WIND POWER PLANT

DL WPP

This trainer allows the students to study the functions and operations of a modern wind power plant simulating on it the effects of the wind force.

It is designed starting with a few related concepts providing in-depth coverage of basic topics related to the field of electrical energy produced from the wind and some major aspects about Wind Power Plant management.

This system operates through a brushless machine and the simulation software, and the Doubly-fed Asynchronous Generator (DFAG) or (DFIG – Doubly-fed Induction Generator) allows a practical and effective approach to this trainer.

Doubly fed electrical generators are like AC electric generators but have additional features which allow them to run at speeds slightly above or below their natural synchronous speed. This is useful for large variable speed wind turbines because wind speed can change suddenly.

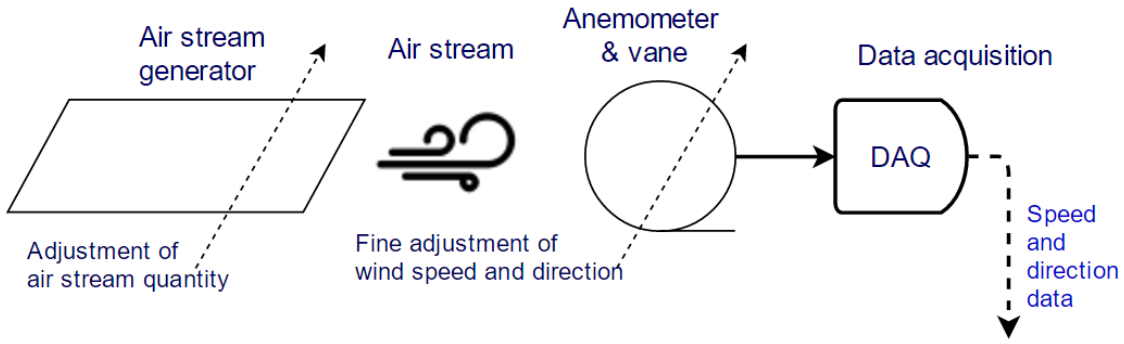
The DFAG can change the speed of the generator rotor by means of controlling the frequency of the rotor field current. When a gust of wind hits a wind turbine, the blades try to speed up, but a synchronous generator is locked to the speed of the power grid and cannot speed up. So large forces are developed in the hub, gearbox, and generator as the power grid pushes back. This causes wear and damage to the mechanism. If the turbine is allowed to speed up immediately when hit by a wind gust, the stresses are lower with the power from the wind gust still being converted to useful electricity.

One approach to allowing wind turbine speed to vary is to accept whatever frequency the generator produces, convert it to DC, and then convert it to AC at the desired output frequency using an inverter. This is common for small house and farm wind turbines. But the inverters required for megawatt-scale wind turbines are large and expensive.

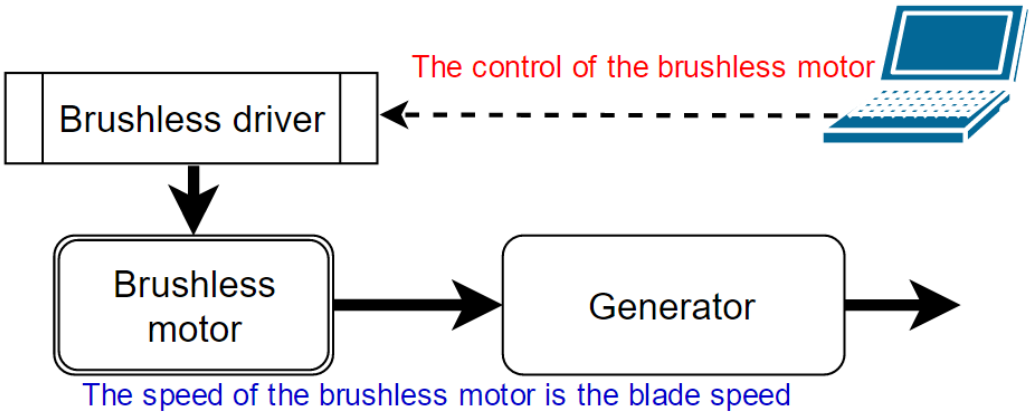
This proposed trainer has a modular structure that will grant teachers and students extreme flexibility during the study of the related topics and the performance of the experiments.
It is divided, from the hardware point of view, in:

- PC with the specific software,
- Wind sub-model,
- Turbine sub-model,
- Frame with modules required for running the Wind Power Plant trainer.

For the **Wind sub-model**, it has the architecture shown below:



For the **Turbine sub-model**, it has the architecture shown below:



The frame includes all the remaining modules of the **DL WPP** trainer such as:

- PC with SCADA application,
- Three- phase power supply unit,
- Three- phase power measuring unit,
- High power switches with local and remote control,
- Brushless driver,
- Hub for communication.

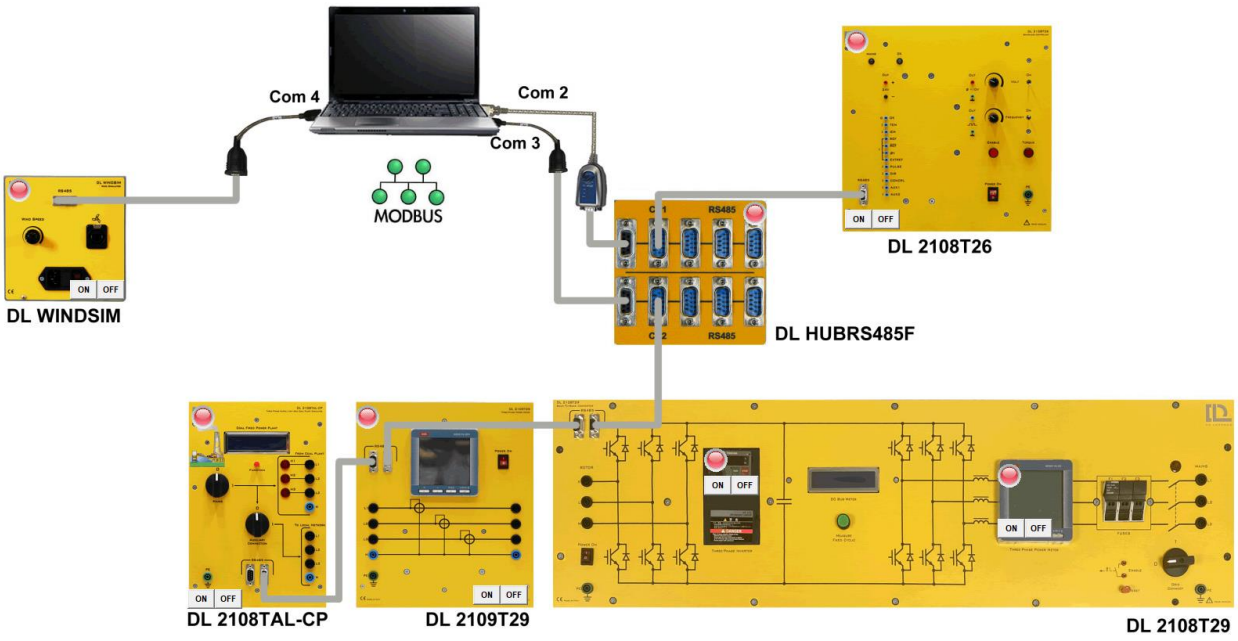
And the main essential control unit of the trainer is the **Back-to back converter**.

RENEWABLE ENERGIES

This control unit allows approaching and theoretically in depth analyzing the following topics:

- Operation of the DFAG,
- Integrated power switch for switching the generator online,
- Reactive and active power, frequency, and voltage control,
- Mains synchronization.

The following figure shows the modules that are wired to the RS485 network through the HUB communication unit:



As previously mentioned, this trainer is complete with interactive multimedia **SCADA** software that can control and set several operations of the system; with this software it is possible to adjust the wind speed and profile and to examine the effects on the operating functions of a real Wind Power Plant. Another important feature of this software is related to the possibility to control, parameterize and visualize the obtained data.

With this software it is possible to perform the following activities:

- Measurement, calculation, and graphic representation of many mechanical and electrical operating parameters,
- Selection of the set-point values for reactive and active power,
- Definition and simulation of wind power and profiles,
- Interactive experiments set-up,
- Values and graphs can be stored,
- Experiments instructions can be viewed directly from the software,
- Possibility to print documents for easy hardcopy printing of experiments instructions with solutions.

With this Wind Power Plant trainer, it is possible to perform the following experiments:

- Study of functions and operations of a modern Wind Power Plant,
- Relationships between a pitch control system and the wind,
- Analysis of the mechanical parameters within an induction generator,
- Analysis of the electrical parameters within an induction generator,
- AC/DC and DC/AC IGBT converter,
- Starting method of a Wind system,
- DFIG (Doubly fed Induction Generator).

Optional modules could be added to the main configuration of **DL WPP** (see **Configurations** at the end of this catalogue) to also perform:

- Experiments on the **Fault Ride Through** control.

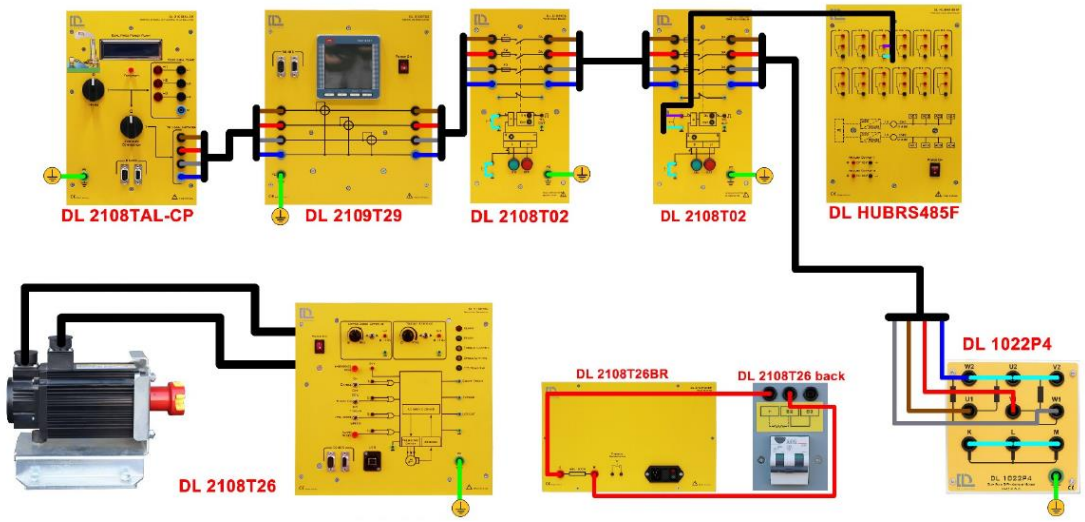
This last optional part Fault Ride Through (**FRT**), sometimes Under-Voltage Ride Through (**UVRT**), or Low Voltage Ride Through (**LVRT**), is the capability of electric generators to stay connected in short periods of lower electric network voltage. It is needed at distribution level to prevent a short circuit at HV or EHV level from causing a widespread loss of generation.

The **DL WPP** trainer is dedicated, first, to students with some electromechanical background who want to understand the use of the wind power plant in the generation of electrical energy.
It is also suggested to be used in the following:

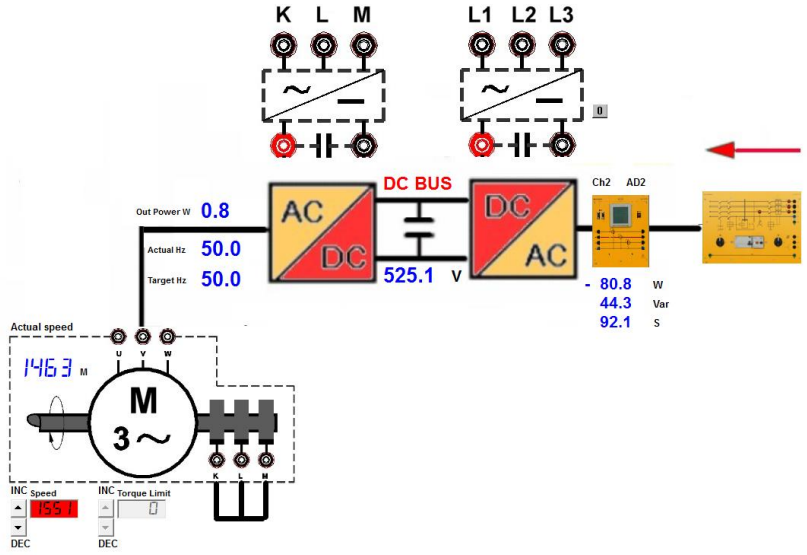
- Departments and/or faculties such as for
  - Mechanical Engineers,
  - Electrical Engineers,
  - Wind farm developers,
  - Renewable Energy field Engineers,
  - Control system Engineers,
  - SCADA developers.
- Postsecondary schools such as for
  - Wind energy technicians,
  - Electromechanical technicians,
  - Power systems electrical technicians,
  - SCADA technicians,
  - Electrical utility technicians.
- Trade schools/colleges and technical institutes and further education such as for
  - Senior multi skilled technicians in electromechanical Engineering,
  - Electrical/Mechanical technology technicians,
  - Field service technicians,
  - Electrical utilities technicians.
- Vocational secondary school of electrical and/or mechanical Engineering.

Power supply: Three-phase 400V+N+PE/50Hz, 2kVA.

Power wiring diagram taken from the manual:



Screen capture example of the SCADA software:



CONFIGURATIONS

DL WPP

DL 2108T26	BRUSHLESS CONTROLLER WITH MOTOR	1
DL 2108T26BR	BRAKING RESISTANCE	1
DL 1022P4	SLIP RING THREE-PHASE ASYNCHRONOUS MOTOR	1
DL 1013A	BASE	1
DL 2108TAL-CP	THREE PHASE SUPPLY UNIT	1
DL 2109T29	THREE-PHASE POWER METER	1
DL 2108T29	BACK TO BACK INVERTER	1
DL 2108T02	POWER CIRCUIT BREAKER	3
DL HUBRS485F	MODBUS COMMUNICATION HUB	1
DL WINDSIM	WIND SIMULATOR	1
DL SCADA-WEB	SOFTWARE SCADA	1
DL 1155WPP	KIT OF CONNECTING LEADS	1
DL A120-3M-LED	THREE-LEVEL FRAME WITH LED STRIP	1
DL PCGRID	ALL-IN-ONE PERSONAL COMPUTER	1
DL T12090_SK	WORKBENCH 120X90	1
DL T06090	WORKBENCH 60X90	1
DL 1196	HOLDER FOR LEADS	1
DL 2600TTI	THREE-PHASE ISOLATION TRANSFORMER	1

OPTION MODULES FOR THE FAULT RIDE THROUGH (FRT)

DL 7901TT	LINE MODEL	1
DL 2108T18	MULTIFUNCTION THREE-PHASE OVERVOLTAGE/UNDERVOLTAGE RELAY	1
DL 1017R	RESISTIVE LOAD	1
DL 2108T02	POWER CIRCUIT BREAKER	1