



**Radar Transmitters**



**Advanced RF Systems**



**Power Converters**

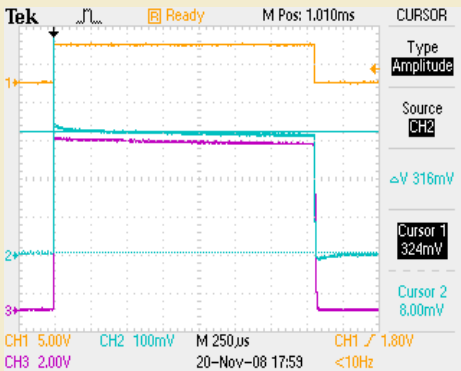
# PowerMod™

## Long Pulse Modulator Systems

### Systems in Action



**DTI Direct-Switched System.** This modular gives greater system availability and klystron reliability than traditional designs, reduces the available arc energy, and simplifies mod-anode voltage control. This system operates at peak 110 kV and 45 A, with a pulse-width of 2 ms.



**100 kV, 42 A, 2 ms Output Pulse** from the modulator pictured above into a resistive load. Scope shows command (yellow, 5V/div), current (blue, 10 A/div); and voltage (purple, 22 kV/div).

DTI's PowerMod™ long pulse modulator and transmitter systems deliver MW peak power levels at frequencies ranging from UHF to W-band. Employing direct, hybrid/transformer-coupled, and Marx-based solid-state switching topologies, PowerMod™ modulator systems offer improved performance and lifetime with:

- Fast rise and fall times
- Outstanding pulse voltage flatness and stability
- Pulse fidelity optimized for the peak power of the preferred tube
- Integrated fault detection with full, internal protection and  $\mu$ s response
- Compact size and weight
- High repeatability with low droop
- Rugged design for years of reliable operation
- Estimated system availability of 99.99%

All DTI systems are fully customizable to meet strict size, weight, and pulse fidelity specifications, with a range of options to meet risetime and droop requirements. Systems may be designed as turn-key solutions to transmitter needs, or integrated into existing equipment via upgrade kits. All systems are designed to fully address both EMI and safety concerns, and may be packaged in racks for laboratory use or in ruggedized environmental enclosures for more demanding applications.

Sample Long Pulse Modulator Systems			
Type	Direct-Switched	Hybrid/Transformer-Coupled	Solid-State Marx
Avg. Power	124 kW	290 kW	108 kW
Tube	Klystron	Klystron	Klystron
Peak Pulse Voltage	110 kV	115 kV	120 kV
Peak Pulse Current	45 A	50 A	120 A
Pulse Width	0.5 to 2 ms	3.5 ms	1.5 ms
Droop	< 5%	< 1%	< 1%
Pulse Repetition Rate	50 Hz	14 Hz	5 Hz

A wide range of specifications are available. All DTI pulse modulators are fully customizable.



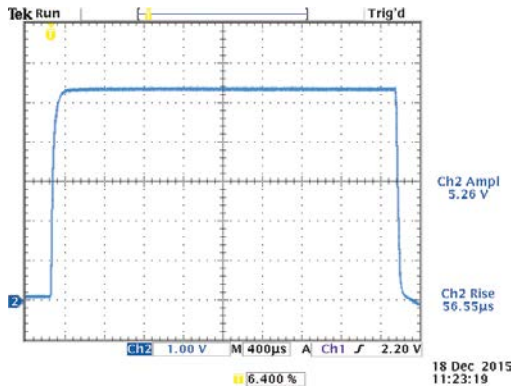
## European Spallation Source Class Modulators

In partnership with SigmaPhi Electronics (SPE) of France, DTI has delivered an advanced, high voltage solid-state modulator for European Spallation Source (ESS) class klystron tubes. This modulator uses a hybrid design (solid-state series-switch driving a pulse transformer), with an advanced regulator design to maintain a highly regulated cathode voltage as well as a constant load to the external power grid.

A capacitor bank capable of directly meeting the ESS pulse requirements would be unrealistically large and expensive. DTI's 'infinite capacitor' regulator (patent pending) operates in opposition to the variation in capacitor voltage, and produces both a flat output pulse and a constant load voltage to the DC power supply. As a result, the power supply can operate at constant current and constant power – and does not produce flicker, regardless of the switching frequency. Because the regulator sinks and sources the same energy during each pulse / charge cycle, the regulator itself is non-dissipative – it uses no net power over a cycle.



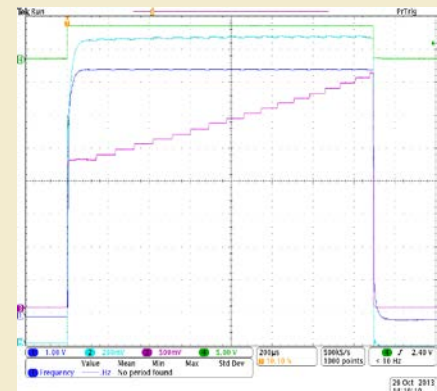
**DTI Hybrid System.** This ESS-class klystron test stand leverages a solid-state driven pulse transformers to provide a stable high voltage pulse (115 kV) over 3.5 ms.



**108 kV, 3.5 ms, 0.07% Flattop Pulse** of DTI's Hybrid System into a Thales TH2179A klystron during site acceptance testing at IN2P3, 18 December 2015.



**DTI Marx Modulator.** Twenty 6 kV "core" switch modules erect a 120 kV output pulse when placed in series. Sixteen 900 V "corrector" switch modules address droop over the 1.5 ms pulsewidth.



**120 kV, 1.5 ms Test Pulse** from modulator pictured above, showing steady voltage (blue) and staggered switching of sixteen "corrector" modules (purple) for droop control.

