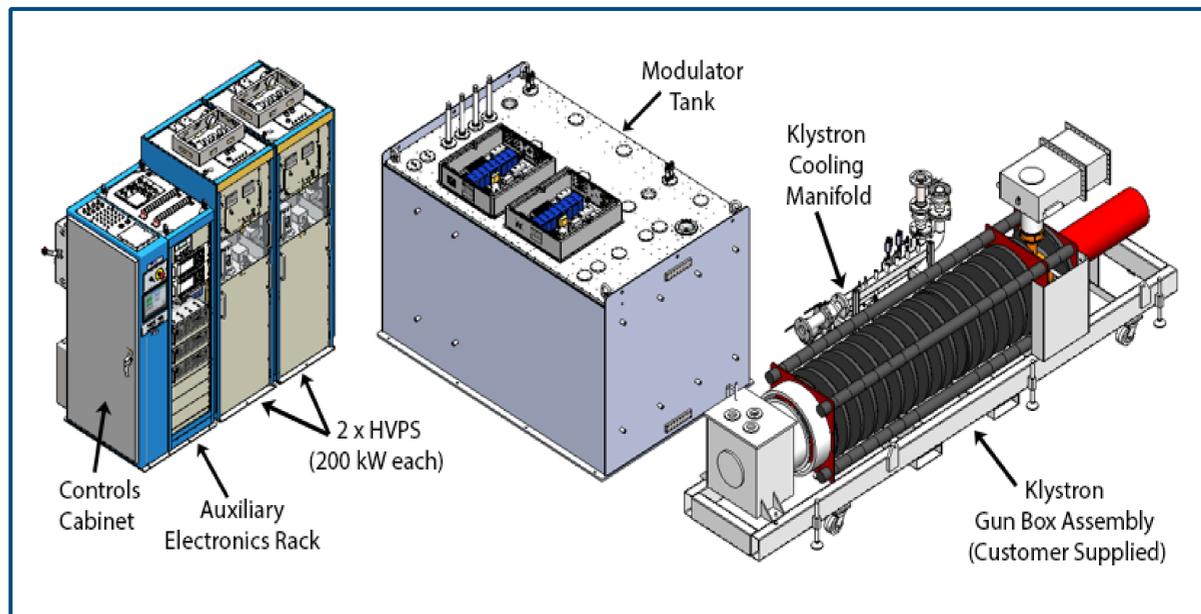


High Stability Klystron Modulator for Commercial Accelerator Application

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OVERVIEW

Diversified Technologies, Inc. (DTI) designed and developed a high stability modulator system for a commercial linear accelerator application. The DTI modulator delivers significant advantages in klystron performance through highly reliable functionality as well as flicker- and droop-free operation from 50-500 μ s up to 400 Hz (duty limited). Two HVPS provide stable and accurate DC voltage which is used to drive a CPI VKP-8352C UHF-band pulsed klystron for the linear accelerator. Operating with four HVPS, the DTI modulator is able to provide a maximum average power of ~750 kW at 105 kV, 47 A nominal. In 2021 DTI completed a Factory Acceptance Test for two klystron modulator systems. DTI's customer expects to be fielding these systems in 2022.



SPECIFICATIONS

Each modulator system includes two high voltage power supplies, oil-filled modular tank, controls, cabinet, auxiliary electronics rack, and cooling manifold.

- Two switching power supplies providing stable and accurate DC voltage
- Design, Build and Test Two Klystron Modulator Systems for a Commercial Linear Accelerator Application
- Each modulator to drive a CPI VKP-8352C UHF-band pulsed klystron
- High Reliability and Stability
- Flicker and Droop Free Operation from 50-500 μ s up to 400 Hz
- High Pulse Fidelity and Flexibility
- Upgradeable Power
- Full Control and Monitoring

| Specification | Parameter |
|---------------------------|--|
| Voltage | 105 kV |
| Current | 47 A |
| Flat-Top Pulse Width | 50-500 μ s |
| Pulse Frequency | 1-400 Hz (within average power) |
| Flat-Top Ripple and Droop | <0.5% |
| Average DC Power | <320 kW (2x HVPS) <759 kW (4x HVPS) |



CONTROL CABINET

- Main System Controls (PLC / Control Boards)
- E-Stop, Touchscreen, BNCs
- Power Distribution for:
 - AC Power Distribution
 - Low Voltage DC
 - Utility

AUXILIARY ELECTRONICS RACK

- I/O Assembly
- Two Solenoid PS
- Vac-Ion PS
- Klystron Gun Solenoid PS

HIGH VOLTAGE POWER SUPPLIES

- Standard DTI High Voltage Power Supply (HVPS) Design
- Over 100 Delivered to Date
- 0.1% Voltage Ripple and Regulation
- Fast Response To Transients
- 480 Volt 3-phase
- Water-cooled
- 7 ft 8 in tall
- PWM Inverter
- System will operate with one to four HVPS
- Each are rated at 110 kV, 200 kW Nominal
- Two HVPS means 320 kW avg. DC Power
- Four HVPS means 750 kW avg. DC Power (operating at 13.6% duty).

MODULATOR TANK

- Tank is submerged in oil and is 8'10" L x 5'8" D x 6'7"H
- HV switch acts as a modulator
- Controls pulses to the klystron
- Provides circuit protection in the case of an arc
- Series connected IGBT modules, and operates at full cathode voltage
- System is built with redundancy - 1/3 of devices can fail
- Capacitor Bank
 - 10 μ F, 120 kV
 - Provides < 0.5% droop at up to 500 μ s pulses
- HV Controls
 - On top of Tank
 - Provides drive supply to modulator switches
- HV Dump Relay
 - Discharges the energy stored in cap bank to 50 V in less than 1 second
- Isolation Transformer
 - 240 VAC to 240 VDC to feed the Filament PS
- Filament PS (Hot Box)
 - On top of Tank
 - Delivers DC power to the klystron tube filament at 35 V and 35 A
- Pulse Shaping Circuitry