Specifications
for
State Modulator for Amplifier Research & Testing (SMART)

The Solid State Modulator for Amplifier Research & Testing (SMART) is a highly-configurable laboratory high voltage modulator for use in millimeter-wave and sub-millimeter-wave amplifier development projects. To support a wide variety of applications and electron gun configurations, the modulator will support cathode voltages up to 35 kV with peak and average beam powers of 210 kW and 21 kW (10% duty), respectively. Modulation options will include cathode-pulsing as well as mod-anode pulsing with pulse widths ranging from 10 to 200 microseconds and pulse repetition rates up to 10 kHz. The modulator will provide an isolated filament supply to power a cathode heater. A unique feature of the SMART system will be the provision of four adjustable voltage taps to provide tailored electrostatic focusing for advanced spatially-distributed electron beam gun designs. The optional depressed collector supplies would enable development of techniques for efficiency optimization.

Base System

1. The Base System will consist of the following:

- a 25 kW, -35 kV DC power supply;
- a 35 kV, 10 A solid state modulator capable of switching at up to 1 kHz;
- a mod-anode modulator capable of operating at up to -7 kV to +2.5 kV with respect to the cathode potential at up to 10 kHz;
- a focus electrode supply, providing 4 taps between 0 and – 5 kV with respect to ground.
- a DC filament supply providing up to 25 V at 20 A, cathode referenced;
- a control system that provides independently controllable inputs for pulse enable and pulse commands for both the cathode and the mod-anode modulators (TTL or fiber optic), as well as manually adjustable cathode, filament, and mod-anode voltages;
- Outputs for ready / fault and BNC connections for monitoring pulse voltage and current; and
- a fault control unit, coordinating the system response from internally detected or externally supplied fault signals.

At a minimum, the base system will provide the following performance:

1.	Cathode voltage:	-35 to 0 kV, continuously variable
2.	Voltage regulation (dc):	0.1%
3.	Intra-pulse voltage droop:	<2% (at 35 kV, 6A and 200 μs pulse length)
4.	Pulsed cathode current:	6 A
5.	Average (CW) current (max):	600 mA
6.	Maximum duty:	10%

7. Pulse repetition frequency:	single shot to 10 kHz (adjustable, mod-anode pulsed), single shot to 1 kHz (adjustable, cathode-pulsed)
8. Pulse duration:	10 μsec minimum 200 μsec maximum (consistent with 10% duty) CW at full duty with mod-anode
9. Pulse rise and fall time (10-90%)	500 nsec max, 300 nsec goal, anode pulsed 1 μsec max, 500 nsec goal, cathode pulsed
10. Heater filament voltage (DC):	0 to -25 V with respect to cathode potential
11. Heater filament current:	20 A (maximum)
12. Mod-anode "beam off" voltage:	up to -7 kV with respect to cathode potential (adjustable)
13. Mod-anode "beam on" voltage:	0 to +2500 V with respect to cathode potential (adjustable)
14. Additional electrostatic focus electrode voltages (4 taps):	0 to -5 kV (each) with respect to GROUND (adjustable)

Control and Indicator Panel: All adjustable parameters must be controllable from the panel and the present settings indicated: cathode voltage; anode voltage; filament voltage and current; cathode modulator pulse duration and repetition rate; anode modulator voltage; repetition rate; and electrostatic focus electrode voltages.

Modulator Lights: Separate indicator lights for Standby/Ready, On, Fault, and Interlock Status.

Standby/Ready Mode: In Standby/Ready mode, only the filament voltage can be applied.

Crowbar: Mechanical short is applied through series resistor on system off to dump stored high voltage. Cathode modulator switch will open on short-circuit fault to ground with maximum response time of 10 μsec.

Prime power: 480V, 3-phase, 60 Hz, vendor to incorporate any required filtering in system. The power feed is to enter from the top of unit.

Cathode Switch: Solid-state.

Mod-anode Switch: Solid-state.

Vac-Ion Pump: The system will be configured with a floating deck to accept a vac-ion controller.

Isolation: Fiber optic cabling will be used to isolate high voltage components from control ground.

External Interlock Connections: Provide for 24-volt relay inputs (eight minimum).

Cooling: Chilled water (10° C, 50°F at > 5 gpm) will be provided in the laboratory. If de-ionized water is required, vendor should include a suitable de-ionizer and heat exchanger with the system.

Cabinets: Maximum size of any individual cabinet/container is 72 inches (L) x 45 inches (W) x 84 inches (H).

Maintainability: Schematic diagrams with notation corresponding to "as fabricated" circuit labeling, layout, test points, etc. must be provided.

Safety: Interlocks must be provided on all cabinet doors providing access to high voltage components, and provision for user-installed external interlocks must be incorporated in the system.

Operability Tests: Initial acceptance testing, witnessed by NRL personnel, will be performed at vendor location prior to shipment. Testing into a resistive load will demonstrate full range of performance. At least 4 hours of operation at full voltage is required. Final acceptance testing will be performed at NRL after installation.

In addition to the Base System as described by the preceding specifications, the following Options are to be separately quoted:

2. OPTION 001: Computer interface to the system to enable parameter adjustment and system readouts from a remote computer.

3. OPTION 002: Vac-ion controller floating at cathode potential as an integral part of the system.

4. OPTION 003: Inclusion of a single depressed collector supply (0 to -15 kV with respect to ground).

5. OPTION 004: Inclusion of two (2) independent depressed collector supplies (0 to -15 kV and 0 to -10 kV with respect to ground)

Quoted price will include packaging and shipping to NRL, 4555 Overlook Ave., SW, Washington, DC 20375.