TECHNOLOGY SURVEY

A SAMPLING OF TWTS, TWT ASSEMBLIES AND MPMS

By Ollie Holt

This month's survey covers traveling wave tubes (TWTs) and Microwave Power Modules (MPMs). For the past few decades, TWTs have been the most popular power amplifier for radar and radar jamming applications. The large global inventory of legacy radars and radar jammers means that TWTs will continue to be used for many years to come. In the 1990s, MPMs arrived on the scene and have slowly been replacing TWTs in many EW and radar applications. More recently, the rapid evolution of Gallium Nitride (GaN) technology has enabled EW designers to consider SSPAs for radar jamming applications. These technology developments have created a somewhat complex market for power amplifiers. This month, we will focus on TWTs and MPMs. (GaN-powered SSPAs will be covered in our August technology survey).

In past surveys, we discussed how TWTs operated, and provided information about improvements in GaN and Gallium Arsenide (GaAs) Monolithic Microwave Integrated Circuits (MMICs) power amplifier technologies. This month, we will talk about a core objective of EW power amplifier designers: delivering power. In other words, how do we get more power from these devices?

POWER

Threat radar systems are becoming more capable. With large Active Electronically Scanned Arrays (AESAs) and coded waveforms to provide greater effective radiated power (ERP) and much longer detection ranges, the EW jammer needs to be able to respond with higher power to be effective against them.

In the past, the only way an EW jammer could develop high power was with a TWT. TWTs could provide anywhere between 100 Watts to many kilowatts. TWTs require high voltage power supplies (in the kilovolts range) and produce lots of heat which limits their efficiency. These high voltage power supplies tended to be large, heavy and hazardous. TWTs also have lower reliability than Solid State Power Amplifiers (SSPAs).

So the problem becomes, how does an EW designers get power from solid state power amplifiers (SSPAs) that typically provide tenths of Watts to low tens of Watts? combining could be performed internally within an assembly vs. externally in space. Three different techniques were developed: Tile (also called Grid); Tray; and Spatium™, a coaxial antipodal finline concept on which CAP Wireless Inc. holds a patent. A simple example of each is shown in Figure 1.

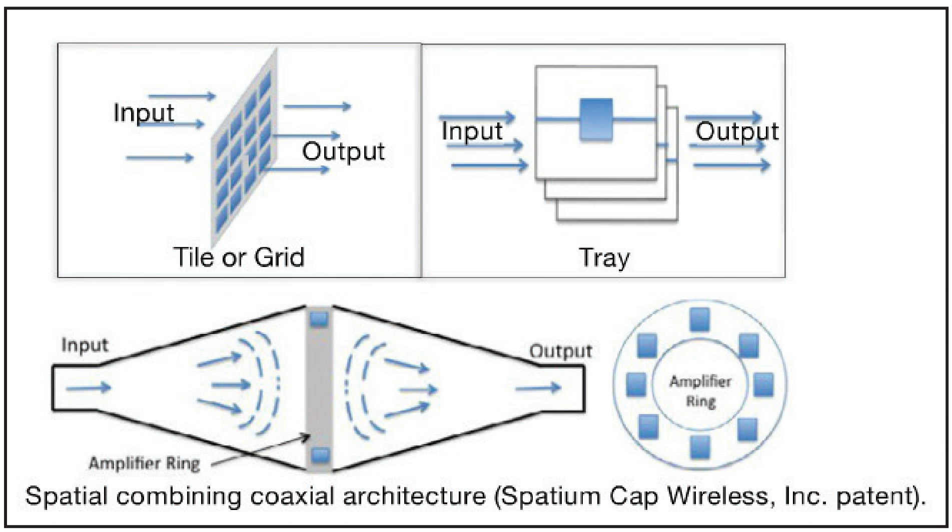

Figure 1. Spatial combining techniques.

The answer is combining a group of SSPAs in some configuration that efficiently combines the power of each individual amplifier. This can be performed by some type of corporate power combining network or by combining spatially, similar to how an AESA works. A corporate feed takes an array of SSPAs and combines their outputs through a series of combiners. This works but has limits on combining efficiency, the size of the combining network and signal integrity.

The typical AESA solves this problems by combining spatially. It has multiple SSPAs each connected to an antenna element, and by controlling the phase of the output signal, it is able to perform a spatial combination in free space without any power-combining network. Similarly it was discovered that spatial power

The Tile or Grid configuration places a number of SSPAs in an array in a rectangular waveguide while a Tray configuration stacks a number of SSPAs in a rectangular waveguide. Both configurations have problems removing heat and have limited bandwidth. The Spatium concept basically mounts the SSPAs in a ring allowing the heat to be removed more efficiently and provides lower loss and broader bandwidth. With these spatial combining techniques, SSPAs can start to replace TWTs in medium-power jamming applications.

The survey accepted inputs on TWTs and MPMs. Some of the MPMs use TWTs, but some also use SSPAs. The SSPA devices used are Silicon (Si), GaAs and GaN, depending on operational frequency. Next month's technology survey will cover radar jammers.

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MODEL	TYPE	OP FREQ. RANGE	OUTPUT POWER/GAIN	LEVELS (dBc)	EFFICIENCY (%)
dB Control; Fremont, CA, USA; +1-510-656-2325; www.dBControl.com					
dB-4127	MPM	6-18 GHz	200W	-2 dBc @ 6 GHz; -50 dBc spur	40
dB-4118	MPM	6-18 GHz	75/100W	-2 dBc @ 6 GHz; -50 dBc spur	25
dB-3758	MPM	9-10 GHz	1000W	15 dBc Harmonic; -70 dBc spur	25

MODEL	INPUT POWER (W)	SIZE (HxWxL inches/mm)	WEIGHT	FEATURES
dB Control; Fremont, CA, USA; +1-510-656-2325; www.dBControl.com				
dB-4127	0 dBm	2.15 x 9.38 x 11 in.	8.5 lb	CW/pulsed.
dB-4118	0 dBm	1.6 x 8 x 11 in.	6.25 lb	CW/pulsed.
dB-3758	0 dBm	4.9 x 9.65 x 12 in.	17.6 lb	Pulsed.