AN/TPQ-18 Radar Transmitter

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Abstract: *Diversified Technologies, Inc. (DTI) is building a new transmitter for the U.S. Air Force (USAF) Western Range AN/TPQ-18 radar facility. This 3 MW C-Band radar transmitter energizes, controls, and protects a CPI VKC- 8313A (5.4 GHz to 5.9 GHz) Extended Interaction Klystron (EIK).*

Keywords: klystron; transmitter; radar; modulator; solid-state; microwave

Introduction

Diversified Technologies, Inc. (DTI) is building a new transmitter for the U.S. Air Force (USAF) Western Range AN/TPQ-18 radar facility. This 3 MW C-Band radar transmitter (Figure 1) energizes, controls, and protects a CPI VKC- 8313A (5.4 GHz to 5.9 GHz) Extended Interaction Klystron (EIK). RF output is to a space-fed Cassegrainian antenna.

At the system core is a modulator which uses a DTI advanced solid-state switch to drive a pulse transformer providing 135 kV pulsing capability. The system includes a DTI high voltage power supply (HVPS), high power RF driver amplifier, custom output waveguide, and control consoles. Figure 2 shows a simplified transmitter system block diagram.

The transmitter is designed to energize the klystron tube within the parameters detailed in Table 1.

Table 1. Transmitter Specifications

Specification	Parameter
Frequency	5.4-5.9 GHz
Peak Power Range	1 watt to 3 megawatts
RF Duty Factor	0.40% maximum
Pulse Width Range	0.5 to 25 µS
Pulse Repetition Frequency	1280 Hz maximum
Attenuation	65 dBm max. @ 0.5 dB increments
S/N Ratio	39 dB min
Output VSWR	≤1.40:1

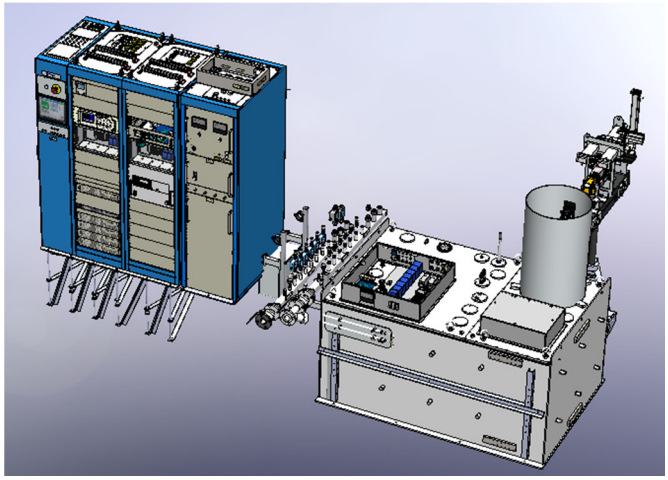

Figure 1. C-Band radar transmitter with modulator, klystron tube, RF driver amplifier, waveguide, cooling manifold, HVPS, and control consoles.

System Power

A 19" rack houses power supplies for the klystron filament heater, pulse transformer core reset, solenoids, and ion pump.

The cathode power is provided by a HVPS is a 40 kV, 100 kW switching power supply assembly. The HVPS high voltage output is supplied to the modulator capacitor. This high stability/low noise unit operates from a 480 VAC, 60 Hz three-phase input.

The HVPS uses an advanced PWM inverter to provide voltage and current regulation over the full output range. Nominal output behavior is 0.1% ripple and voltage regulation, with fast response to transients. Internal filter components reduce the line disturbance to modest levels. The high voltage section is built into a small tank filled with transformer oil. A heavy-duty high voltage cable connects the power supply to the modulator. A front panel provides local controls, indicators, and voltage/current limits for the collector HVPS.

RF Rack

The RF rack houses the Microwave Control Unit (MCU), RF drive amplifier, and I/O components. The MCU handles RF faults and communicates with the Klystron Control board for pulse timing and fault interlock initiation.

Output Waveguide

Klystron RF output is fed to a WR187 waveguide composed of heavy walled copper which is pressurized with Sulfur Hexafluoride (SF6) gas to 30 psig (nominal) to prevent arcing. The waveguide includes an optical arc detector, directional couplers for signal monitoring, isolator for protection from reflected antenna power, and a switch which allows full power testing into a dummy load.

System Controls

The control cabinet houses the main system controls and interface, as well as most of the power distribution. The cabinet is divided into separate compartments to accommodate AC power distribution, low voltage DC utility distribution, and a controls section which includes the Klystron Control board and the Programmable Logic Controller (PLC) for system sequencing and other functions. The cabinet front panel provides an E-Stop button, touchscreen, and BNC monitor panel which allows convenient monitoring of buffered signals from the control board.

Summary

Construction and factory acceptance testing are planned to be completed early 2020, with installation and acceptance testing at Vandenberg AFB scheduled for mid-2020 to accommodate range operations. This design is applicable to a number of other range instrumentation radars operated by the USAF and US Navy.

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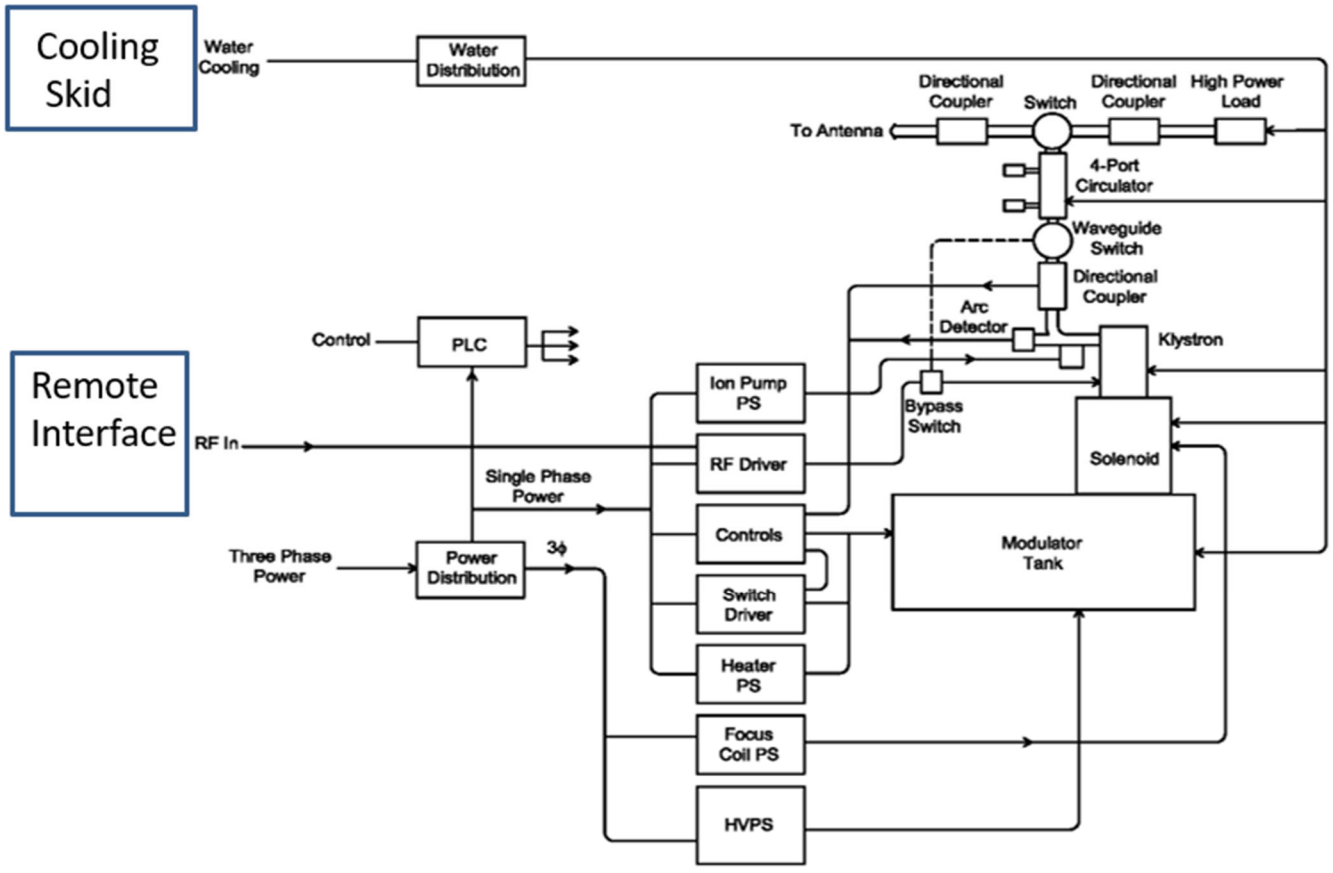

Figure 2. Simplified Transmitter System Block Diagram.