AUTOMATIC TEST BENCH FOR ELECTRIC MACHINES

DL EM-TEST

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1. DESCRIPTION OF THE BENCH

The **DL EM-TEST** is a multipurpose bench for the study and characterization of the Eurolab series (0.3 kW) and Unilab series (1.1 kW) electric machines using an **automated test approach**. The system is composed of the following main sections:

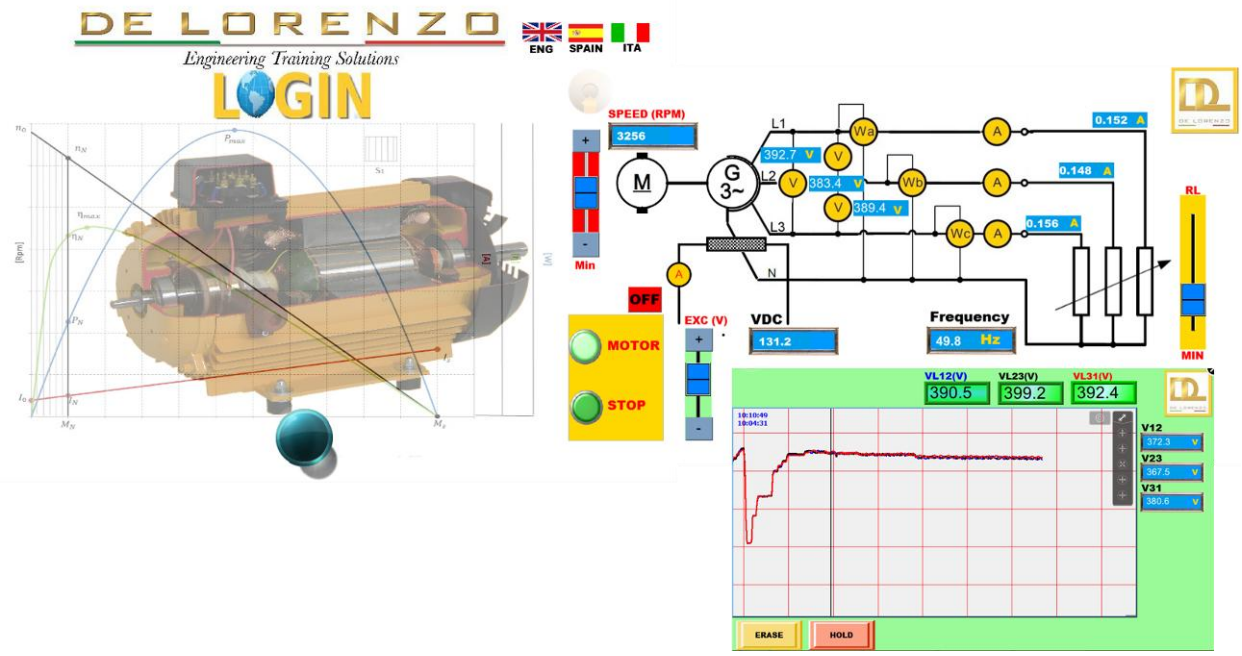
Prime mover: A squirrel cage three-phase asynchronous machine controlled by an inverter in four quadrant operation providing the mechanical power and torque necessary for the characterization of the machine under study.

Data acquisition software for electric machines: performs the test automation and provides the user interface to execute the experiments. The SW developed in LabVIEW communicates with the acquisition devices via serial port using the Modbus protocol, reading electrical and mechanical data from instruments.

Instruments: collect mechanical data (speed, torque and temperature) as well as electrical data (AC and DC, Voltage, current and Power).

2. DATA ACQUISTION SYSTEM

The didactic acquisition and automation software guides the student through the different experiments available for the study of various types of single and three-phase AC, DC and brushless machines, motors and generators, through an intuitive user interface.



The automated test approach enables the student to monitor and control several variables of the electric machine under test in real-time, to easily observe their behaviour and interaction under several operating conditions such as load, no load, variable speed and torque, or different excitation values. The characteristic curves that can be obtained with the system provide accurate information to create a model of the machine, tune its controller and study the machine applications.

According to the machine under test, the studies that can be performed include:

- Motor and generator operation
- Torque vs. speed characteristic
- Torque vs. current characteristic
- Voltage vs. speed characteristic
- Efficiency
- Generator synchronization with network
- Power factor.

3. TEST BENCH COMPOSITION

The DL EM-TEST is composed by the following modules:

CODE	DESCRIPTION	QTY
DL 1021	Squirrel cage three-phase asynchronous motor	**1**
DL 2108T28	Inverter for three-phase induction motors	**1**
DL 2108T26BR	Brake resistance	**1**
DL 10065NF	Electric power measuring module	**1**
DL 50050TR1	Mechanical power measuring module	**1**
DL 50050TR-EM	Digital torque meter and speed encoder	**1**
DL 2109D33	Digital true RMS meter	**1**
DL HUBRS485F	Communication MODBUS	**1**
DL 4251	Multifunction Digital HMI Gateway	**1**
DL PCGRID	PC	**1**
DL EM-TEST-SW	Data acquisition and processing software	**1**
DL A120-3M-LED	Three-level aluminium frame	**1**
DL 1013M1	Motorized DC and AC power supply module	**1**
DL T12090	120x90 Workbench	**1**
DL T06090	60x90 Workbench	**2**
DL 1013A	Universal base	**1**
TL EM-TEST	Connecting cables	**1**

4. TEST BENCH CONFIGURATIONS

Bench for the study of three-phase asynchronous motors (0,3 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Squirrel cage three-phase asynchronous motor	
DL 30115	Squirrel cage three-phase asynchronous motor	**1**
DL 2035	Star/delta starter	**1**
	Slip ring three-phase asynchronous motor	
DL 30120	Slip ring three-phase asynchronous motor	**1**
DL 30125	Starting and synchronization unit	**1**
	Two speed squirrel cage three-phase asynchronous motor	
DL 30180	Three-phase two speed asynchronous motor	**1**
DL 2036	Pole switching unit	**1**
	Two speed separate windings three-phase motor	
DL 30270D	Two speed separate windings three-phase motor	**1**
DL 30275	Pole switching unit	**1**

Experiments list:

NO.	EXPERIMENT	DL 30115	DL 30120	DL 30180	DL 30270D
1.	**Stator Winding Resistance**	**V**	**V**	**V**	**V**
2.	**Rotor Winding Resistance**		**V**		
3.	**Transformation Ratio Test - Stator/Rotor**		**V**		
4.	**Transformation Ratio Test - Rotor/Stator**		**V**		
5.	**No-load Test**	**V**	**V**	**V**	**V**
6.	**Short-circuit Test**	**V**	**V**	**V**	**V**
7.	**Star/Delta Motor Starter**	**V**			
8.	**Pole Switching Test**			**V**	**V**
9.	**Direct Test with Electromagnetic Brake**	**V**	**V**	**V**	**V**

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Bench for the study of three-phase asynchronous motors (1 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Squirrel cage three-phase asynchronous motor	
DL 1021	Squirrel cage three-phase asynchronous motor	**1**
DL 2035	Star/delta starter	**1**
	Slip ring three-phase asynchronous motor	
DL 1022	Slip ring three-phase asynchronous motor	**1**
DL 1022RHD3	Starting and synchronization unit	**1**
	Two speed squirrel cage three-phase asynchronous motor	
DL 1027	Three-phase two speed asynchronous motor	**1**
DL 2036	Pole switching unit	**1**

Experiments list:

NO.	EXPERIMENT	DL 1021	DL 1022	DL 1027
1.	**Stator Winding Resistance**	**V**	**V**	**V**
2.	**Rotor Winding Resistance**		**V**	
3.	**Transformation Ratio Test - Stator/Rotor**		**V**	
4.	**Transformation Ratio Test - Rotor/Stator**		**V**	
5.	**No-load Test**	**V**	**V**	**V**
6.	**Short-circuit Test**	**V**	**V**	**V**
7.	**Star/Delta Motor Starter**	**V**		
8.	**Pole Switching Test**			**V**
9.	**Direct Test with Electromagnetic Brake**	**V**	**V**	**V**

Bench for the study of single-phase motors (0,3 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Split phase motor	
DL 30130	Split phase motor	**1**
DL 30135	Capacitor unit	**1**
	Single phase motor with capacitor	
DL 30140	Single phase motor with capacitor	**1**
	Universal motor	
DL 30150	Universal motor	**1**
	Repulsion motor	
DL 30170	Repulsion motor	**1**

Experiments list:

NO.	EXPERIMENT	DL 30130	DL 30140	DL 30150	DL 30170
1.	**Starting a split phase motor (with running, starting and two capacitors)**	V			
2.	**Direct test with electromagnetic brake for universal motor with AC power supply**			V	
3.	**Direct test with electromagnetic brake for universal motor with DC power supply**			V	
4.	**Direct Test with Electromagnetic Brake**	V	V		V

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Bench for the study of single-phase motors (1 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Split phase motor	
DL 1028	Split phase motor	**1**
DL 1028AC	Capacitor unit	**1**
	Single phase motor with capacitor	
DL 1028C	Single phase motor with capacitor	**1**
	Universal motor	
DL 1029	Universal motor	**1**
	Repulsion motor	
DL 1029R	Repulsion motor	**1**

Experiments list:

NO.	EXPERIMENT	DL 1028	DL 1028C	DL 1029	DL 1029R
1.	**Starting a split phase motor (with running, starting and two capacitors)**	V			
2.	**Direct test with electromagnetic brake for universal motor with AC power supply**			V	
3.	**Direct test with electromagnetic brake for universal motor with DC power supply**			V	
4.	**Direct Test with Electromagnetic Brake**	V	V		V

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Bench for the study of direct current motors (0,3 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Poly-excitation DC machine	
DL 30220P	Direct current poly-excitation machine	**1**
DL 30200RHD	Starting rheostat	**1**
DL 30205	Excitation rheostat	**1**
DL 30206	Excitation rheostat	**1**
	Direct current motor compound excitation	
DL 30220	Direct current motor compound excitation	**1**
DL 30200RHD	Starting rheostat	**1**
DL 30205	Excitation rheostat	**1**
	Direct current motor shunt excitation	
DL 30200	Direct current motor shunt excitation	**1**
DL 30200RHD	Starting rheostat	**1**
DL 30205	Excitation rheostat	**1**
	Direct current motor series excitation	
DL 30210	Direct current motor series excitation	**1**
DL 30200RHD	Starting rheostat	**1**
DL 30206	Excitation rheostat	**1**

Experiments list:

NO.	EXPERIMENT	DL 30220P	DL 30220	DL 30200	DL 30210
1.	**Measurement of the windings resistance**	**V**	**V**	**V**	
2.	**No-load losses**	**V**	**V**	**V**	
3.	**Conventional efficiency**	**V**	**V**	**V**	
4.	**Direct test with electromagnetic brake**	**V**	**V**	**V**	**V**
5.	**Electromechanic characteristic**	**V**		**V**	

ELECTRIC MACHINES

Bench for the study of direct current motors (1 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Poly-excitation DC machine	
DL 1024R	Direct current poly-excitation machine	**1**
DL 1017RHD	Starting rheostat	**1**
DL 1017RHE	Excitation rheostat	**1**
DL 1017RHES	Excitation rheostat	**1**
	Direct current motor compound excitation	
DL 1023	Direct current motor compound excitation	**1**
DL 1017RHD	Starting rheostat	**1**
DL 1017RHE	Excitation rheostat	**1**
	Direct current motor shunt excitation	
DL 1023P	Direct current motor shunt excitation	**1**
DL 1017RHD	Starting rheostat	**1**
DL 1017RHE	Excitation rheostat	**1**
	Direct current motor series excitation	
DL 1023S	Direct current motor series excitation	**1**
DL 1017RHD	Starting rheostat	**1**
DL 1017RHES	Excitation rheostat	**1**

Experiments list:

NO.	EXPERIMENT	DL 1024R	DL 1023	DL 1023P	DL 1023S
1.	**Measurement of the windings resistance**	**V**	**V**	**V**	
2.	**No-load losses**	**V**	**V**	**V**	
3.	**Conventional efficiency**	**V**	**V**	**V**	
4.	**Direct test with electromagnetic brake**	**V**	**V**	**V**	**V**
5.	**Electromechanic characteristic**	**V**	**V**		

Bench for the study of direct current generators (0,3 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Direct current generator compound excitation	
DL 30240	Direct current generator compound excitation	**1**
DL 30205	Excitation rheostat	**1**
DL 30045	Motor-driven resistive load	**1**
	Direct current generator shunt excitation	
DL 30250	Direct current generator shunt excitation	**1**
DL 30205	Excitation rheostat	**1**
DL 30045	Motor-driven resistive load	**1**
	Direct current generator series excitation	
DL 30230	Direct current generator series excitation	**1**
DL 30206	Excitation rheostat	**1**
DL 30045	Motor-driven resistive load	**1**

Experiments list:

NO.	EXPERIMENT	DL 30240	DL 30250	DL 30230
1.	**Measurement of the windings resistance**	**V**	**V**	
2.	**Magnetization characteristic curve**	**V**	**V**	
3.	**No-load losses**	**V**	**V**	
4.	**External characteristic curve**	**V**	**V**	
5.	**Regulation characteristic curve**	**V**	**V**	
6.	**Conventional efficiency**	**V**	**V**	
7.	**Direct test**			**V**

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Bench for the study of direct current generators (1 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Direct current generator compound excitation	
DL 1024	Direct current generator compound excitation	**1**
DL 1017RHE	Excitation rheostat	**1**
DL 2096	Motor-driven resistive load	**1**
	Direct current generator shunt excitation	
DL 1024P	Direct current generator shunt excitation	**1**
DL 1017RHE	Excitation rheostat	**1**
DL 2096	Motor-driven resistive load	**1**
	Direct current generator series excitation	
DL 1024S	Direct current generator series excitation	**1**
DL 1017RHES	Excitation rheostat	**1**
DL 2096	Motor-driven resistive load	**1**

Experiments list:

NO.	EXPERIMENT	DL 1024	DL 1024P	DL 1024S
1.	**Measurement of the windings resistance**	**V**	**V**	
2.	**Magnetization characteristic curve**	**V**	**V**	
3.	**No-load losses**	**V**	**V**	
4.	**External characteristic curve**	**V**	**V**	
5.	**Regulation characteristic curve**	**V**	**V**	
6.	**Conventional efficiency**	**V**	**V**	
7.	**Direct test**			**V**

Bench for the study of three-phase synchronous machines (0,3 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Three phase synchronous machine	
DL 30190	Three phase synchronous machine	**1**
DL 1030	Parallel board	**1**
DL 30040R	Resistive load	**1**
DL 30040L	Inductive load	**1**
DL 30040C	Capacitive load	**1**
	Reluctance motor	
DL 30270	Reluctance motor	**1**

Experiments list:

NO.	EXPERIMENT	DL 30190	DL 30270
1.	**Measurement of the resistance of the armature windings**	**V**	
2.	**Measurement of the resistance of the excitation winding**	**V**	
3.	**Study of the magnetization characteristic**	**V**	
4.	**Measuring the mechanical, the iron and the additional losses**	**V**	
5.	**Direct test with electromagnetic brake**		**V**
6.	**Study of short-circuit characteristic**	**V**	
7.	**Study of the external characteristics**	**V**	
8.	**Study of regulation characteristics**	**V**	
9.	**Parallel of the alternator with three-phase network**	**V**	
10.	**Study of a "V" characteristic curve**	**V**	

Bench for the study of three-phase synchronous machines (1 kW)		
CODE	**DESCRIPTION**	**QTY**
	Workstation	
DL EM-TEST	Automatic test bench for electric machines	**1**
	Three phase synchronous machine	
DL 1026A	Three phase synchronous machine	**1**
DL 1030	Parallel board	**1**
DL 1017R	Resistive load	**1**
DL 1017L	Inductive load	**1**
DL 1017C	Capacitive load	**1**
	Reluctance motor	
DL 1026R	Reluctance motor	**1**

Experiments list:

NO.	EXPERIMENT	DL 1026A	DL 1026R
1.	**Measurement of the resistance of the armature windings**	**V**	
2.	**Measurement of the resistance of the excitation winding**	**V**	
3.	**Study of the magnetization characteristic**	**V**	
4.	**Measuring the mechanical, the iron and the additional losses**	**V**	
5.	**Direct test with electromagnetic brake**		**V**
6.	**Study of short-circuit characteristic**	**V**	
7.	**Study of the external characteristics**	**V**	
8.	**Study of regulation characteristics**	**V**	
9.	**Parallel of the alternator with three-phase network**	**V**	
10.	**Study of a "V" characteristic curve**	**V**	