

Low Cost Antenna Skins

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ABSTRACT

Low-cost technologies are presented for TR modules and beam forming networks for future space-borne and airborne Active Electronically Scanned Arrays (AESA). These technologies include state-of-the-art highly integrated circuits to miniaturise front-end, solutions to lower-cost interconnection technologies, MEMS, new beam forming aspects and new architectures.

The MMICs address the needs for current and future phased-array topologies as for example the concept of "structurally integrated skins". The MMICs functions to be presented are highly integrated RF-control circuits and wide-band, high gain, high-efficiency solid state power amplifiers.

Various MMIC solutions at X-band and at Ka-band for amplitude and phase control are shown. The design, manufacturing, performance and application of fully integrated multi-functions mixed-signal chips are presented.

High-power amplifiers are described that comply with future active phased array operations. As typical examples the development of MESFET and HEMT power amplifier at X-band are described with more than 10 Watt output power. These amplifiers are intended as alternatives to replace the cascade chain of the traditional driver and high-power amplifier in TR-modules. The impact of new substrate materials like GaN will be shown. Gallium-Nitride is a promising material for the next generation high-power amplifiers. Compared to GaAs, GaN exhibits a much larger breakdown voltage. As a result single transistors with about 10-Watt output power seem to be feasible. A significant size reduction can be achieved with these amplifiers. But, more important, due to the higher breakdown voltages, also savings regarding complexity and cost of the DC-DC converters become feasible.

Micro Electro Mechanical Systems offer significant cost savings in phased-array antennas. Especially applications are foreseen to replace the FET-switches in phase shifters and in TR-switches, but also in tuneable filters.

Interconnection problems are avoided using multi-layer substrates that carry as well as digital control lines also the RF lines. Antenna elements including stacked arrays and FSS functions could also be integrated in these substrates. A scaleable or modular approach reduces the manufacturing costs of these front ends.

The preferred architectures, advantages and realised for optical beam forming techniques are shown. The use of photonics for phased-array applications has been discussed for quite some time. Main difficulties up to now have been the component count and cost for relatively complex systems. The advances in photonic integration are very promising to bring down volume and weight of phased-array beam forming networks as compared to their electrical counterparts. In addition, photonics enables the use of antenna remoting and optical signal processing. In general two classes of optical beam forming networks can be distinguished: coherent beam forming and incoherent beam forming. Coherent adding of optical signals requires control over the optical phase but has the advantage of additional circuit gain, which reduces the required dynamic range of the modulators. Using a coherent detection scheme, phase and amplitude of an optical signal can be directly transferred to a microwave signal. In this way modulation of phase and amplitude of a microwave signal can be performed using optical phase and amplitude modulators.

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