

SECTION-C

TENDER NO. IPR/TN/PUR/TPT/ET/20-21/3 DATED 8/6/2020

Technical Specifications

1. Maximum Output Voltage : 20 kV (Negative Polarity)
2. Output Voltage Range : 0 to – 20 kV (variable)
3. Peak Current : 1 Amp
4. Input : 3 phase, 415 V AC, 50 Hz
5. Preferred Type : Solid state modulator type
6. Mode of Operation : Pulsed (**negative** with reference to the ground)
7. Maximum overshoot or undershoot : $\pm 2\%$ of set voltage
8. Peak Power : 20 kW (Peak power)
9. Average Power : 3 kW (for pulse at 20kV,1A, 1kHz for duration 150 μ s)
10. Pulse repetition Frequency : 100 – 1000 Hz
11. Pulse Duration : 25 μ S to 150 μ S
12. Pulse Duration tolerance : $\pm 10\%$
13. Pulse rise time : 5 μ S $\pm 10\%$
14. Pulse fall time : 10 μ S $\pm 10\%$
15. Voltage ripple (peak to peak) : $\leq 1\%$ of the set voltage
16. Line regulation : $\leq 1\%$ of the set voltage
17. Load regulation : $\leq 1\%$ of full scale (i.e. ≤ 200 V for 0 to 1A load current)
18. Protections : Following protections shall be provided
 - a) Over current, (to trip)
 - b) Over voltage, (to trip)
 - c) Over temperature (to trip)
 - d) short-circuit (to trip)
19. Control through HMI : Control shall be provided by microcontroller or PLC based HMI
 - a) voltage setting (with a resolution of 100V)
 - b) frequency setting (with a resolution of 10 Hz or better)
 - c) pulse duration setting(with resolution of 5 μ S or better)
20. Monitoring : Real time voltage and current monitoring signals should be provided. The signal is preferable to be from 0 to 10 V or from 0 to 5 V. Suitable terminals or BNC connectors should be provided to capture these signals using an oscilloscope
21. Continuous operation : The power supply should be able to operate continuously for at least 5 hours at maximum rating
22. Output cable type : Co-axial type OR individual high voltage cables
23. Output cable length : ≥ 3 m
24. Power supply output terminals : Co-axial HV connector
OR
Following terminals to be provided
 - a) Negative HV (for HV cable core connection)

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- b) Ground (for HV cable shield connection)
- c) Power supply Body ground (for safety ground connection)

Note: Power supply body, output ground terminal can be electrically connected within power supply

- 25. Cable load end terminations : cable ends suitable for Corona free connections.
- 26. Warranty : Minimum 1 year on-site warranty from the date of acceptance of Power Supply.
- 27. Manuals : User manual must be provided with the power supply
- 28. Size of the power supply : It is preferable to fit into a standard 19" rack.

Note: The detailed schematic including topology and control of the power supply must be attached with the quotation.

The required load bank, for testing the power supply – during Factory Acceptance Tests (FAT) at vendor's premises – should be arranged by the vendor.

Factory Acceptance Tests (FAT)

Power supply will be subjected to the following tests at the vendor's factory site, in the presence of IPR's representatives:

1. Performance of the power supply should be demonstrated using a suitable resistive load. This consists, demonstration of the power supply operating at...
 - a) three different frequencies viz. 100, 500, and 1000 Hz for one hour each at peak voltage
 - b) 20 kV, 1 A and 1000 Hz for at least 5 hours, with 150 microseconds on time
 - c) Pulse rise time (10% to 90% set value) and fall time (90% to 10% set value) should be demonstrated at, for example, 20 kV, 1 Amp, 1000 Hz, and 25 μ s on time.
(The necessary load-bank and other accessories for the test have to be arranged by the vendor)
2. Maximum overshoot and undershoot values of voltage will be tested randomly at different applied voltages for ex. at 1 kV, 5 kV, 10 kV, 15 kV and 20 kV. It must be within limits of $\pm 2\%$ of the set voltage value.
3. Ability to set the required output voltage (with 100 V resolution), pulse repetition frequency (with a resolution of 10 Hz), and pulse duration (with a resolution of 5 μ s) should be demonstrated.
4. It should be demonstrated that the voltage ripple is $\leq 1\%$ of the set output voltage. For example at 1 kV, 5 kV, 10 kV, 15 kV, 20 kV; the peak to peak ripple should be ≤ 10 V, ≤ 50 V, ≤ 100 V, ≤ 150 V, ≤ 200 V respectively.
5. It should be demonstrated that the line regulation is as per our requirement. For example with a $\pm 10\%$ of variation in the input voltage, the variation in the output voltage should be ≤ 10 V, ≤ 50 V, ≤ 100 V, ≤ 150 V, ≤ 200 V for a set output voltage of 1 kV, 5 kV, 10 kV, 15 kV, 20 kV respectively.
6. It should be demonstrated that the load regulation is as per our requirement. At any set parameters (like output voltage, pulse duration, pulse repetition frequency), the voltage pulse

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without load, and with dummy resistive load should be demonstrated. For example with a set output voltage of 20 kV (with a pulse duration of 150 μ S, and at a pulse repetition frequency of 1000Hz), at different resistive loads of 20 k Ω , 40 k Ω , 60 k Ω , 80 k Ω , it should be demonstrated that the variation in the output voltage with and without load should be within limits i.e. ≤ 200 V only.

7. All the protections i.e. for over current, over voltage, over temperature, and short-circuit should be demonstrated by actual/ simulated fault condition.
8. Monitoring of the real time voltage and current pulse should be demonstrated (Necessary additional instruments for the test shall be arranged by the vendor).
9. Recording of real time voltage and current pulse, with pulse repetition frequency, pulse duration etc. shall be demonstrated (Necessary additional instruments like oscilloscope etc. for the test shall be arranged by the vendor).
10. Calibration between 'the signals used for real time monitoring of voltage and current' and 'the actual high voltage and actual current measured using a mechanism external to the power supply' should be demonstrated.

For example: Voltage monitoring signal of power supply should be displayed on one channel of oscilloscope. And it should be compared with the actual high voltage measured by a high voltage probe connected to another channel of the oscilloscope. Similarly current monitoring signal of the power supply should be compared with actual current measured with a suitable pulse current transformer on output cable connected external to the power supply.

11. FAT must be carried out in the presence of IPR representatives. FAT reports to be submitted to IPR.
12. Dispatch clearance would be issued by IPR, after scrutiny of FAT test reports. Power supply to be dispatched only after receiving the Dispatch clearance.

Site Acceptance Tests (SAT)

Power supply will be subjected to the following tests at FCIPT campus, IPR:

1. Vendor must successfully complete the installation of the power supply
2. Performance of the power supply should be demonstrated using a suitable resistive load. This consists demonstration of the power supply operating at...
 - a) three different frequencies viz. 100, 500, and 1000 Hz for one hour each at peak voltage
 - b) 20 kV, 1 A and 1000 Hz for at least 5 hours, with 150 microseconds on time
 - c) Pulse rise time and fall time should be demonstrated at 20 kV, 1 Amp, and 150 microseconds on time.

(The necessary resistive load-bank for the test has to be arranged by the vendor. The load-bank can be taken back after the site acceptance)
3. All other parameters of the power supply, as mentioned in the tender documents, will be tested
4. Vendor's representative must be present at site (FCIPT, IPR), throughout all these tests.