 10.4018/978-1-7998-0117-7.ch005
receive RF signals from satellites in our home on our satellite TV receivers, as well as at our smart phones from global positioning systems (GPS). We are driving cars that equipped with new tools that employ microwave technology such as radars for collision detection (Ribate, et al., 2018). Other types of radars are used in detection, identification and navigation applications. Basically, almost every device of these communication systems has some sort of transceiver, and inherently a power amplifier operates in one of the following bands determined by IEEE Standard 521-1984: L, S, C, X or Ku bands (IEEE, 1984).

However, with the rapid evolution of wireless communications, driven mostly by system-level requirements, and the subsequent growing demand to transmit mounting quantity of data, which resulted in the adoption of complex modulation schemes such as Orthogonal Frequency-Division Multiplexing (OFDM) and Wideband Code-Division Multiplexing Access (WCDMA), a growth request of broadband applications pop up (Coleman, 2004). As a consequence, the compelling necessity to evolve efficient and cheaper power amplifiers in order to satisfy these demands has pushed researchers towards sophisticated architectures and solutions.

In general, whether characterized as narrowband, broadband, low noise, high efficiency, high power or otherwise, the design of all power amplifiers is ultimately equivalent to the design of an appropriate circuit able to convert the DC power supplied to an active device, into Microwave/ RF energy, thereafter transferred to an external load (Colantonio, Giannini, & Limiti, 2009). Various classes of operation and techniques have been developed and investigated towards this purpose, attempting to reduce overall DC power consumption and optimize power conversion as well as increasing system efficiency and spreading the operating bandwidth. Among such approaches, the Broadband Power Amplifiers (BPA), thanks of its numerous features including low cost, low complexity and broad bandwidth. In addition, BPAs can significantly reduce the hardware research & develop costs due to compatibility for the new and old wireless standards (Kazimierczuk, 2015).

Essentially, Broadband Power Amplifiers span a wide range of areas, among which microwave crop drying and quarantine in agriculture, medical diathermy, medical imaging, heating, electronic warfare, telecommunications, tracking and navigation systems represents just a few examples. Given such tremendously diversified fields, PA requirements may greatly vary in design, operating and technological specifications, which resulted in the broad variety of power amplifier realizations from microwave heating tubes to power amplifiers composing hyperthermia devices, and from travelling-wave tube amplifiers used in satellite payloads to solid state power amplifiers deployed in personal wireless communication handsets.

The design of BPAs, as that for any other power amplifier circuit, is basically subdivided in a chain of methodical steps, from the identification of BPA specifications up to the concluding characterization and measurements of the fabricated circuit, to prove fulfilment of the design requirements. Throughout the design of BPAs, essential and commonly contrasting specifications have to be at the same time fulfilled. On the one hand, wide bandwidth, high output power as well as high power gain are typically needed to minimize the number of PA stages, and consequently reduce the size of the whole unit. Furthermore, in order to ensure adequate signal amplification unaccompanied by affecting the data content, as well as preserve the suitable quality for the transmitted signal, high linearity must be assured (Bahl, 2009).

There are several techniques and circuit topologies deployed to realize broadband power amplifiers. These techniques include the Real Frequency Technique (RFT), parallel or shunt resistive feedback, the traditional resistive / reactive matching, the traveling-wave approach and balanced configurations. The microwave power amplifier that reactively matched employs completely reactive matching circuits at the input and the output of the active device. Either transmission lines or lumped capacitors and induc-
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