# ELECTRICAL MACHINE TRAINER (Model : XPO-EMT)

## SALIENT FEATURES

- Facilitates easy and safe wiring by students due to use of 4mm sturdy **Shrouded** banana patch cords and shrouded socket arrangements.
- All machines are mounted on finely painted sturdy base frame with easy machine **interchangeability**.
- Use of gear coupling facilitates **screwless coupling**.
- With due emphasis on student safety machines operate upto **300W power** levels and upto 1500 RPM, without compromising on didactic use. Able to draw all graphs. Contact factory for **3 HP EMT Trainer**.
- Trunnion mounted DC Integrated machine is used as **Dynamometer** for loading other machines (Motors / generators both); unlike magnetic powder brake or eddy current brake which can load only coupled Motors and **not generators**, with facility to measure shaft power using electronic torque / speed measurement
- PC interface should be provided.

**Recommendation :** Order 8 sets each containing one Dynamometer type DC m/c per aluminum Rack with 17 (14+3) panels each (such 8 sets) & one each of following m/c to complete the 8 sets.

## Technical Specifications

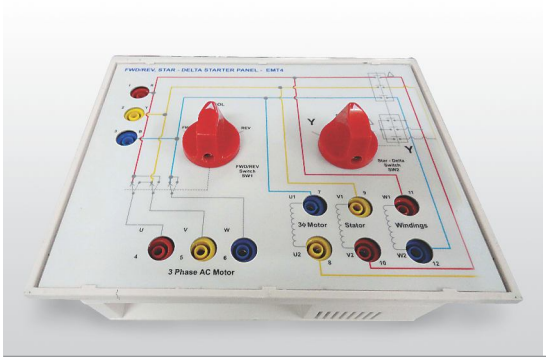
**A] Aluminum profile sturdy Modular flat panel (table top) system, carrying various high voltage components housed in plastic enclosures (panel) to minimise shock possibility.**

- **Mechanical Dimension(mm):** 1170 (L) x 300(W) x 990(H) ● **Net Weight :** 65 Kg. ● **Gross Weight :** 73 Kg
- **Accessories:** 1) Patch Cord Set 2) 20E/200W Rheostat
- **Optional Accessories:**
  1) Hand held non contact Digital tachometer
  2) EMT-34 bidirectional power meter & analyser with RS232C /RS485
  3) 3 Phase / 3 Amp. Variac / Dimmer

- **Input 3 phase DOL Starter panel (EMT1)** [10 Shrouded Banana]
  - 4 pole MCB of 415 V/4A .
  - DOL 9A Contactor with 230V / 50 Hz / 11VA COIL .
  - Bimetallic thermal O/L relay with range 1.4A - 2.3A .

- **Integrated (1 Ph.) measurement panel (EMT 20F)** [8 shrouded Banana]
  - Multifunction.
  - 0 to 300VAC, CT 1A/5A
  - LCD/LED Display, Aux supply 230VAC 45-65Hz, 5W.
  - V,A., Hz, PF, KW, KVA, KVAr, Energy.
  - 1A/5A current selector switch

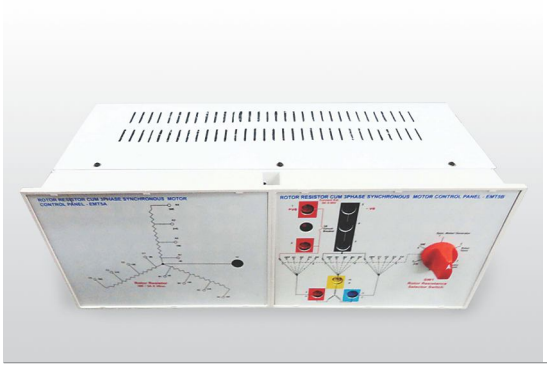
- **3 Ph. Bidirectional power cum Energy meter panel (EMT 34/20)** [8 shrouded Banana]
  - Bidirectional Multifunction
  - 3 Phase ¾ wire, 415V, CT Input 5A
  - LCD/LED display, Aux supply 230V, 45-65 Hz, 5W
  - V,I., Hz, Pf, KVA, KW,KWH
  - Modbus RTU RS 485 (optional)




- **FWD/REV, Star-Delta starter panel (EMT 4)**

[12 Shrouded Banana]

- FWD/REV, 3 pole 3 way switch with centre OFF, 6A/440V.
- Star/Delta switch 3 pole, 3 way with centre OFF, 6A/440V.



- **3 Phase wound Rotor & Sync. Motor panel (EMT 5A/B)**

[8 Shrouded Banana]

- Rotor resistors of 30E/5A with 3 taps of 15E, 21E, 30E each - 3 Nos.
- Rotor resistor selector switch, 3 pole. 6 Way 6A/440 V.

DC Rotor excitation with circuit breaker (3Amp)


- **1 ph. Motor, Alternator & Sync. Motor Panel (EMT 16)**

[14 Shrouded Banana]

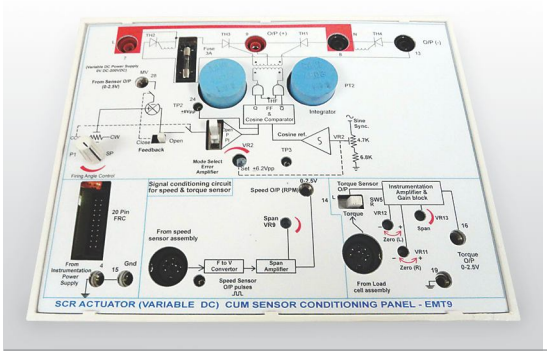
- 1 ph. MCBs of 4A/1.6A 1 each.
- 2 no. 2P2W selector switches to run as 1ph. alternator then as synchronous motor.
- 8A pushbutton switch to simulate as centrifugal switch.



- **DC voltmeter and DC ammeter panel (EMT 6A/B)**

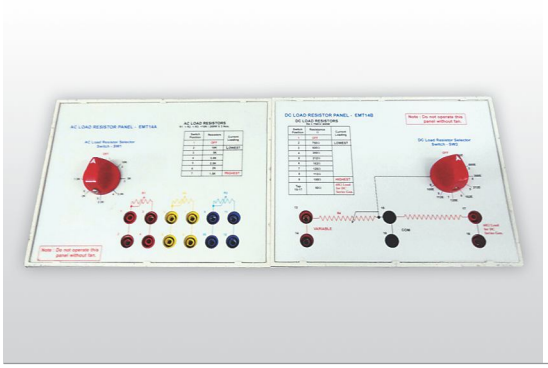
[14 Shrouded Banana]

a) DC voltmeter(0-300V)
b) DC Ammeter (0-5A) with polarity protection diode
c) Field failure relay to control Armature supply.
d) 4A Circuit Breaker.



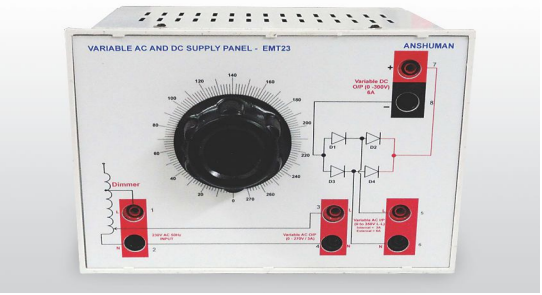

- **SCR Actuator (variable DC) cum sensor signal conditioning panel (EMT9)** [4 Shrouded Banana]
  - Full bridge SCR based 0V-195V / 3 Amp cosine firing with linear characteristics.
  - Supports signal conditioning circuit for speed, torque in kg. to give output 0-2.5Vdc (FS).
  - 3 Nos. of these supplies required for DC Armature, DC motor field and AC generator field.


- **Instrumentation Power supply cum Multichannel DPM panel (EMT 8)** [10 Shrouded Banana]
  - a) 1 Ph. MCBs of 4A/1.6A x 3 Nos.
  - b) +12 V, -12V, 500 mA
  - c) +5V, 300mA
  - d) Unregulated 17VDC /750 mA
  - e) line synchronizing signal.
  - f) Multi channel 4 position DPM for digital display of 2 speeds, torque, misc., etc.



- **Resistive Load (EMT14A/B)**
  - **(1) AC Resistors** 10K/5K/3.5K/2.5K/2K/1.5K/OFF 200W x 3 phases/ 6 taps
  - **(2) DC Resistors** 750E/600E/300E/212E/162E/ 125E/ 112E/100E/400W /8 taps + OFF + separate 60E tap for DC series Gen.

- **LC Load (EMT 15A/B) panel**
  - **(1) Inductive load** = 0.15H/0.3H/0.45H/0.6H/0.75H/ 1.5H/3H/400mA X 3Nos.
  - **(2) Capacitive load** = 1.25µF/2.5µF/5µF/415VX 3Nos




- **Variable AC & DC Supply Panel (EMT23)**

[8 banana sockets]

- Variable O/P : AC 0-270V/3A
- Variable O/P : DC 0-250V/3A

## B) Electrical Machine Units Offered :

### DC Integrated (Trunion Mounted) Machine

**Voltage :** Varm= 180V Vfield = 180V

**Capacity/RPM /Terminals:** 300W/2 Pole m/c / 1500RPM 6 terminals

**Rotor Construction:** Standard commutator / brush arrangement with laminated stack, brought out on 2 terminals

**Stator construction:** Separately excited field winding with laminated solid yoke 2 pole and series winding brought out on 4 terminals.

**Winding Temp.:** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Toque Speed Characteristic:** Provision of load cells 6 kg. 2 No. & speed sensor assembly to measure the torque speed.

**Frame/ Mounting Shaft dia:** 100 Frame, Chais with handle clamps to easy coupling two motors with 4 vibration mould with soft nylon coupler to be provide. **Net Weight :** 42Kg **Gross Weight:** 62Kg.

**Experiments Covered:**

**I) Motors** 1) Speed torque curves of a) Shunt motor b) DC series motor c) Separately excited DC motor d) DC compound motor (Cumulayive & Differential)

**II) Generator (Needs to be driven)** 1) V-I, Efficiency curves for a) C Shunt generator b) DC series generator c) DC separately excited generator d) DC compound generator

**III) Armature resistance Starter & SCR based soft start mechanism**

**IV) Efficiency of all above DC m/c**

## 3 Phase AC Integrated Machine

**Voltage :** 415VAC, 50Hz

**Capacity/RPM /Terminals :** 300W/4 Pole m/c / 1500RPM 10 terminals

**Rotor Construction :** Star connected, four terminals including star point brought out on 4 slip rings mounted on shaft.

**Stator construction :** Six terminals to be brought out to start the machine using STAR-DELTA starter.

**Winding Temp. :** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Frame/ Mounting Shaft dia :** 100 Frame, Chasis mounted 19mm dia. With easily swappable gear coupling

**Net Weight :** 35Kg **Gross Weight :** 54Kg

**Experiment Covered : I) Motors** a) Speed torque curves of wound rotor induction motor with rotor shorted & with different rotor resistors. b) DOL/Star-Delta starters, rotor resistance Slater c) Application of sync. Motor as power factor improvement device / V Curve.

**II] Generator (Needs to be driven)** a) Synchronous generators V-I curve of sync generator.

**III) Efficiency of all above 3 phase AC machines.**

**IV) Paralleling / Synchronising of two 3 ph. Alternators (Optional)** Needs 2 sets of XPO-EMT & (EMT-26) A/B Panel with 3 x 2 lamps, sync switch, synchroscope and 2 sets of coupled machine sets

## 3 Phase Salient Pole Alternator

**Voltage :** 415VAC, 50Hz

**Capacity/RPM /Terminals :** 300W/4 Pole m/c / 1500RPM

**Rotor Construction :** Star connected, four terminals including star point brought out on 4 slip rings mounted on shaft.

**Stator construction :** Separately excited field winding with laminated solid yoke, 4 pole brought out on 2 terminals

**Winding Temp. :** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Frame/ Mounting Shaft dia :** 100 Frame, Chasis mounted 19mm dia. With easily swappable gear coupling

**Net Weight :** 35Kg **Gross Weight :** 54Kg

**Experiments Covered : I) Motors a**) Speed torque curves of salient pole motor. b) Use of synchronous motor as power factor improvement device. Study of V curves. c) Regulation of 3 phase alternator by i) Synchronus Impedance Method ii) ZPF or POTIER Method iii) Actual Load Test **d) Paralleling / synchronising** of two 3 ph. Altemators (Optional). Needs 2 sets of XPO-EMT & (EMT-26A/B) panel with 3 x 2 lamps, sync switch synchroscope and 2 sets of coupled machine sets. Can parallel with 3 ph. AC integrated machine set or 3 phase AC mains supply and/or 3 phase salient pole alternator.

## 1 Phase Synchronous machine

**Voltage :** 230 VAC, 50Hz

**Capacity/RPM /Terminals :** 300W/4 Pole m/c / 1500RPM 4 terminals

**Rotor Construction :** Single phase wound rotor with terminals brought out on two slip rings mounted on shaft.

**Stator construction :** One winding will be used to configure synchronous motor & Alternator output when used as single phase generators

**Winding Temp. :** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Frame/ Mounting Shaft dia :** 100 Frame, Chasis mounted 19mm dia. With easily swappable gear coupling

**Net Weight :** 35Kg **Gross Weight :** 54Kg

**Experiments Covered : I) Motors a**) Speed torque curves of sync. motor. **b) V curve**

**II] Generator (Needs to be driven)** a) V-I curves of sync. single phase generator with excitation at rotor slip rings.

**III] Efficiency** of all above single phase AC Gen. & Sync. Motor.

## 1 Phase AC Integrated Motor

**Voltage :** 230 VAC, 50Hz

**Capacity/RPM /Terminals :** 300W/4 Pole m/c / 1500RPM 10 terminals

**Rotor Construction :** Diecast Squirrel cage motor

**Stator construction :** Two windings brought out on 4 terminals for main and auxilliary. These will be used to configure different motors Split phase, CSCR, CSIR.

**Winding Temp. :** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Frame/ Mounting Shaft dia :** 100 Frame, Chasis mounted 19mm dia. With easily swappable gear coupling

**Net Weight :** 35Kg **Gross Weight :** 54Kg

**Experiments Covered : I) Motors** a) Speed torque curves of split phase induction motor. b) Speed torque curves of CSIR C) Speed torque curves of CSCR.

## Universal Motor

**Voltage :** 230 VAC, 50Hz **/** 150VDC

**Capacity/RPM /Terminals :** 300W/4 Pole m/c / 1500RPM 4 terminals

**Rotor Construction :** Standard commulator brush arrangement brought out on 2 terminals

**Stator construction :** Stator brought out on 2 terminals to facilitate AC/DC operation and direction change. Built in compensetting winding to minimize AR and sparking.

**Winding Temp. :** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Frame/ Mounting Shaft dia :** 100 Frame, Chasis mounted 19mm dia. with easily swappable gear coupling**.**

**Net Weight :** 35Kg **Gross Weight :** 54Kg

**Experiments Covered :** Speed- torque curves of universal motor when operated with a) 220/240VAC b) 180VDC

## Repulsion Motor

**Voltage :** 230 VAC, 50Hz

**Capacity/RPM /Terminals :** 300W/4 Pole m/c / 1500RPM 2 terminals

**Rotor Construction :** Standard commulator brush but short circuited.

**Stator construction :** Stator brought out on 2 terminals. Settable handle to rotate brush position w.r.t. Neutral axis.

**Winding Temp. :** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Frame/ Mounting Shaft dia :** 100 Frame, Chasis mounted 19mm dia. with gear coupling.

**Net Weight :** 35Kg **Gross Weight :** 54Kg

**Experiments Covered : Motors** a) Speed torque curves b) Speed control and reversal with brush setting using handle to rotate brush position w.r.t. Neutral axis.

## 3 Phase Squirrel Cage Induction Motor

**Voltage :** 415 VAC, 50Hz

**Capacity/RPM /Terminals :** 300W/4 Pole m/c / 1500RPM 12 terminals

**Rotor Construction :** Diecast Squirrel cage motor

**Stator construction :** 6x2 terminals brought out to run machine at two speeds using pole changing method **(Dahellander Winding)**

**Winding Temp. :** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Frame/ Mounting Shaft dia :** 100 Frame, Chasis mounted 19mm dia. with easily swappable gear coupling.

**Net Weight :** 35Kg **Gross Weight :** 54Kg

**Experiments Covered : I) Motors** a) Speed torque curves of squirrel cage rotor induction motor at two speeds. b) DOL/Star-Delta/Pole change starters**)** Efficiency of 3 phase AC Squirrel cage motor.

**III) Induction Generator** : Torque -Speed curve in both motor as well as generator mode. Needs EMT-34 (3 phase Bidirectional Power cum Energy Meter Panel)

## DC Integrated (Foot mounted) Machine

**Voltage :** Varm= 180V Vfield = 180V

**Capacity/RPM /Terminals :** 300W/2 Pole m/c / 1500RPM 6 terminals

**Rotor Construction:** Standard commutator / brush arrangement with laminated stack, brought out on 2 terminals

**Stator construction :** Separately excited field winding with laminated solid yoke 2 pole and series winding brought out on 4 terminals.

**Winding Temp.:** A embedded Thermistor brought out on 2 eyelets mounted on terminal box for monitoring winding temperature.

**Experiment Covered :** 1) Hopkinson's Test 2) Swinburne's test 3) Motors - Speed torque curves of a) Shunt motor b) DC series motor c)Separately excited DC motor d) DC compound motor (Cumulayive & Differential) 4) Generator (Needs to be driven) V-I, Efficiency curves for a) C Shunt generator b) DC series generator c) DC separately excited generator d) DC compound generator 5) Armature resistance Starter & SCR based soft start mechanism 6) Efficiency of all above DC m/c.

## Optional Addons

**A. PC interface (Optional): EMT needs following additional panels:**

**1) AC Multi parameter measurement meter (MMM)/Power Network analyzer/EMT34 - 2 nos.** (8 shrouded banana sockets)

- These MMM meters replace above EMT20/20F since they offer modbus connectivity.
- Modbus RS485 to USB converter needed – 2nos.

**2) DC Current /Voltage Measurement Expt. Panel / MIT12**

(4 shrouded + 22 banana sockets)

- DC current hall sensor (x2nos.): Closed Loop current measurement using Hall sensor IC (max. I/P upto 20A, 50/60Hz), Isolation = 2.1KV, Proportional O/P = 0 - 2.5V, 1 CH. • DC Voltage transducer (x2 nos): Using high speed opto coupler IC (max. up to 600Vdc), isolation = 2 KV, 1 CH.
- Function Blocks Used : Precision rectifier (x 2 nos) with gain = 5, LPF (x2nos) with gain = 2, Span Zero Circuit to interface with ADC(0-2.5Vdc) for both current and voltage, only 1 functional block each supplied, 2nd , Field failure/zero current detector.
- Needs CIP panel to interface with PC USB port.

**3) Computer Interface panel (CIP)** (10 banana sockets)

- Connects to PC USB port using USB IO module through 25 pin D (M) connector on CIP & type A to mini B cable.
- 4 ADC channels I/P: 0 to 2.5V FS with 1no input simulation pot. 1 DAC channel O/P 2.5V FS.
- V to I function block: I/P 0 to 2.5V & O/P 0-20 or 4-20mA (100E load) switch settable.
- I to V function block : I/P 4 to 20mA & O/P 0 - 2.5V

**4) Software on CD:**

- Virtual Workbench package is a USB / serial modbus based software working on windows dot Net platform coupled with USB IO module useful as general purpose utility which supports different control strategies like Single or multi loop PID controllers, Fuzzy controller etc, Graph plotting in XY, XT and polar mode etc, Modbus interface, Data logging, Event trigger, inbuilt Function generator etc

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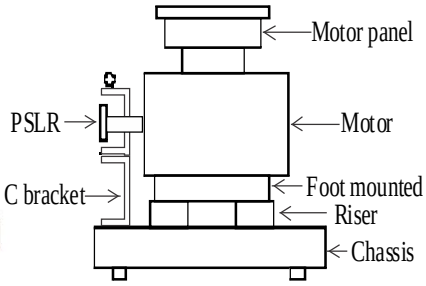
**B. Phase Shift Lock Rotor Mechanism [PSLR] :**




I) **Mounting Method:** By mounting PSLR mechanism on C bracket, using 4 nuts & bolts, it can be directly inserted on to the shaft of diameter 19mm of 3Phase AC machine & to screw the C bracket securely to U shaped open slots of chassis.

II) **Block Rotor Test :** Above mechanism is mounted on chassis as shown & coupled to 3 phase AC induction squirrel cage motor (0.5HP) to carry out block rotor test. Here the turning wheel or knob of PSLR mechanism has no role to play.

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**C. Ward - Leonard Speed Control Trainer :**

- Consists of 4x2 rack with following panels.

  EMT1, EMT20, EMT4, EMT8, EMT9, EMT6B
- **Table Top Machines / Accessaries required :**

1) Squirrel cage (300W) I.M. 2 speed coupled to 300W trunnion mounted DC integrated M/C (generator)
2) 300W DC shunt M/C (motor) with spring balance loading arrangement.

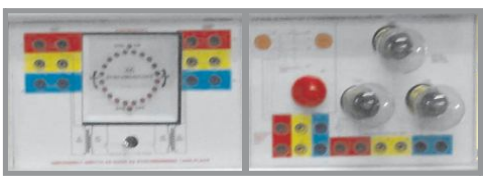
- **Experiments covered :**

1) Open loop torque speed characteristics with DC motor.
2) Closed loop speed control / Regulation characteristics using speed / armature voltage feedback using ward leonard as well as p / PI modes of controller. 3) Transfer function . determination (Optional)

**NOTE : Can also perform these expts. using XPO-EMT by adding 1 extra spring balance loading arrangement DC shunt machine in 8 machine EMT set.**

**D. Paralleling / synchronizing** of two 3 ph. Alternators (Optional). Needs 2 sets of XPO-EMT & (EMT-26A/B) panel with 3 x 2 lamps, sync switch, synchroscope and 2 sets of coupled machine sets. Can parallel with another 3 phase AC integrated machine or 3 ph. AC mains supply or 3 Ph. AC grid supply. In case of grid parallelling, you will need only one coupled set & above synchronizing test gear panel set.

**EMT26A/B Panel**



**E. Transformer Trainer :** Single phase Transformer (2 Nos.) + 3 phase transformer (1 No.) with additional measurement panel EMT-2, EMT-3 OR EMT-20, EMT-6C, 3 Ph./3A variac.