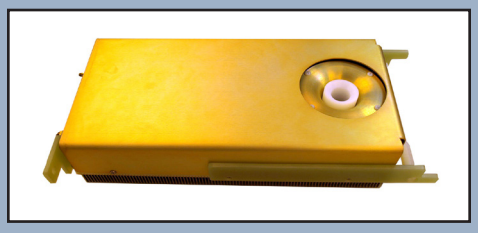
DIVERSIFIED TECHNOLOGIES, INC.®

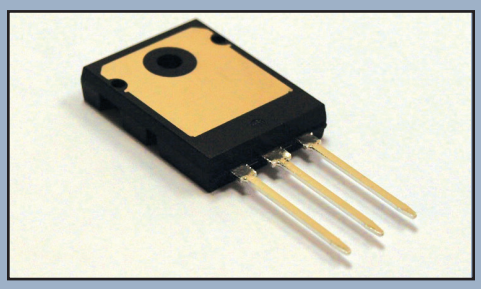
Diversified Technologies, Inc.

Systems In Action



Switch plates are used in high-current applications, such as particle accelerators. This switch plate is rated at 3 kV, 1 kA.

Switch modules handle lower current applications, such as some radar transmitters. These modules are rated at 5 –10 kV, 10 – 50 A.



This Insulated Gate Bipolar Transistor (IGBT) package, developed in association with a leading electronics manufacturer, is a key building block for DTI's solid-state switches. These IGBTs are optimized for pulsed power applications.

PowerMod™ Technology

DTI's PowerMod technology delivers the revolutionary advantages of solid-state high power switching to demanding pulsed power and power conversion applications. DTI's solid-state switches are built from a series stack of IGBTs configured for very high voltage standoff and operated as a single switch. Highly synchronized gate drives ensure the load on the switch is shared equally between devices. The entire switch can be closed or opened in less than a microsecond, safely disconnecting the load in the event of an arc. Each switch is fully isolated from ground, and can open without damage under fault currents up to 20 kA.

Switch modules and plates are controlled with a simple magnetically-coupled loop, and are easy to operate in floating high voltage circuits. The entire switch can float at over 200 kV where required. Switches require no ancillary high voltage power and operate fully on or fully off, greatly easing high voltage management when compared to conventional floating decks.

PowerMod solid-state switches offer nearly ideal switching behavior. Less than 1 µA of leakage current is present when the switch is open. When closed, the voltage drop across the switch is less than 0.1% of the total voltage. Switching can occur in as little as 5 ns, and pulse repetition frequencies over 300 kHz can be achieved. Pulse-widths are variable on a pulse-to-pulse basis from 5 ns to DC. Switches require only 110 VAC control power for operation, and accept pulse commands via fiber optic link.

Technology Comparison

Technology	PowerMod™ Solid-State Switches	Vacuum Tubes (Triodes, Tetrodes)
Reliability	Millions of hours	Thousands of hours
Voltage Range	Up to 200 kV with multiple modules in series	< 100 kV, typically tens of kV
Current Range	Up to 20 kA	1 – 200 A opening & closing
PRF	DC – 300 kHz	DC – 5 kHz
Efficiency	> 98% (load dependent)	80 – 90% peak
Switching Speed	5 – 500 ns	10 ns – 500 ns
Infrastructure Requirements	None	• Filament/grid supplies • Tube sockets • Active cooling • Protection circuits
Lifetime Costs	Very low	High

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PowerMod™ Technology

Solid-State Topologies

PowerMod technology enables the following classes of pulse modulators, optimized for your application:

Hard Switch

DTI's solid-state switches provide broad flexibility in controlling pulse width, PRF, peak current, voltage, and duty cycle. Dissipated heat is low, and is distributed across multiple air, water, or oil-cooled switch modules, allowing the modulator to generate pulses from 1 µs to DC. The pulse flattop in a hard switch modulator is completely determined by the power supply and storage capacitor, simplifying overall system design and providing the ultimate in pulse fidelity. DTI's switches are inherently fault-tolerant, opening in less than a microsecond when an arc is sensed. Hard switches are most appropriate for high voltage (10 – 200 kV) systems, long pulses (100 µs and above), high pulse frequencies, and any time pulse fidelity is critical.

Hard Switch/Pulse Transformer (Hybrid Modulator)

Combining a solid-state switch with a pulse transformer can provide the lowest cost solution to many modulator requirements. This class of modulator is especially appropriate for short pulses (< 50 µs), since the pulse transformer remains small. Pulse transformers are also ideal for very high voltage, short pulse systems (200 kV – 500 kV), since the DC power supply needs to operate at a fraction of the output voltage. Pulse transformer systems, however, can have longer rise times, greater pulse variation, and higher losses than a hard switch system, and are often limited in pulse frequency.

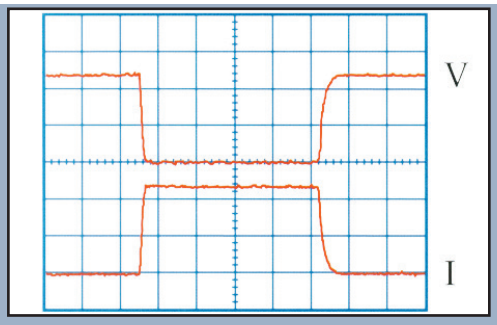
Marx

In a Marx modulator, individual modules are charged in parallel, then erected in series using solid-state switches to achieve high voltage outputs. Marx modulators are appropriate for designs requiring compact, low input voltage systems with fast rise and fall times. Their modular nature also allows tuning of the rise time or flattop of the pulse itself, optimizing performance into complex loads. Marx systems can be ideal for systems where neither hard switch or hybrid topologies are optimal.

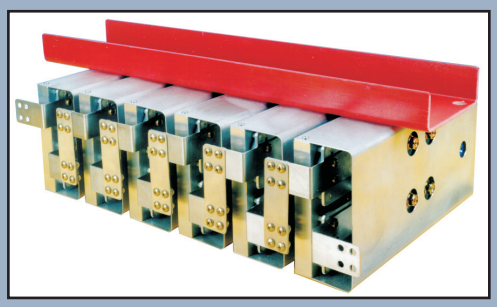
Power Control and Conversion

DTI's PowerMod Technology can also be used in power conversion applications, where our high voltage switches can be used directly in inverters, active rectifiers, and buck or boost regulators. This allows, for example, MVDC power to be directly converted to lower voltage DC or AC power for flexible grid applications, and enables highly efficient DC-DC converters at high voltage (10 – 200 kV). DTI's switch modules can efficiently operate at high frequency, allowing very precise power control.

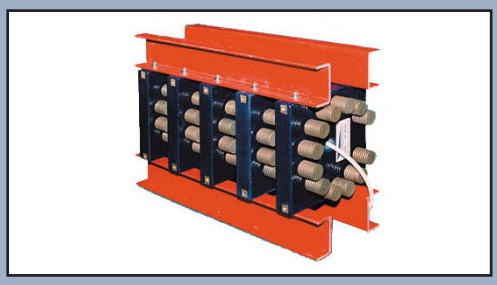
Systems In Action



Very fast pulse rise and fall times and low ripple produce a nearly ideal flat-top pulse. Scope shot shows 20 kV, 100 A, 1 µs/div.



High current switch plate assemblies such as this 20 kV, 1500 A unit replace thyratrons, PFNs, and crowbars in particle accelerators, x-ray systems, and e-beams.



Switch module assemblies such as this 45 kV, 30 A unit are used in radar systems, light sources, and other low current applications.

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