



# ELECTRIC MACHINES – OPENLAB - 0.2 kW



THIS SYSTEM IS A COMPLETE SET OF COMPONENTS AND MODULES SUITABLE FOR ASSEMBLING THE ROTATING ELECTRIC MACHINES, BOTH FOR DIRECT CURRENT AND FOR ALTERNATING CURRENT.

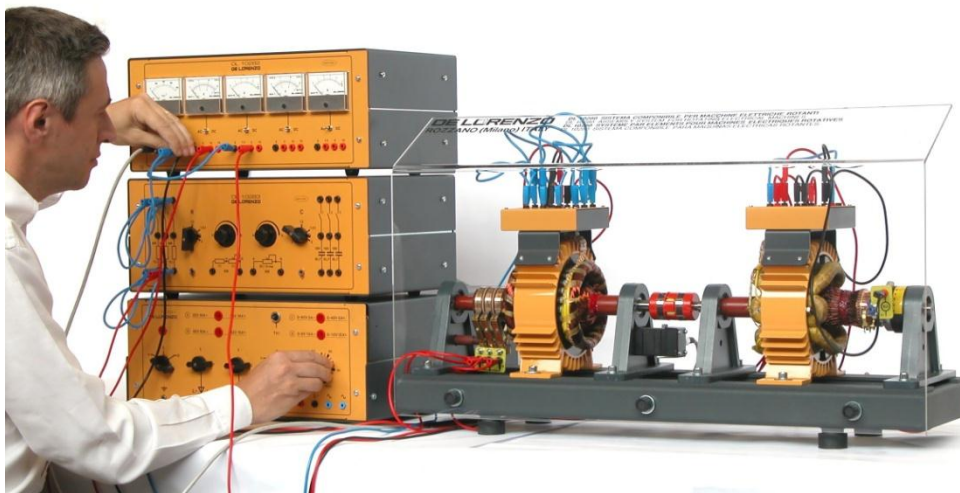
STUDENTS CAN PERFORM A CRITICAL AND WELL ANALYZED ASSEMBLY, IN ORDER TO UNDERSTAND THE PRODUCTION TECHNIQUES BEFORE PERFORMING PRACTICAL TESTS OF THE OPERATING CHARACTERISTICS. THE SYSTEM IS SUPPLIED AT LOW VOLTAGES IN ORDER TO PREVENT THE RISK OF ACCIDENTS. HOWEVER, THE MACHINES HAVE FULLY INDUSTRIAL FEATURES.

The OPENLAB system, in its basic configuration, is composed of:

- |                                 |          |
|---------------------------------|----------|
| • A set of components           | DL 10280 |
| • A power supply module         | DL 10281 |
| • A measurement module          | DL 10282 |
| • A loads and rheostat module   | DL 10283 |
| • An adapter bracket            | DL 10284 |
| • A locking and rotating device | DL 10285 |
| • A parallel board              | DL 10310 |
| • A pole changing module        | DL 10185 |

and the following options are suggested:

- |                                |            |
|--------------------------------|------------|
| • Electromagnetic brake        | DL 10300A  |
| • Star/Delta starter           | DL 10116   |
| • Starting and synchronization | DL 10125   |
| • Fault simulators             | DL 10280FF |



## APPLICATIONS

- Assembly, operation and tests on electric machines and, in particular:
  - Study of the magnetic field
  - Principles of the electromagnetic induction
  - Separately shunt, series and compound excited dc motors
  - Separately shunt, series and compound excited dc generators
  - Induction motors: three-phase slip ring and squirrel cage, single-phase repulsion and with capacitor
  - Dahlander connection
  - Synchronous three-phase motor, induction regulator and phase shifter, alternator, universal motor



## DL 10280 - SET OF COMPONENTS

It includes the following components:

1. Base plate
2. Supports with bearing
3. Coupling joints
4. Flexible coupling
5. Electronic speed transducer
6. Assembling screws
7. Wrenches
8. DC stator
9. AC stator
10. Rotor with commutator
11. Brush holder with 2 brushes
12. Cage rotor
13. Ring rotor
14. Brush holder with 6 brushes

Besides, a magnetic probe is foreseen to display the magnetic fields and a transparent covering, for safety reasons, prevents students from the accidental contact with the rotating parts.



The **AC STATOR** is composed of a metal frame supporting the laminated magnetic circuit, because interested by a flux variable in time, and the electrical winding.

The sheet iron pack is 60 mm long, with internal diameter of 80 mm and external one of 150 mm and it presents 24 half-closed slots inside of which there is a double three-phase winding: the beginnings and the ends of the different phases are shown outside the stator on a suitable educational terminal board.

The winding is a double layer one of the long coil lap type, with winding span 6 (1÷7).

Every slot contains two coils of 19 turns each of enameled wire of diameter 1.12 mm.



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The **SQUIRREL CAGE ROTOR** is composed of a shaft to which a pack of magnetic sheet irons is fixed, where the slots suitable to contain the rotor winding are set. The sheet iron pack is 60 mm long, with external diameter of about 78 mm.

To avoid the phenomenon of the motor crawling in starting phase and to reduce the noise, the slots are inclined as regards the stator ones. The rotor winding is composed of the squirrel cage.

The cage is carried out by setting in every rotor slot some conducting bars that are closed in short-circuit at both ends by means of some conducting rings.

The rotor winding can be therefore considered a multi-phase winding, with a single conductor for pole-phase, so it does not present its proper pole number but it assumes one that is equal to the stator winding one.

The **RING ROTOR** is composed of a shaft to which the collector rings and a magnetic sheet iron pack are fixed: the iron pack has 21 semi-closed slots suitable to contain the winding.

The sheet iron pack is 60 mm long, with external diameter of about 78 mm. To avoid a noisy mechanical running the rotor slots are inclined as regards the stator ones.

The rotor winding is composed of coils and it is two pole three-phase.

The winding is a double layer one of the long coil lap type, with winding span 9 (1-10).

Every slot contains two coils of 8 turns each of enameled wire of diameter 1.5 mm.

The winding is star connected and it is subordinate to the collector rings while the star centre is internal and not accessible.

The terminals of the rotor winding are accessible by means of the collector rings on which the bushes supported by a brush holder graze.

The brushes are two for each phase and they are subordinate to an external terminal board that shows the synoptic of the rotor winding.

The **DC STATOR** is composed of a metal frame supporting the laminated magnetic circuit, with 2 main poles and 2 inter poles, and the electrical windings.

The sheet iron pack is 60 mm long, with internal diameter of 80 mm. On the poles the coils are wound whose terminals are shown on a suitable educational terminal board.

The **DC ROTOR** is composed of a shaft to which the segment commutator is fixed and of a magnetic sheet iron pack where 20 semi-closed slots suitable to contain the electrical winding are set.

The sheet iron pack is 60 mm long, with external diameter of about 80 mm.

The winding is a double layer one of the long coil lap type, with winding span 9 (1÷10).

Every slot contains two coils with two sections of 5+5 turns carried out with enameled wire of diameter 1.12 mm.

The winding is subordinate to the 40 segments of the commutator on which two brushes are supported by a brush holder graze.

The brushes are subordinate to terminals set on two external boards that show the synoptic of the rotor winding.

## DL 10281 - POWER SUPPLY

Outputs in ac:

- Three-phase: 24 V/14 A, 42V/10A
- Single-phase: 0 – 48 V/5 A, 0 – 10 V/12A

Outputs in dc:

- 32 V/14 A, 42 V/10 A, 0 – 40 V/5 A, 0 – 8 V/12 A

Three-phase power supply from mains.

Complete with over-speed protection





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## DL 10282 – ELECTRIC AND SPEED MEASUREMENT

- 2 digital voltmeters ac/dc  
Full scale: 99.9 V
- 2 digital ammeters ac/dc  
Full scale: 19.9 A
- 1 speed meter: 0 - 4000 rpm

Single-phase power supply from mains.

Complete with output for overspeed protection.

## DL 10283 – LOADS AND RHEOSTAT

- resistors:  
3x15 Ohm, 90 W each,  
1 Ohm + (0 - 2 Ohm), 80 W
- capacitors: 3 x 80  $\mu$ F, 150 V
- rheostat: 0 - 80 Ohm, 1 A



## DL 10284 – ADAPTER BRACKET

Necessary for connecting the locking device, the brake or the drive motor.



## DL 10285 – LOCKING AND ROTATING

Suitable for locking and rotating the rotor of slip-ring induction motors to obtain an induction regulator and phase transformer.

## DL 10185 – POLE CHANGING

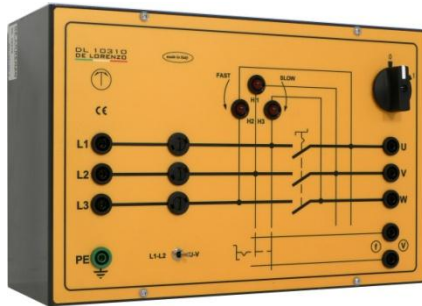
Switch to change the number of poles on Dahlander motors.







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## DL 10310 – PARALLEL BOARD

Rotating light synchroscope to perform the parallel connection between synchronous generators or between the alternator and the mains.

## DL 10300A –ELECTROMAGNETIC BRAKE

Smooth roll rotor and salient pole stator.



## DL 10116 – STAR/DELTA STARTER

For three-phase squirrel cage induction motors.

## DL 10125 – STARTING AND SYNCHRONIZATION

Rotor starter for three-phase slip ring motors and excitation device for synchronization with the mains.





## FAULT SIMULATORS

### DL 10280FF – FAULT SIMULATORS

Set of 4 masks to insert simulated faults in the machines of the OPENLAB system.

The set includes:

- FAULT SIMULATOR FOR A THREE-PHASE CAGE MOTOR
  - Short-circuit between two phases
  - Break-up of a stator phase
  - Break-up of two phases
  - Internal short-circuit
- FAULT SIMULATOR FOR A SLIP RING MOTOR
  - Short-circuit between two phases
  - Break-up of a stator phase
  - Internal short-circuit
- FAULT SIMULATOR FOR A SINGLE-PHASE CAPACITOR MOTOR
  - Unsuccessful starting of the motor
- FAULT SIMULATOR FOR A COMPOUND EXCITED DC MOTOR
  - Unsuccessful starting of the motor
  - Break-up of a stator phase
  - Shunt excitation circuit reversal





# ELECTRIC MACHINES – OPENLAB - 0.2 kW



## EXPERIMENTS for the manual configuration

Nr.	Experiment	Basic configuration								Brake	VΔ	Starter
		10280	10281	10282	10283	10284	10285	10185	10310	10300A 10284	10116	10125
1	Flux produced by the poles	X	X	X								
2	Main magnetic field	X	X	X								
3	Intensity of the magnetic field	X	X	X								
4	Induced voltage	X	X	X								
5	Inter pole effect	X	X	X								
6	No-load magnetic neutral axis	X	X	X								
7	Rotating magnetic field	X	X	X	X							
8	3-phase squirrel cage motor, 2 poles, 24 VΔ	X	X	X						X		
9	3-phase squirrel cage motor, 2 poles, 42 VY	X	X	X	X					X		
10	3-phase squirrel cage motor, 2 poles, 24 VΔΔ	X	X	X						X		
11	3-phase squirrel cage motor, 2 poles, 42 VYY	X	X	X						X		
12	3-phase squirrel cage motor, 4 poles, 24 VΔ	X	X	X						X	X	
13	3-phase squirrel cage motor, 4 poles, 42 VY	X	X	X						X		
14	3-phase Dahlander motor, 4/2 poles, 42 VΔ/Y	X	X	X				X		X		
15	Split phase motor	X	X	X	X					X		
16	Capacitor start and run motor	X	X	X	X					X		
17	3-phase motor with wound rotor, 2 poles, 42 VYY	X	X	X	X					X		
18	Phase shifter	X	X	X	X	X	X					
19	Induction regulator	X	X	X	X	X	X					
20	3-phase synchronous induction motor, 2 poles, 24 VΔ	X	X	X						X		X
21	3-phase synchronous induction motor, 2 poles, 24 VΔΔ	X	X	X						X		X
22	DC motor with separate excitation	X	X	X	X					X		
23	DC motor with shunt excitation	X	X	X	X					X		
24	DC motor with series excitation	X	X	X	X					X		
25	DC motor with compound excitation, long shunt	X	X	X	X					X		
26	DC motor with compound excitation, short shunt	X	X	X	X					X		
27	Single phase series motor	X	X	X						X		
28	Repulsion motor	X	X	X	X					X		
29	Synchronous motor winding resistance	X	X	X								
30	Synchronous motor no-load test	X	X	X	X							
31	Synchronous motor short-circuit characteristics	X	X	X	X							
32	Synchronous motor short-circuit test	X	X	X	X							
33	Synchronous motor Behn - Eschenberg's method	It uses the data from experiments 29, 30, 31										
34	Synchronous motor load test	X	X	X	X							
35	Synchronous motor conventional efficiency	It uses the data from experiments 29, 30, 32, 33										
36	Parallel connection of the alternator with the mains	X	X	X	X				X			
37	Alternator as synchronous motor	X	X	X	X				X			
38	DC generator winding resistance	X	X	X								
39	DC generator test of the no-load motor (Swinburne)	X	X	X	X							
40	DC generator no-load e.m.f.	X	X	X								X
41	DC generator excitation characteristics	X	X	X								X
42	Separate excitation dynamo	X	X	X	X							X
43	Shunt excitation dynamo	X	X	X	X							X
44	Series excitation dynamo	X	X	X	X							X
45	Compound excitation dynamo	X	X	X	X							X