

TWTAs, MPMs Continue Upward Performance Climb

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If the RF and microwave industry prophets had been correct in their predictions, traveling wave tubes (TWTs) and other vacuum electron devices used for microwave power generation would be extinct by now. Instead, these devices are very much alive and the prognosis for their continued good health is rosy. One reason for the market's continuing demand for "tubes" is that no solid state device can deliver the combination of high RF output power, instantaneous bandwidth, and ability to operate far into the millimeter-wave region.

Companies like dB Control that use these devices to form the core of amplifiers for radar, electronic warfare (EW), electronic countermeasures (ECM), and satellite communications systems continue to make incremental improvements in many areas year after year. For example, the company's two new TWT Amplifiers (TWTAs) and a Microwave Power Module (MPM) from dB Control clearly illustrate not only what can be achieved in TWT-generated power, but also with the low prime power required to achieve it. Plus, all three units feature incredibly compact packaging.



Figure 1: The dB-4409 is a 30- by 8.5-inch pod-mountable TWT delivering 300 W CW from 2 to 18 GHz in two overlapping bands through the use of two TWTs and solid state drive amplifiers, power supplies and control circuits.

New TWTAs Pack High Power in Compact Package

dB Control's new dB-4409 (Figure 1) is an excellent example of how far TWTAs have come in the ability to condense capabilities into a very small package compared to TWTAs of the past. This pod-mounted TWT designed for airborne EW, ECM, and broadband or multiband communication systems delivers RF output power of 300 Watts continuous wave (CW) in two bands (2 to 8 GHz and 7.5 to 18 GHz) with a 55 dB gain and spurious rejection of -50 dBc. The TWT, utilizing two TWTs and two high-voltage power supplies in one 30-inch long by 8.5-inch wide package, operates from either a 115 VAC or 200 VAC, 400 Hz, three-phase power supply.

The amplifier is protected by circuits covering helix overcurrent and arcing, cathode overvoltage, TWT and power supply over-temperature, and loss of phase. A high-voltage supply interlock is included for safety. Indicators are provided for warm-up, standby, operate, and fault. Liquid cooling is provided through the base plate. A variety of options are available including custom frequency bands, different prime power requirements, convection cooling, different RF and control interfaces, gain equalizers and a PIN diode modulator input.



Figure 2: The 10.7- by 8.9-inch dB-4410 TWT (300 W CW from 7.5 to 18 GHz) has the interfaces and standard features that make it well suited for applications such as EW threat simulators, airborne data links and ECM transmitters.

A second TWT recently introduced by the company, the dB-4410 (Figure 2), is designed for a somewhat different set of applications such as airborne data links, ECM transmitters, and EW threat simulators. It delivers at least 300 Watts CW from 7.5 to 18 GHz with 57 dB of gain, spurious rejection of -45 dB, and AM-to-PM conversion of six degrees per decibel. The amplifier operates from either 115 or 200 VAC. In addition to providing protection for helix overcurrent and arcing, cathode overvoltage, TWT and power supply over-temperature, and phase loss, the dB-4410 also offers protection from extreme impedance mismatch (high VSWR), and an RF output monitoring port with signal level attenuated by 60 dB. This amplifier can be either TTL- or RS-422 controlled and can be reconfigured for different frequency ranges, power supply requirements, interfaces, gain equalization, and also with a PIN-diode modulator at the RF input. It provides output switching into an internal "dummy load" for testing, along with comprehensive built-in test (BIT) routines. The unit measures 10.7 inches long by 8.9 inches wide by 18.3 inches deep and weighs 70 pounds.

Small MPMs Well Suited for Airborne Apps

There have been continuous advancements in MPMs since these devices were first introduced, thanks to development of the "mini-TWT." dB Control has been at the forefront of MPM technology



Figure 3: For pulsed-signal applications such as radar systems, the dB-3814 MPM provides 1kW of peak power from 15 to 18 GHz, high amplitude and phase stability, low phase noise and high spurious and harmonic rejection. The module operates from 23 VDC, measures only 12- by 10- by 3-inches and weighs just 14 pounds.

Table 1: New dB Control TWTAs and MPM at a Glance

	dB-4409	dB-4410	dB-3814
Type of amplifier	TWTA	TWTA	MPM
Frequency range (GHz)	2 to 8 & 7.5 to 18	7.5 to 18	15 to 18
RF output power (W)	300 CW	300 CW	1000 peak ¹
Gain (dB)	55	57	60
Spurious rejection (dBc)	-50	-45	-60
Load VSWR	1.5:1	1.5:1	1.5:1
Dimensions (inches, LxWxD)	30 x 8.5 x 8.1	10.7 x 8.9 x 19.3	12 x 10 x 3
Weight (lb.)	90	70	14
Environmental			
Operating temp. (°C)	-40 to +70	-30 to +60	-40 to +85
Altitude (ft.)	55,000	75,000	40,000
Humidity (non-condensing), %	100%	100%	95%
Vibration (g RMS)	6, 20 Hz to 2000 kHz	4.4, 20 Hz to 20 kHz	0.02 g/2Hz, 10 to 1000 Hz
Shock (g)	15, 11 ms	15, 11 ms	
Cooling	Liquid	Liquid	Conduction
Protective circuits	Over-temperature, over-current, Helix over-current/Arc, cathode over-voltage, phase loss, HV Wconnector interlock		At left, plus excessive PRF, pulse width, or duty cycle

¹. 7% duty cycle, 40 kHz PRF, 0.2 to 50 µs pulse width)

since the beginning, and in fact helped develop the earliest working specimens. The company's new dB-3814 MPM (Figure 3) for pulsed (i.e., radar) applications is about the size of a hardcover novel (12 inches by 10 inches by 3 inches). It weighs only 14 pounds, and operates from 28 VDC, yet delivers 1 kW of peak power (7 percent duty cycle, 40 kHz pulse repetition frequency, and 0.2 to 50 microsecond pulse width) from 15 to 18 GHz.

The MPM's phase and amplitude stability and other features make it well suited for airborne synthetic aperture radars (SARs) and multi-mode radars, as well as EW threat simulators and ECM transmitters on either manned or unmanned airborne platforms. It has gain of 60 dB, uses a GaAs MMIC amplifier to drive the TWT, and provides harmonic suppression of -12 dBc, spurious rejection of -60 dBc, and phase noise of 110 dBc/Hz at a 1 kHz carrier offset. The dB-3814 has the same protection circuits as its TWTA counterparts, as well as circuits for excessive pulse repetition frequency, pulse width and duty cycle. Control is provided by RS-422, and a variety of options are available to configure the MPM for specific applications. Detailed specifications for all three products are shown in Table 1.

These two new TWTAs and the MPM join dB Control's other amplifiers for defense applications that cover 500 MHz to 40 GHz with RF output power from 10 W to 1 kW CW and up to 20 kW pulse. As power supplies and power control subsystems are essential to ensure the performance and longevity of TWTs, dB Control has invested considerable resources to advance the performance of these devices. The result is a family of amplifiers that deliver reliable long-term performance and compact packaging. Information about the dB-4409, dB-4410, and dB-3814 is available at www.dBControl.com, by calling (510) 656-2325, or by sending an e-mail to marketing@dBControl.com.

For more information, please visit our website.

www.dbcontrol.com