

PMSG Wind Turbine Emulator (Model: XPO- DFIG1)



Salient Features

- 3HP power ratings
- The 3 phase Permanent Magnet Synchronous Generator acts as DFIG coupled to 3 phase Induction motor simulating variable speed wind power (F1) with electronic torque & speed sensors mounted to determine wind power input accurately.
- Manual synchronization with grid provided using 3 lamp method & synchroscope.
- Variable frequency & variable amplitude VFD provided to supply rotor winding of DFIG (F2).
- 16X2 LCD is provided to observe VFD frequency
- Multifunction Measurement AC analysers (MMM) read the rotor input voltage /power and stator voltage /power & frequency.
- Experiments with ON grid & OFF grid measurements to verify $F1 \pm F2$ algebraic addition of shaft frequency & VFD frequency to match supply grid frequency.
- Facilitates easy and safe wiring by students due to use of 4mm sturdy Shrouded banana patch cords and shrouded socket arrangements for high voltage circuits
- Each panel has ABS molded plastic sturdy enclosure, and colorful screw less overlays showing circuits diagrams & its connection tag numbers for easy understanding and connection
- Set of Instructor Guide & Student Workbook.

Technical Specifications

■ Input 3 phase DOL Starter panel (EMT1) X 1 No.

- 4 pole MCB of 415V/4A.
- DOL 16A Contactor with 24DCV / 11VA COIL
- Settable thermal O/L relay with range 1.4A (2.4A)
- RYB inputs indicators.
- Manual start / stop with local trip contact
- Power ON LED indicator

■ Instrumentation power supply cum multichannel DPM panel (EMT 8) X 1 No.

- Power supply +12V, -12V, 500 mA, +5V/300mA
- Unregulated 17VDC /750 mA
- line synchronizing signal.
- Multi channel DPM for digital display of torque & speed.

■ Variable AC and DC supply panel (EMT 23) X 3 Nos.

- Input 0-230VAC, 50Hz
- Variable O/P AC: 0-270V/3A (6A)
- Variable O/P DC: 0-250V/3A (6A)

■ 3 Phase Bidirectional Power cum Energy meter panel (EMT 34) X 3 Nos.

- Bidirectional Multifunction
- 3 phase 3/4 wire, 415VAC, CT Input 5A
- LCD/LED display, Aux. supply 230V, 45-65Hz, 5W
- Measure V, I, Hz, Pf, KVA, KW, KWH
- Optionally modbus RTU RS 485 for RTU/SCADA interface.

■ Synchronization Panel (EMT26A/B) X 1 No.

- Consisting of synchronization digital meter (Synchroscope)
- Manual Synchronization switch.
- 15W lamps X 6 nos.
- Manual start / stop with local trip contact

■ 8 nos of IGBT Power ckt & sensing panel (PE7A-L/R) 1 No

- 1200V/40A IGBT with opto isolated (LV) TTL compatible driver circuit & individual heat sink with built in isolated DC power supply for gate drive - 8 nos.
- 2 nos of push buttons to increment/decrement frequency
- Forced air cooling fans 2 nos
- 1000µf/250V electrolytic capacitor paralleled with 2.2µf/400V film capacitor for DC smoothening & to dampen surge
- Test points are provided to observe gate signals

■ FPGA based controller panel (XPO-EST) FPGA-II (XC3S400) X 1 No.

- 16MHz crystal operated multi-output clock source to operate various resources on Mother Board like CPU, Baud rate, T/C etc.
- 6 LV TTL gate drive outputs to and 6 status feedback inputs from 6 nos IGBT power modules through 26 pin FRC cable.
- 16X2 LCD display to observe VFD frequency
- 8 nos of LEDs to indicate IGBT faults

■ LC filter panel (EMT74A/B) X 1 No.

- Inductors (0.15H-2.5/5A) X 3 nos.
- Capacitors (100µf/440Vac) X 3 nos.

■ List of experiments:

- 1) To verify $F1 \pm F2$ algebraic addition of delta connected stator of DFIG.
- 2) To verify $F1 \pm F2$ algebraic addition of star connected stator of DFIG.
- 3) To calculate the efficiency of DFIG (delta stator) setup when connected ON grid by manual Synchronization of DFIG with grid supply.
- 4) To calculate the efficiency of DFIG (star stator) setup when connected ON grid by manual Synchronization of DFIG with grid supply.
- 5) To study DFIG (delta stator) power sharing between grid & load when grid tied.
- 6) To study DFIG (star stator) power sharing between grid & load when grid tied.
- 7) To study active and reactive power control of DFIG (Delta stator) when grid tied.
- 8) To study active and reactive power control of DFIG (Delta stator) when grid tied.

■ Setup parameters

SN	Parameters	XPO-PET/DFIG (3HP Setup)
1	3 phase Indication motor	Rating 3HP 3- Phase, 415V, 50Hz, 4 Pole coupled with PMS Generator
2	3Phase Permanent Magnet Synchronous Generator	Rating 3HP 3 Phase, 360–400V

Note: We can commit MATLAB compatibility which means mostly, NI-PXI also compatibility, OPAL-RT we are not sure but you may extrapolate to conclude.

■ Single phase supply panel (EMT16A) (3HP) X 1 No.

- Single phase MCBs of 4A/20A 1each
- Lamp load

■ Resistor Load panel (EMT42A) (3HP) 1 No.

- 3 nos of 600W resistors with switch selectable 6 nos of taps at 100, 112, 150, 175, 200, 225Ω & 265Ω fix

1st Motor Controller

- Input: 3Phase, 415 V, 50 Hz
- Output: suitable for driving 3Phase Induction motor
- Grid side inverter is configured as vector control based Active front end converter
- Motor side inverter is suitable for 4 Quadrant operation & control is closed loop programmable

2nd Motor Controller

- Input: 3Phase, 415 V, 50 Hz
- Output: suitable for driving 3Phase Permanent magnet synchronous generator
- Grid side inverter is configured as vector control based active front end converter (FEC)
- Motor side inverter is suitable for 4 Quadrant operation & control is closed loop vector control

System details:

- One of the machine is programmed as motor & the other will be programmed as a generator.
- Controller connected to the motor draws power from the Grid & the controller connected to the generator feeds the power to the Grid
- Current/ Output voltage/ PWM pulses are isolated & the same are available for viewing purpose
- Necessary grid side filters, protection switchgear are part of the system
- Machines are coupled on a suitable base plate. Suitable encoders are fixed on the machine.
- Induction motor is of dynamo meter type & having necessary torque measurement equipment