



University of Calcutta
Dept. of Applied Physics, UCSTA
92 APC Road, Kolkata 700009

Tender Notice

Enq No.: AP/UGC-SAP-DRs-II/JNB/ENQ/18-19/07

Date: 20/12/2018

Dear Sir/Madam

All the Authorized Suppliers are invited to submit Quotation/Tender by sealed envelope at the office of the Department of Applied Physics for the item mentioned overleaf. Please enclose the copy of the following papers along with the quotation. The last date of submission of quotation is **31/12/2018**. However you quote your price items as overleaf according to the CU rules and following terms & conditions.

- I. The vendor or their authorized representative must be a Company or have an office registered under the Indian Companies Act, having GST Registration, PAN card, PF & ESI Registration and associated statutory Clearances along with all of the following credential:
- II. The bidder must have more than five years of prior and proven experience of successfully installation, commissioning and interfacing of 4-quadrant Power Amplifier(s) and other power system components suitable for PHIL Testing in any Government Institution or PSU or Government organization.
- III. The bidder must have the Office and Service Centre with valid GST Registration in any State of India. Service center should be equipped with competent technical persons. (Necessary Documentation proof along with list of name and designation of service personnel shall be provided).
- IV. All applicable taxes and others incidental charges as well as premiums for insurance against all kind of risks, if applicable, must be mentioned and are to be included in the quoted amount.
- V. The manufacturer must have to submit valid copy of manufacturing certificate(s) or any Sole/only authorized distributors must have to submit valid copy of certificates with signed & seal by appropriate authority along with quotation.
- VI. The vendor must have supplied such amplifiers for PHIL simulation with RTDS in India for at least two academic institutes.
- VII. No joint ventures shall be allowed.

Please enclose the copy of the above papers along with the quotation. The particulars of the items to be supplied are as follows

PARTICULARS.	QUANTITY.
I. Supply of 4-quadrant Power Amplifier(s) compatible with RTDS simulator suitable for PHIL Testing.	2
II. Transportation of 4-quadrant Power Amplifier(s) up to the Netaji Subhas Chandra Bose International Airport at Kolkata, India.	
II. Installation and Commissioning of 4-quadrant Power Amplifier(s) and demonstration of its working with RTDS simulator	
V. At least one-day training to the people provided by us at the Department of Applied Physics, University of Calcutta, 92 APC Road, Kolkata-700009 to demonstrate connecting it to the RTDS and its operation.	

A. TECHNICAL SPECIFICATION

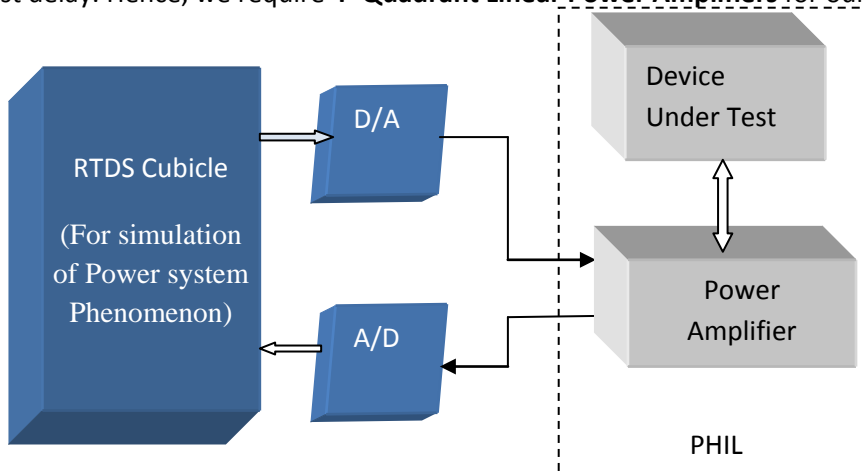
1.0 Title of the Work

Supply of 4-quadrant Power Amplifier(s) compatible with Real Time Digital Simulator (RTDS)

2.0 Outline of the Scheme of the work:

Calcutta University is going to set up a power hardware in the loop (PHIL) testing facility for studying power system components using Real-Time Digital Simulator (RTDS). One of the essential components for this experiment is a power amplifier. We want to have a very flexible test facility that allows us to perform a variety of PHIL experiments where power hardware Device Under Test (DUT) can either be a power generator (for example, PV, Fuel Cell, a battery discharging in to the grid) or a load such as a battery being charged from the grid including electric vehicle load or a power electronic drive. If the DUT is a power generator, the amplifier should be able to sink the power from the DUT and if the DUT is a load, the amplifier should be able to source the power required by the load. The amplifier should also be able to dynamically straddle between these modes (such as a battery transitioning from charging to discharging mode), the amplifier should be a full **4-quadrant power amplifier**.

Calcutta University also wants the PHIL setup to be a closed loop PHIL setup as depicted in the schematic diagram below. In a closed loop PHIL, loop delay has a significant impact on the stability of the experiment. In real power system, there is no delay in the power interface between the DUT and the grid to which it is connected. To approach the real system conditions in the simulated setup, we need to reduce the delays introduced by Input/Output interface as well as the delay introduced by the amplifier response-time. There are two categories of power amplifiers used in the power hardware testing – switched mode and linear. Linear amplifier provides the fastest response and least delay. Hence, we require **4- Quadrant Linear Power Amplifiers** for our experiments.



Some of the technical specifications that are unique to amplifiers and essential for our PHIL experiments are:

1. Very fast slew rate $> 52\text{V}/\mu\text{s}$ (rise time $< 5\mu\text{s}$ at 230Vrms)
2. Extremely low harmonic distortion - even under very non-linear load conditions
3. Operates from DC up to 10kHz large signal bandwidth (-3dB)

4. Optional up to 30kHz and a small signal bandwidth up to 50kHz or 100kHz
5. High long-term overload characteristic (up to 1-hour)
6. High short-term overload characteristic (for 5 ... 10mins.)
7. Very low internal resistance

Item	Description	Qty.
1	2500W 4-Quadrant Linear Power Amplifier (see specification below)	2
2	4000W matching resistive load (see specification below)	1

Specification:

Item 1: Power Amplifier

Specification Parameter	Value
Type	Four-Quadrant Linear Power Amplifier
Application	Power hardware in the loop (PHIL) simulation with Real-Time Digital Simulator
Output AC Power	– continuous: 2500VA – 1 hour: 3750VA
Output DC Power	– continuous: 2500VA – 1 hour: 3750VA
Output Short-time Power	5000VA
Output Peak Power	– at 135V: 10500VAp – at 270V: 21000VAp
Digital Instrument Measuring Ranges	Voltage Range: 300V Current Range: 40A
Accuracy Voltage Max./Typical	DC; 45Hz-450Hz: 0.5%/0.2% 15Hz-45Hz; 450-5kHz: 1.0%/0.4%
Accuracy Current Max./Typical	DC; 45Hz-450Hz: 0.8%/0.4% 15Hz-45Hz; 450-5kHz: 1.6%/0.8%
Input signal	Analog: ±10V analog signal Built-in onboard: Yes, programmable
Output Measurement Signal Range	±10V analog signal
Input Power Supply (±10%, 50Hz)	230V
Protection:	48A
Harmonic Distortion	Should be extremely low
Internal resistance	Should be very low
Output Slew Rate	52V/μs or more
Output Rise Time	5 μs at 230Vrms or less
Large Signal Bandwidth	DC-5kHz (-3dB)
Small Signal Bandwidth	Up to 50kHz
Normal overload characteristics	Up to 1 hour at minimum 150%
Short term overload characteristics	Up to 10 minutes at minimum 200%
Peak overload characteristics	Up to 5ms at minimum 800% at max voltage range
Cooling	Air cooled

Item 2: Resistive Load

- Air cooled

- The load should be of matching characteristics to work with the amplifier in parallel with Device Under Test (DUT). The purposed of the R-Load is to increase the sink capacity of the power amplifier when a DUT connected to the amplifier generates power such as Solar PV converter or battery storage system.

Warranty:

The manufacturer should warrant the supplied amplifier(s) for 2 years.

For
Professor Jitendra Nath Bera
Dept of Applied Physics
University of Calcutta