



PowerMod Technology Breakthrough Brings High Availability to High Power Electronics

# **PowerMod™**

## **Cobra Judy S-Band Transmitter Upgrade**

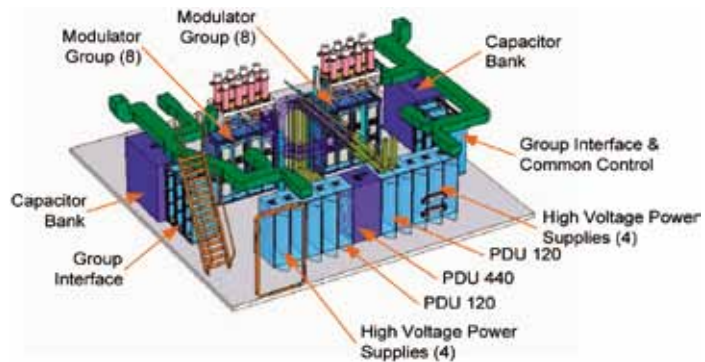


**The Cobra Judy S-Band radar** is located on the aft section of the USNS Observation Island. Working in conjunction with its sister X-Band radar, it is operated by the U.S. Air Force and deployed worldwide.

Cobra Judy S-band is a phased-array data collection radar mounted aboard the USNS Observation Island. Designed in 1976 and first made operational in 1981, the transmitter hardware became difficult to support, with some components entirely obsolete. In December 2004, DTI began the effort to modernize the transmitter by installing modern, solid-state technology. All of the transmitter's electronic systems between ship's power and the radar's sixteen Traveling Wave Tubes (TWTs), their solenoids, the solenoid power supplies and ion pump controllers, were upgraded. Installation was completed in October 2006.

One of the chief objectives of the modernization program was to replace the highest failure rate items in the existing transmitter. A new solid-state opening series switch replaced the triggered gas gapshorting crowbar, enhancing TWT protection, significantly extending operational lifetime, and simplifying the operation, maintenance, and control of the transmitter. In addition, a solid-state series regulator replaced the vacuum tetrode regulator.

Eight new 45 kV, 100+ kW switching power supplies replaced the old power supplies, induction voltage regulator, and electronic voltage regulator. The new supplies provide N+1 redundancy for the sixteen TWTs at approximately 40 kW (38 kV x 18 A x 6% duty cycle) per TWT. They are combined and controlled to insure continued group operation at full power should an individual supply fail.



**Layout of the new Cobra Judy S-Band radar transmitter.** The radar's sixteen TWTs are arranged in two groups of eight, each group having its own electronics. The new electronics for each TWT group consists of one modulator assembly for each of the eight TWTs, two Power Distribution Units (PDU), four (N+1) power supplies, a filter cabinet with solid-state and a linear voltage regulator, and a capacitor bank.



A DTI solid-state voltage regulator further modernizes the transmitter, compensating for any capacitor bank droop during the longest (600  $\mu$ s) pulse. The regulator controls the combined ripple, pulse-to-pulse stability, and droop of the TWT cathode voltage to  $\pm 10$  V ( $\pm 0.025\%$ ) for normal radar operating conditions.

Each TWT has a dedicated modulator assembly consisting of a series opening switch and gate drive, a filament supply, and a solid-state grid modulator. In contrast, the previous system shared a large grid and filament power system among all eight TWTs. Each modulator assembly also contains the isolation transformer and power supply for the cathode-referenced filament power supply and grid modulator, and the controls and monitoring interface for each TWT. The modulator assembly further provides simplified and independent diagnostics and maintenance, and minimizes the impact of any single TWT failure on the group's performance.

The entire transmitter is controlled and monitored by a multi-level system that greatly enhances transmitter fault handling and diagnostics. The first level provides fast response with a hard-wired fault detection with safety shutdowns. The second level provides supervisory automatic controls and average response fault detection with safety shutdowns using a commercial programmable logic controller. The third level enables operator control using a personal computer with a color touch screen, and offers backup hardware switches so the radar can be operated without the PC if necessary. The PC also provides data logging and trending to record performance, and extensive diagnostic information to minimize down time. Finally, a remote touch screen in the Operations Control Center (OCC) allows control of the transmitter to be transferred between the transmitter room and the OCC.

The S-band transmitter upgrade builds substantially upon a similar program DTI completed for the COBRA JUDY X-band radar transmitter and maximizes commonality of spares, support, and operation.



**CJS transmitter modulator cabinet.**

Two cabinets are used in the upgrade. Each cabinet holds eight modulator assemblies, one for each TWT in the group. One assembly is shown in the inset.

