



PowerMod Technology Breakthrough Brings High Availability to High Power Electronics

## **PowerMod™** AN/SPQ9A Radar Transmitter Upgrade



**This solid-state cathode modulator** assembly replaced the entire mod-anode modulator (HVPS, PFN, SCR switch, pulse transformer, test load), and crowbar circuit.



**The modulator portion of the upgrade** is built from two solid-state switch modules similar to the one shown above. The modules are linked in series to make a -12 kV, 2 A cathode modulator.

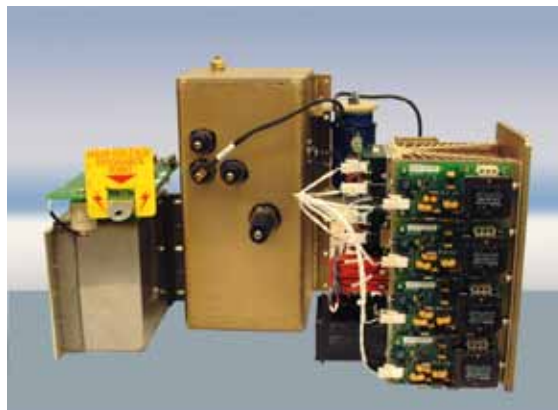
AN/SPQ-9A Kit Specifications	
Duty Cycle	6.3% maximum
Pulse Width	< 25 $\mu$ s
PRF	3 kHz
Voltage	-12 kV
Current	< 2 A

The AN/SPQ-9A is a high resolution, narrow beam X-band radar designed for air surveillance and early warning against hostile aircraft and sea-skimming, anti-ship missiles. These radar systems have been operational in the U.S. Navy fleet since 1975. After nearly thirty years of service, parts obsolescence, decreasing reliability, and increasing maintenance costs, mandated an upgrade to the radar's transmitter.

DTI's development of reliable, high power solid-state switches offered the Navy the opportunity to replace the transmitter's outdated components and greatly extend the life of the radar system. Under contract with the Naval Surface Warfare Center's Port Hueneme Division, DTI built fully MIL-Qualified AN/SPQ-9A modulator upgrade kits for on-board installation. The kit includes high voltage power supply, storage capacitor, filament supply, and solid state modulator.

The upgrade replaces the original mod-anode modulator and supporting components with solid-state cathode modulation / tube protection hardware. Replaced items include the original cathode HVPS and set point variacs, filament transformer - limiter, and the entire mod-anode modulator (HVPS, PFN, SCR switch, pulse transformer, test load), and crowbar circuit.

The innovative design confirmed that DTI's PowerMod™ solid-state switching technology could perform in compliance with system requirements, and that the radar could be pulsed successfully using a cathode-switch topology. In addition, the life expectancy of the new transmitter increased to more than 50,000 hours.



**Additional kit components.** Left: high voltage capacitor, voltage divider, and safety discharge; Center: high voltage transformer; Right: power supply and inverter. These are installed in the lower compartment of the transmitter cabinet.



The upgrade promises significant benefits for the AN/SPQ-9A installed base.

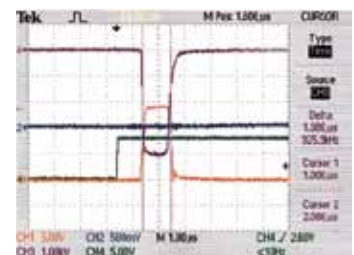
- Significant reduction in the number of TWT failures.
- Elimination of the radar's crowbar, itself a source of major problems.
- Enhanced safety of personnel. Diagnostics and test points are available without accessing the high voltage sections of the transmitter.
- TWT arcs no longer cause system downtime because transmitter operation is resumed on the next pulse.

In addition, the new solid-state modulator can operate with a damaged tube. A TWT having mod-anode arcing conditions, or excessive mod-anode leakage will perform flawlessly in systems modulated by solid-state devices. These tubes would otherwise have to be scrapped or re-built.

The new modulator interfaces with the transmitter using existing signals, and no changes to the Signal Data Processor or any of the remaining LRUs in the transmitter are required. Future modulators will be interchangeable between all systems with no adjustments or alignments required.



**AN/SPQ-9A cabinet** with the upgrade kit installed in the lower cabinet.



**AN/SPQ-9A test data** showing the response of the modulator to a fault. Acting as a "crowbar", the modulator can remove power from the TWT in less than 1  $\mu$ s.

