The Journal of Electronic Defense

JED TECHNOLOGY SURVEY

A SAMPLING OF TWTS AND MPMS

By Ollie Holt

This month's technology survey focuses on traveling wave tubes (TWTs) and microwave power modules (MPMs), which are power amplifiers widely used in radar jamming systems and towed decoys. TWTs still have a place in EW, but with improvements in Gallium Nitride (GaN), new power amplifier designs are being implemented with GaN. If you read last month's article, "is EW ready for AESA," by Barry Manz, you will note that a lot of future EW development will be focused on GaN – powered AESA technology.

However, the pace of GaN development, and the degree to which it replaces TWTs and MPNs in EW systems, is still to be determined. In other words, you can expect TWTs and MPMs to remain popular EW power amplifier technologies for many, many years to come.

Since *JED*'s last TWT-MPM survey in March 2010, very little has changed in TWT and MPM power amplifier technology. Some new MPMs have been developed with improvements in efficiency, reliability and increased power output, but little in TWT technology has changed.

The March 2010 survey provided a technical description of the operation of a TWT. Following is a quick summary of that description. The TWT was originally developed by the British in 1942, and the design was improved by Bell Labs in the US. The TWT was a very important development during World War II because of the need for high-power radar systems that could detect enemy aircraft and ships. The TWT provided the power to those radars. **Figure 1** shows a diagram of a simple helix TWT. It looks like a long vacuum tube. The electron gun on the left emits electrons through the helix wire directed towards the collector. The magnets form a containment field focusing the electron beam through the helix coil towards the collector. The RF input device is a directional coupler which induces the RF signal into the helix coil.

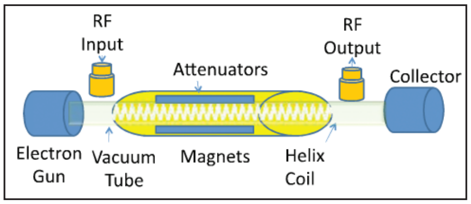

Figure 1: Helix TWT Example

It directs the input signal towards the collector, not towards the electron gun. As the RF signal travels along the helix coil towards the collector, the electromagnetic field created by the RF current in the helix, the signal interacts with the electron beam traveling through the center of the helix causing a phenomenon called velocity modulation. The electron beam induces more current into the helix as the signal flows through the helix towards the collector causing amplification of the RF signal. The RF out-put is another directional coupler positioned near the collector. The coupler removes the amplified RF signal from the TWT. The attenuators are used or to prevent reflected RF waves from traveling back down the helix towards the electron gun.

The survey also includes MPMs. Some of the MPMs use TWTs. But some also use solid-state devices as the power amplifier. The solid-state devices used are Silicon (Si), Gallium Arsenide (GaAs) or Gallium Nitride (GaN), depending on operational frequency.

The survey requested information on parameters that impact power amplifier performance. The operational frequency range defines the lower to upper frequency range of the device. Gain defines the increase in power that can be achieved from the input to output. Output power defines the maximum output power expected at the maximum gain.

dBc or dB relative to the carrier is a measure of how much higher the carrier signal is with respect to harmonics or spurious signals created within the device will. For most applications, the larger this value is the better the performance.

Efficiency is defined as the power added efficiency, which is the devices output power (RF) minus the input power (RF) divided by the DC power. In high-gain systems, the results are about the same as efficiency (output power [RF] divided by input power [DC]). In low-gain systems, however, the efficiency can be very different. Also note that in the survey the input power (DC power) is average power input. For a pulsed system, the power added efficiency is calculated using the input power DC, when the pulses created, and not the average input power DC.

This TWT-MPM survey lists of sampling of products from 14 companies. Information was gathered from manufacturers that responded to our survey questionnaire, data from web research and responses to our previous TWT-MPM survey.

JED's next survey, which will cover it EW and SIGINT antennas, will appear in the January 2013 issue.

TWTs & MPMs

MODEL	TYPE	OP FREQ. RANGE	OUTPUT POWER/GAIN	LEVELS (dBc)
dB Control; Fremont, CA, USA; +1-510-656-2325; www.dBControl.com				
dB-4120	MPM	2-7 GHz	100 W	-5 dBc Harmonic, -55 dBc Spurious
dB-4121	MPM	6-18 GHz	100 W	-4 dBc Harmonic, -55 dBc Spurious
dB-4117	MPM	18-40 GHz	50 W	0 dBc Harmonic, -55 dBc Spurious

EFFICIENCY (%)	INPUT POWER	SIZE (HxWxL inches/mm)	WEIGHT (lb/kg)	FEATURES
22%	530 W (typical)	2.5 x 8.0 x 13.75 in.	10 lb	CW/pulsed
22%	500 W (typical)	1.6 x 8.0 x 11.0 in.	6 ib	CW/pulsed
15%	475 W (typical)	2.5 x 8.0 x 13.75 in.	10 lb	CW