Spatium ™ Spatially Combined Amplifiers

The Spatium ™ spatially combined amplifier with CAPLine™ technology was originally developed in response to the need for an amplifier architecture that could support moderate to high power levels, provide the reliability and ruggedness associated with solid state power amplifiers (SSPAs), have a low thermal noise signature characteristic of solid state performance, operate linearly with minimal harmonic and intermodulation distortion, over very broad frequency ranges, in a compact package, at a competitive price.

OK, that's a mouthful.

What we ended up with is a patented structure that unites an innovative combining structure with state of the art MMIC power devices, providing the optimum method of achieving multiple element power combining. The platform is largely frequency independent, and compatible with a large number of available MMICS. We can offer numerous combinations of power and bandwidth by changing only the devices. The rest of the structure takes advantage of commonality, and lowers the cost.

That's nice. How does it work?

In a word, it works well! How it achieves its remarkable performance is an amalgamation of innovation, sophisticated modeling, and implementation. The arrangement can be visualized as an oversized coaxial guided wave structure. A tapered center conductor transitions from the traditional SMA coax connector to a larger center conductor. Once the enlarged radius coaxial line is reached, multiple antipodal finline antenna elements arranged radially around the center gather all of the microwave energy across a wide

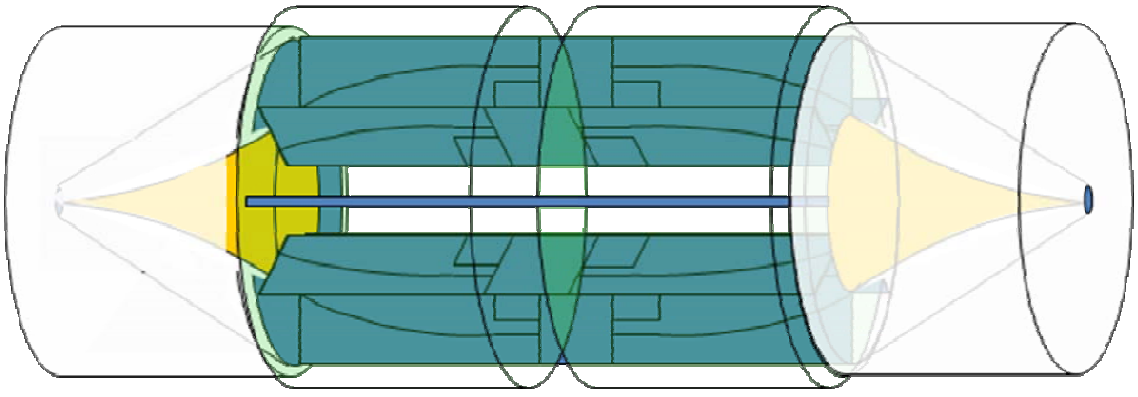

Figure 1

frequency spectrum, and transition the gathered signals to several microstrip transmission lines. Each of the microstrip lines feeds a MMIC power amplifier housed in a 20 GHz resonance free ceramic package, where the signals are simultaneously amplified by equal amounts. The amplified signals out of the MMICs are launched back onto microstrip lines that then couple to output antipodal finlines, back into a coaxial waveguide, where the fields coherently combine. The output signal transitions through a

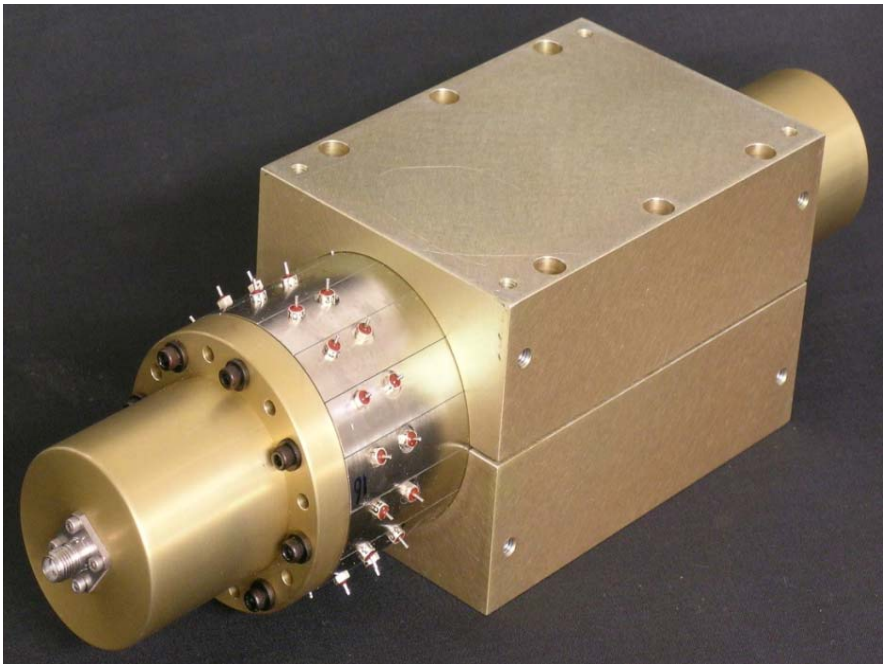

Figure 2

tapered coaxial line back to an SMA connector, providing the high output power levels. Figure 1 shows a simplified pictorial representation of the structure. Figure 2 shows the completed mechanical structure that makes up the "engine".

The uniformity of the MMICs and the intrinsic structure helps maintain nearly identical phase and amplitude variation through all amplification channels, resulting in high power combining efficiencies. Typical combining efficiency across the 2-20 GHz band is < 0.5 dB loss with 16 way combining. Also, the loss is independent of the number of combined elements, unlike a corporate structure where the losses increase as the number of combined elements increases. Because the combining losses are low, the operational efficiencies are maximized by not throwing away power in the combining scheme, resulting in lower heat dissipation, less prime power for a given power level. Also, because of the high number of

combined elements, the RMS phase noise of the amplifier is less than that of a single comparable device and significantly lower than what might be expected from a traveling wave tube amplifier.

What are the characteristics and advantages?

Table 1 below quantitatively compares the Spatium amplifier capability with alternative amplifier technologies. Spatium has a significant advantage in combining efficiency, bandwidth, platform commonality, and thermal characteristics over traditional SSPA technology. It offers significantly lower noise, better linearity, longer life, safer operating voltages, and longer life than traveling wave tube amplifiers.

	Spatium	**Traditional Solid State Power Amplifier (SSPA)**	**Traveling Wave Tube Amplifier (TWTA)**
Combining Efficiency	>90% - independent of number of combined elements	75-90% suffers diminishing returns as combining increases	100%
Bandwidth Capability	Decade+	Two Octave	Two Octave
Single Point Failure	No	No	Yes
Noise Figure	8 dB	8 dB	35 dB
Harmonics at PSat	-20 dBc	-20 dBc	0 to -6 dBc
Platform Commonality Across Frequency	Replace MMICs	New Devices, New Package, New Combiner Structure	New Design
Phase Noise	Low	Low	High
Supply Voltage	Low (<32 V)	Low (<32 V)	High (> 1kV) Personnel hazard
Reliability	>100 kHrs	>100 kHrs	<10 kHrs

	Spatium	**Traditional Solid State Power Amplifier (SSPA)**	**Traveling Wave Tube Amplifier (TWTA)**
Thermal	Three Dimensional Cooling – Minimal Mutual Heating	Single Plane Cooling – Center Devices Suffer mutual Heating	Three Dimensional Cooling
Output Noise Power	Low	Low	High
Load Mismatch Tolerance	Good	Good	Poor
Required Warm Up	None	None	3-5 minutes

Table 1

This novel structure with its patented architecture holds the promise to revolutionize the microwave power amplifier industry. Applications traditionally dominated by traveling wave tube solutions, such as test and measurement, Electronic warfare, electronic counter measures, simulators, now have a solid state option with all of the associated preferable performance attributes – CAP Wireless Spatium series amplifiers!