

Waveguide-Based Spatial Power Combining

Nai-Shuo Cheng, Lee-Yin Chen Robert A. York*
Department of Electrical and Computer Engineering
Engineering I
University of California
Santa Barbara, CA 93106

Spatial power combiners are attractive for efficient combining of large numbers of solid-state devices. Spatially-fed/Spatially-combined arrays have been the focus of much research activity during the past decade. Most of the work has centered on planar arrays with normally incident or outgoing beams. Such arrays have (generally) limited bandwidths, and also present difficult challenges in thermal management (edge cooling) and efficient power collection (coupling to Gaussian beams). We have developed a broadband waveguide-based spatial combining approach which addresses these issues.

The waveguide-based system uses stacked trays of broadband travelling-wave antenna structures such as tapered-slot antennas, housed in a metal waveguiding enclosure that is operated in the dominant TE mode. Each antenna is then essentially a waveguide-to-transmission-line transformer that couples energy from the waveguide mode to a set of power amplifier circuits. We have found that the antennas can be placed electrically close for high power density. Thermal management is simplified by virtue of the “tray” architecture and the surrounding metallic walls which provide a convenient heat sink. Power enters and leaves the system in a single well-defined mode and therefore power distribution and collection is simplified. Such arrays also pose a well-defined electromagnetic problem, and consequently significant progress has been made towards optimization of the structures for bandwidth and combining efficiency.

We will report on recent results in the development of X-band and K-band waveguide-based systems. Current state-of-the-art at X-band is a 40 Watt system with 70% combinign efficiency from 8-11 GHz which uses GaAs-based MMIC amplifiers and optimized finline transitions. Modelling and optimization techniques will be discussed, as well as other potential enhancements for bandwidth and power-handling. A multi-octave 64-way passive combiner system using oversized coaxial waveguide will also be presented.

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1. (a) Robert A. York
ECE Dept, Engineering I
University of California
Santa Barbara, CA 93106 USA
rayork@ece.ucsb.edu
(b) 805-893-7113
(c) 805-893-3262
2. D
3. (a) Spatial Power Combining
4. I, Program chair: A.
Mickelson
5. none

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