



INTRODUCTION

Technological development in the electronic field has transformed power electronics from static conversion technology to its essential element in the electrical and electronic area. Its aim is the power flow control through the voltage conversion from mains by power semiconductors capable to perform switching, control and convert electrical energy functions efficiently and reliably.

On the last years, there have been significant improvements on this technology sector.

Results achieved on the microelectronics field have allowed the use of linear circuits with integrated components such as controllers on power electronics systems.

The new production techniques have improved components voltage and current characteristics and increased their switching speed.

Furthermore, computers development, communication systems and commercial electronics products, on the need for a better use of the available energy, have led to an increase stable power supply requirement. As a particular interest is the use of power electronics on a DC and three-phase motors at constant and variable speed control.

All of this fits into a wide and reliable applications on many sectors, from residential (cooling systems, air conditioning, kitchen lighting), to commercial (similar to residential, but with additional office equipment and a computer, continuity group, elevators), from industrial (pumps, compressors, fans, robots, welding systems, industrial laser) to an absolutely important area, transportation (electric train, battery loaders, tram, metro, car); from telecommunications (power supply and battery loaders) to space technology (power supply systems on satellites and aircrafts).

De Lorenzo has designed a laboratory on power electronics study, which allows students a practical learning based on a practical implementation of guided exercises. All components that make up the laboratory are industrial used, mounted on didactic panels for a proper handling; all of this enables the laboratory to be used for educational purposes, as well as, design, development and research, thanks to its modular qualities.

Starting from basic principles, with the aid of high-training manuals, the student follows a didactic path into a gradual study of complex circuits.



ALTERNATE CURRENT - DIRECT CURRENT CONVERSION

In most of the applications of power electronics, the input power is in the form of a sinusoidal wave coming from the mains network which is then converted to direct current.

In many cases, the conversion is of the non-controlled type, with the use of diode rectifiers.

However, in some applications, such as, for example, some types of drives of ac and dc motors, it is necessary that the dc output voltage be controllable.

In this case, thyristor converters for the mains frequency phase control are used. They are utilized in particular in high voltage dc power transmission or in all those applications where it is necessary to control the power flow in both directions between the dc side and the ac side.

This trainer have a modular structure and it consists of didactic panels installed on a vertical frame. It is supplied with a theoretical and practical manual. The modularity of these didactic system grants to the students a direct and immediate approach to the topics, offering the opportunity to study various subjects performing several experiments as following:

DCA 201.1 DIODES AND UNCONTROLLED RECTIFIERS

Uncontrolled diodes

- Selenium diode
- Silicon diode

Uncontrolled static converter circuits

- Single pulse rectifier E1UK, ohmic load
- Single pulse rectifier E1UK, ohmic-inductive load
- Two-pulse rectifier M2UK, ohmic load
- Two-pulse rectifier M2UK, ohmic-inductive load
- Two-pulse bridge rectifier B2UK, ohmic load
- Two-pulse bridge rectifier B2UK, ohmic-inductive load
- Three-pulse rectifier M3UK, ohmic load
- Three-pulse rectifier M3UK, ohmic-inductive load
- Six-pulse rectifier M6UK, ohmic load
- Six-pulse rectifier M6UK, ohmic-inductive load
- Six-pulse bridge rectifier B6UK, ohmic load
- Six-pulse bridge rectifier B6UK, ohmic-inductive load



DCA 201.2 SCR AND CONTROLLED RECTIFIERS

Thyristors

- SCR

Single pulse converters

- Single pulse converter E1CK, ohmic load
- Single pulse converter E1CK, inductive load
- Single pulse converter E1CK, ohmic-inductive load
- Single pulse converter E1CK, ohmic-inductive load and free-wheeling diode
- Single pulse converter E1CK, ohmic-inductive load and back e.m.f.
- Single pulse rectifier E1UK, ohmic-capacitive load
- Single pulse converter E1CK, ohmic-capacitive load

Two-pulse midpoint converters

- Two-pulse midpoint converter M2CK, ohmic load
- Two-pulse midpoint converter M2CK, ohmic-inductive load

Multi-phase converters

- Three-pulse midpoint converter M3CK, ohmic load
- Three-pulse midpoint converter M3CK, ohmic-inductive load
- Six-pulse midpoint converter M6CK, ohmic load
- Six-pulse midpoint converter M6CK, ohmic-inductive load

Drainage-coil converters

- Double three-pulse star converter M3CK2, ohmic load

Bridge converters

- Half-controlled bridge B2HK, ohmic load
- Half-controlled bridge B2HK, ohmic-inductive load
- Half-controlled bridge B2HZ, ohmic load
- Half-controlled bridge B2HZ, ohmic-inductive load
- Fully-controlled bridge B2C, ohmic load
- Fully-controlled bridge B2C, ohmic-inductive load
- Fully-controlled bridge B2C, ohmic load and back e.m.f.
- Fully-controlled bridge B2C, dc motor load
- Fully-controlled bridge B2C, ohmic load and supplementary dc voltage
- Fully-controlled bridge B2C, dc generator load
- Three-phase half-controlled bridge B6HK, ohmic load
- Three-phase fully-controlled bridge B6C, ohmic load
- Three-phase fully-controlled bridge B6C, ohmic-inductive load



Code	Description	DCA 201.1	DCA 201.2	Total quantities
DL 2601	SELENIUM RECTIFIER	1		1
DL 2602	SILICON DIODE	1		1
DL 2603	GROUP OF DIODES	1	1	1
DL 2604	SCR		1	1
DL 2605	GROUP OF SCR		1	1
DL 2613	DC POWER SUPPLY		1	1
DL 2614	VOLTAGE REFERENCE GENERATOR		1	1
DL 2615	TRIGGER POINT LIMITER		1	1
DL 2616	TWO PULSE CONTROL UNIT		1	1
DL 2617	SIX PULSE CONTROL UNIT		1	1
DL 2626	MAINS TRANSFORMER	1	1	1
DL 2628	SUPER-FAST FUSES	2	2	2
DL 2635	LOAD	1	1	1
DL 2636	SOCKETS WITH LAMPS		1	1
DL 2637	STABILIZED POWER SUPPLY		1	1
DL 2643	SUPPORT WITH 3 SHUNTS 1 OHM	1	1	1
DL 2644	SUPPORT WITH 3 SHUNTS 0,1 OHM		1	1
DL 12B12	BATTERY STACK		1	1
DL 2025DT	TACHOMETER		1	1
DL 2109D33	TRUE RMS METER	2	2	2
DL 2109T3PV	MOVING IRON VOLTMETER	1	1	1
DL 2109T2A5	MOVING IRON AMMETER	1	1	1
DL 10200A1	SHUNT EXCITATION DC MOTOR		1	1
DL 10250A1	SHUNT EXCITATION DC GENERATOR		1	1
DL 10400	BASE		1	1
	For the Countries where the 3-phase mains supply is different from 380V:			
DL 2600TTI	THREE PHASE TRANSFORMER	1	1	1



ALTERNATE CURRENT - ALTERNATE CURRENT CONVERSION

The electrical power in alternate current is controlled by means of thyristors.

The main fields of application of the control of alternate current are in the control of temperature, lighting and induction motors.

The main types of control are: phase control, on-off control and proportional time control.

LIST OF EXPERIMENTS

DCA 202.1 THYRISTORS AND CONTROLLED AC/AC CONVERTERS

Thyristor

- TRIAC

Single-phase controllers

- Single-phase ac controller W1C, ohmic load
- Single-phase ac controller W1C, inductive load
- Single-phase ac controller W1C, ohmic-inductive load
- Single-phase ac controller W1, ohmic load
- Single-phase ac controller W1, ohmic-inductive load
- Half-controlled single-phase controller W1H, ohmic load

Three-phase controllers

- Fully controlled three-phase controller W3C, star ohmic load without neutral
- Fully controlled three-phase controller W3H, star ohmic load without neutral
- Three-phase controller W3C2, star ohmic load without neutral

DCA 202.2 LIGHT DIMMER FAULT SIMULATOR

Phase control for the regulation of lighting with fault simulation.

Double time-constant standard light dimmer circuit consisting of triac, diac, two control potentiometers, resistors and capacitors.

20 faults can be switched on using switches located behind a cover. Typical faults: interruptions, short-circuit, faulty components and faulty design.

Examples of exercises:

- Fault-free dimmer
- DIAC shorted
- DIAC with high resistance
- The gate of TRIAC works like a diode
- Control circuit break
- Assembly or component fault
- Trimmer shorted
- Auxiliary RC circuit not included
- Variable resistance R shorted
- TRIAC shorted



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Code	Description	DCA 202.1	DCA 202.2	Total quantities
DL 2603	GROUP OF DIODES	1		1
DL 2605	GROUP OF SCR	1		1
DL 2607	TRIAC	1		1
DL 2613	DC POWER SUPPLY	1		1
DL 2614	VOLTAGE REFERENCE GENERATOR	1		1
DL 2616	TWO PULSE CONTROL UNIT	1		1
DL 2617	SIX PULSE CONTROL UNIT	1		1
DL 2626	MAINS TRANSFORMER	1	1	1
DL 2628	SUPER-FAST FUSES	1		1
DL 2635	LOAD	1		1
DL 2636	SOCKETS WITH LAMPS		1	1
DL 2639	PHASE CONTROL FAULT SIMULATOR		1	1
DL 2643	SUPPORT WITH 3 SHUNTS 1 OHM	1		1
DL 2109T26	POWER METER	1		1
DL 2109D33	TRUE RMS METER	2		2
DL 2109T3PV	MOVING IRON VOLTMETER	1		1
DL 2109T2A5	MOVING IRON AMMETER	1		1
DL 2100-3M	FRAME	2	2	2
DL 1001-1	WORKING BENCH	1	1	1
DL 1155POW	CONNECTING LEADS	1	1	1
	Accessory:			
DL 2100TA	STORAGE CABINET	1	1	1
	For the Countries where the 3-phase mains supply is different from 380V:			
DL 2600TTI	THREE PHASE TRANSFORMER	1	1	1



DIRECT CURRENT DIRECT CURRENT CONVERSION

Dc - dc converters are widely used in dc power supplies and in some applications of dc motor drive. Often, the input to this type of converters is a dc non-regulated voltage, obtained by rectifying the mains voltage and, consequently, fluctuating due to changes in the amplitude of the line voltage. The result of the conversion is a controlled dc output at the desired voltage level.

LIST OF EXPERIMENTS

DCA 203.1 CHOPPERS

- Main SCR
- MOSFET
- IGBT
- Step-down converter with SCR with turn-off circuit. PWM control.
- Step-down converter with IGBT. PWM control.
- Speed control of a dc motor
- Step-down converter with MOSFET. PWM control.
- Step-down converter with MOSFET. PFM control.
- Step-down converter with MOSFET. TPC control .
- Step-up converter with IGBT. PWM control.
- Step-up converter with IGBT. TPC control.
- Inverting converter with IGBT. PWM control.

DCA 203.2 SWITCHABLE POWER SUPPLY

- Flyback converter with IGBT. PWM control.
- Forward converter with IGBT. PWM control.
- Asymmetric half-bridge forward converter with IGBT. PWM control.



POWER ELECTRONICS



Code	Description	DCA 203.1	DCA 203.2	Total quantities
DL 2602	SILICON DIODE	1	4	4
DL 2608	MOSFET	1		1
DL 2609	IGBT	1	2	2
DL 2611	BRIDGE THREE PHASE RECTIFIER	1	1	1
DL 2612	SCR WITH TURN OFF CIRCUIT	1		1
DL 2613	DC POWER SUPPLY	1	1	1
DL 2614	VOLTAGE REFERENCE GENERATOR	1	1	1
DL 2619	PWM/PFM/TPC CONTROL UNIT	1	1	1
DL 2626	MAINS TRANSFORMER	1	1	1
DL 2627	CAPACITORS	1	1	1
DL 2628	SUPER FAST FUSES	1	1	1
DL 2629	SWITCHING TRANSFORMER		1	1
DL 2630	CURRENT TRANSFORMER	1		1
DL 2635	LOAD	1	1	1
DL 2640	EMI FILTER		1	1
DL 2643	SUPPORT WITH 3 SHUNTS 1 OHM	1	1	1
DL 2644	SUPPORT WITH 3 SHUNTS 0,1 OHM		1	1
DL 2025DT	TACHOMETER	1		1
DL 2109D33	TRUE RMS METER	2	2	2
DL 10200A1	SHUNT EXCITATION DC MOTOR	1		1
DL 10400	BASE	1		1
DL 2100-3M	FRAME	2	2	2
DL 1001-1	WORKING BENCH	1	1	1
DL 1155POW	CONNECTING LEADS	1	1	1
DL 2100TA	Accessory: STORAGE CABINET	1	1	1
	For the Countries where the 3-phase mains supply is different from 380V:			
DL 2600TTI	THREE PHASE TRANSFORMER	1	1	1



DIRECT CURRENT ALTERNATE CURRENT CONVERSION

This type of converters are used in ac motor drives and in ac uninterruptible power supplies, where the objective is to supply a sinusoidal ac output with controlled amplitude and frequency.

In this section of the laboratory inverters and frequency converters are studied.

LIST OF EXPERIMENTS

DCA 204.1 INVERTERS

- Single-phase full-bridge dc chopper. PWM control.
- Single-phase full-bridge inverter. Square-wave PWM control.
- Single-phase full-bridge inverter. Sinusoidal PWM control.

DCA 204.2 FREQUENCY CONVERTERS

- Frequency converter
- Input controlled rectifier
- Output power inverter

Code	Description	DCA 204.1	DCA 204.2	Total quantities
DL 2610	GROUP OF IGBT	1		1
DL 2611	BRIDGE THREE PHASE RECTIFIER	1		1
DL 2613	DC POWER SUPPLY	1	1	1
DL 2614	VOLTAGE REFERENCE GENERATOR	1	1	1
DL 2619	PWM/PFM/TPC CONTROL UNIT	1		1
DL 2625	MATCHING AMPLIFIER	1		1
DL 2626	MAINS TRANSFORMER	1		1
DL 2627	CAPACITORS	1		1
DL 2628	SUPER FAST FUSES	1		1
DL 2633	FUNCTION GENERATOR	1		1
DL 2635	LOAD	1	1	1
DL 2637	STABILIZED POWER SUPPLY	1		1
DL 2640	EMI FILTER	1		1
DL 2643	SUPPORT WITH 3 SHUNTS 1 OHM	1		1
DL 2644	SUPPORT WITH 3 SHUNTS 0,1 OHM	1		1
DL 2646	FREQUENCY CONVERTER		1	1
DL 2108SAL	SINGLE PHASE SUPPLY UNIT		1	1
DL 2109D33	TRUE RMS METER	2	2	2
DL CRON	ELECTRONIC STOPCLOCK		1	1
DL 2100-3M	FRAME	2	2	2
DL 1001-1	WORKING BENCH	1	1	1
DL 1155POW	CONNECTING LEADS	1	1	1
DL 2100TA	Accessory: STORAGE CABINET	1	1	1
DL 2600TTI	For the Countries where the 3-phase mains supply is different from 380V: THREE PHASE TRANSFORMER	1	1	1



APPLICATIONS

Motor drives are used in a wide range of power values, from few watts up to many thousands of kilowatts, in applications ranging from high precision position control in robotics to variable speed drives for regulating the rate of flow in pumps.

In all drives where speed and position must be controlled, a power electronics converter is needed as interface between input power and motor.

Constant, or slightly variable according to load, speed drives use almost exclusively induction motors, thanks to their simple, robust and cheap construction, in addition to the fact that they do not need special maintenance. However, the multi-phase motors supplied at constant network voltage and frequency have a rigid relationship between supply frequency and speed.

Direct current motor drives are mainly used in applications requiring the control of the speed of the motor (DCA 205.1). In variable speed drives direct current machines are used everywhere; however, today, with the development of power electronics, induction motor drives are also widely used .

In these cases, the speed of the motor can be varied in three different ways: by varying the number of polar couples, by varying the slip speed (DCA 205.2), by varying the supply frequency (DCA 205.3).

LIST OF EXPERIMENTS

DCA 205.1 DC MOTOR DRIVE

- Single-quadrant drive with converter B2C
- Single-quadrant drive with converter B2C and armature voltage feedback
- Single-quadrant drive with converter B2C and armature voltage feedback with RI compensation
- Single-quadrant drive with converter B2C and tacho-voltage feedback
- Single-quadrant drive with converter B2C and tacho-voltage feedback with inner current loop
- Two-quadrant drive (I-IV) with converter B2C
- Two-quadrant drive (I-III) with converter (B2C)2I
- Two-quadrant drive (I-III) with converter (B2C)2I and tacho-voltage feedback with inner current loop
- Four-quadrant drive with converter (B2C)2I
- Four-quadrant drive with converter (B2C)2I and tacho-voltage feedback with inner current loop
- Single-quadrant drive with converter B6C
- Single-quadrant drive with converter B6C and tacho-voltage feedback with inner current loop

DCA 205.2 AC SLIP-RING MOTOR DRIVE

- Control of stator voltage with transformer
- Control of stator voltage with controller W3C
- Control of stator voltage and tacho-voltage feedback
- Rotor starter
- Rotor pulsed resistor
- Rotor pulsed resistor and tacho-voltage feedback
- Scherbius static drive
- Scherbius static drive and tacho-voltage feedback

DCA 205.3 AC SQUIRREL CAGE MOTOR DRIVE

- Preliminary investigation of the squirrel cage motor
- Six-pulse PAM
- Pulsed square-wave triggering
- Trapezoidal modulation
- Pulse width modulation (PWM)



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- Voltage vector control (VVC)
- Motor magnetization for linear U/f characteristic
- Extra start magnetization
- IxR compensation
- Operation in standard converter setting
- Slip compensation
- Motor operation in star connection
- Brake chopper
- Speed control with tacho-voltage feedback

Code	Description	DCA 205.1	DCA 205.2	DCA 205.3	Total quantities
DL 2603	GROUP OF DIODES		1		1
DL 2605	GROUP OF SCR	2	1		2
DL 2609	IGBT		1		1
DL 2613	DC POWER SUPPLY	1	1	1	1
DL 2614	VOLTAGE REFERENCE GENERATOR	1	1	1	1
DL 2615	TRIGGER POINT LIMITER	1	1		1
DL 2616	TWO PULSE CONTROL UNIT	1			1
DL 2617	SIX PULSE CONTROL UNIT	1	1		1
DL 2619	PWM/PFM/TPC CONTROL UNIT		1		1
DL 2620	RUN-UP CONTROL UNIT	1	1		1
DL 2622	PID CONTROLLER	1	1	1	1
DL 2623	ABSOLUTE VALUE GENERATOR	1			1
DL 2624	ADAPTIVE PID CONTROLLER	1			1
DL 2625	MATCHING AMPLIFIER	1			1
DL 2626	MAINS TRANSFORMER	1	1		1
DL 2628	SUPER FAST FUSES	1	2		2
DL 2630	CURRENT TRANSFORMER	1			1
DL 2631	TRIGGER PULSE SWITCH	1			1
DL 2632	SWITCHING LOGIC	1			1
DL 2634	VOLTAGE DIVIDER 20:1	1			1
DL 2635	LOAD	1	1	1	1
DL 2636	SOCKETS WITH LAMPS	1			1
DL 2637	STABILIZED POWER SUPPLY	1			1
DL 2643	SUPPORT WITH 3 SHUNTS 1 OHM	1	1		1
DL 2646	FREQUENCY CONVERTER			1	1
DL 2648	PWM CONTROL UNIT			1	1
DL 2655	VARIABLE THREE PHASE TRANSFORMER		1		1
DL 2025DT	TACHOMETER	1			1
DL 2108SAL	SINGLE PHASE SUPPLY UNIT			1	1
DL 2108TAL-SW	THREE PHASE SUPPLY UNIT		1		1
DL 2109D33	TRUE RMS METER	2	2	1	2
DL 2109T3PV	MOVING IRON VOLTMETER		1		1
DL 2109T2A5	MOVING IRON AMMETER	1	1		1
DL 10115A1	SQUIRREL CAGE THREE PHASE MOTOR			1	1
DL 10120A1	SLIP RING THREE PHASE MOTOR		1		1
DL 10120RA	ROTOR STARTER	1	1		1
DL 10200A1	SHUNT EXCITATION DC MOTOR	1			1
DL 10250A1	SHUNT EXCITATION DC GENERATOR	1			1
DL 10300P	POWDER BRAKE		1	1	1
DL 2006D	LOAD CELL		1	1	1
DL 10300PAC	POWDER BRAKE CONTROL UNIT		1	1	1
DL 10400	BASE	1	1	1	1
DL 10410	FLYWHEEL			1	1
DL 2100-3M	FRAME	2	2	2	2
DL 1001-1	WORKING BENCH	1	1	1	1
DL 1155POW	CONNECTING LEADS	1	1	1	1
	Accessory:				
DL 2100TA	STORAGE CABINET	1	1	1	1
	For the Countries where the 3-phase mains supply is different from 380V:				
DL 2600TTI	THREE PHASE TRANSFORMER	1	1	1	1



POWER ELECTRONICS TOTAL CONFIGURATION

The code **DCA TOT** covers all modules and experiment described in the previously configurations.

Code	Description	DCA 201.1	DCA 201.2	DCA 202.1	DCA 202.2	DCA 203.1	DCA 203.2	DCA 204.1	DCA 204.2	DCA 205.1	DCA 205.2	DCA 205.3	DCA TOT
DL 2601	SELENIUM RECTIFIER	1											1
DL 2602	SILICON DIODE	1				1	4						4
DL 2603	GROUP OF DIODES	1	1	1							1		1
DL 2604	SCR		1										1
DL 2605	GROUP OF SCR		1	1						2	1		2
DL 2607	TRIAC			1									1
DL 2608	MOSFET					1							1
DL 2609	IGBT					1	2				1		2
DL 2610	GROUP OF IGBT							1					1
DL 2611	BRIDGE THREE PHASE RECTIFIER					1	1	1					1
DL 2612	SCR WITH TURN OFF CIRCUIT					1							1
DL 2613	DC POWER SUPPLY		1	1		1	1	1	1	1	1	1	1
DL 2614	VOLTAGE REFERENCE GENER.		1	1		1	1	1	1	1	1	1	1
DL 2615	TRIGGER POINT LIMITER		1							1	1		1
DL 2616	TWO PULSE CONTROL UNIT		1	1						1			1
DL 2617	SIX PULSE CONTROL UNIT		1	1						1	1		1
DL 2619	PWM/PFM/TPC CONTROL UNIT					1	1	1			1		1
DL 2620	RUN-UP CONTROL UNIT									1	1		1
DL 2622	PID CONTROLLER									1	1	1	1
DL 2623	ABSOLUTE VALUE GENERATOR									1			1
DL 2624	ADAPTIVE PI CONTROLLER									1			1
DL 2625	MATCHING AMPLIFIER							1		1			1
DL 2626	MAINS TRANSFORMER	1	1	1	1	1	1	1		1	1		1
DL 2627	CAPACITORS					1	1	1					1
DL 2628	SUPER FAST FUSES	2	2	1		1	1	1		1	2		2
DL 2629	SWITCHING TRANSFORMER						1						1
DL 2630	CURRENT TRANSFORMER					1				1			1
DL 2631	TRIGGER PULSE SWITCH									1			1
DL 2632	SWITCHING LOGIC									1			1
DL 2633	FUNCTION GENERATOR							1					1
DL 2634	VOLTAGE DIVIDER 20:1									1			1
DL 2635	LOAD	1	1	1		1	1	1	1	1	1	1	1
DL 2636	SOCKETS WITH LAMPS		1		1					1			1
DL 2637	STABILIZED POWER SUPPLY		1					1		1			1
DL 2639	PHASE CONTROL FAULT SIM.				1								1
DL 2640	EMI FILTER												1
DL 2643	SUPPORT WITH 3 SHUNTS 1 OHM	1	1	1		1	1	1		1	1		1
DL 2644	SUPPORT WITH 3 SH. 0.1 OHM		1				1	1					1
DL 2646	FREQUENCY CONVERTER								1			1	1
DL 2648	PWM CONTROL UNIT											1	1
DL 201SW	POWER EL. SW												1
DL 2655	VARIABLE THREE-PHASE TRANSF.										1		1
DL 12B12	BATTERY STACK		1										1
DL 2025DT	TACHOMETER		1			1				1			1
DL 2108SAL	SINGLE PHASE SUPPLY UNIT								1			1	1
DL 2108TAL-SW	THREE PHASE SUPPLY UNIT										1		1
DL 2109T26	POWER METER			1									1
DL 2109D33	TRUE RMS METER	2	2	2		2	2	2	2	2	2	1	2
DL 2109T3PV	MOVING IRON VOLTMETER	1	1	1							1		1
DL 2109T2A5	MOVING IRON AMMETER	1	1							1	1		1
DL 10115A1	SQUIRREL CAGE THREE PHASE M.											1	1
DL 10120A1	SLIP RING THREE PHASE MOTOR										1		1
DL 10120RA	ROTOR STARTER										1		1

