ZIGOR CORPORACIÓN S.A.

GRID INTEGRATION SEMINAR
TECHWINDGRID 09

INNOVATION IN VOLTAGE CONTROL SYSTEMS FOR AN OPTIMAL WIND TURBINES ELECTRICAL INTEGRATION

SEPEC EOLICO

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NOTICE :

All data shown in this presentation comes from the test results obtained from equipments designed and manufactured by ZIGOR CORPORACIÓN.

All data about Topology advantages and disadvantages are obtained from our own developments and do not refer directly or indirectly to any solution from other manufactures.

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ZIGOR CORPORACIÓN S.A.

ZIGOR

Zigor is committed to the Research, Design, Manufacture and Sale of products and services in fields such as DC/AC Power Conversion Systems, Development of Customised Electronic Solutions and Renewable Energy, in an attempt to strengthen the current Energy Model.

HOW?

- **Guaranteeing the construction of a future based on uninterruptible and incident-free power supplies.**
- **Allowing to our clients to obtain greater profitability from their investments and by optimising Energy Saving.**

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ZIGOR -Innovation commitment

KEYS TO COMPETE

- Zigor Corporation Invests more than 1.350.000 USD per year to the new products development in favour to the High Electronic technology.
- Electronic CAD-Based Simulations are systematically done at schematic design stages.
- The Advanced Modelling and Simulation Tools highly reduce Zigor's product launching time and increase the reliability of the designs.
- At prototyping stage, Advanced Test Software and Equipment are available to guarantee specs and qualification test fulfilment.
- Zigor Microelectronic Designs (Hardware & Software) are fully developed in in-house, achieving highly robust and prise competitive devices.
- Zigor products final test is assisted by Automated Protocols (using Labview&TestStand), reducing errors and manufacturing test times.

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ZIGOR Products Portfolio

PROTECTION & BACK-UP:

* Uninterruptible Power Supplies (UPS series).
* Surge protections (SIL range).

ENERGY SAVING & EFFICIENCY:

* Energy optimising centre (COE range).
* Light Flow Regulator/Power Reducer (SET LUX range).

RENEWABLES:

* Solar energy: Photovoltaic modules, Solar Kits, Photovoltaic components, Single phase/Three phase solar inverters for On-grid and Off-grid systems. (SUN ZET range), etc.
* Wind energy: Off-grid solutions, System designed to Adapt Wind turbines (EOLIC SEPEC), etc.

DIRECT CURRENT:

* Battery rectifier-chargers, (MIT range).
* Power supplies.
* Converters.

BATTERIES:

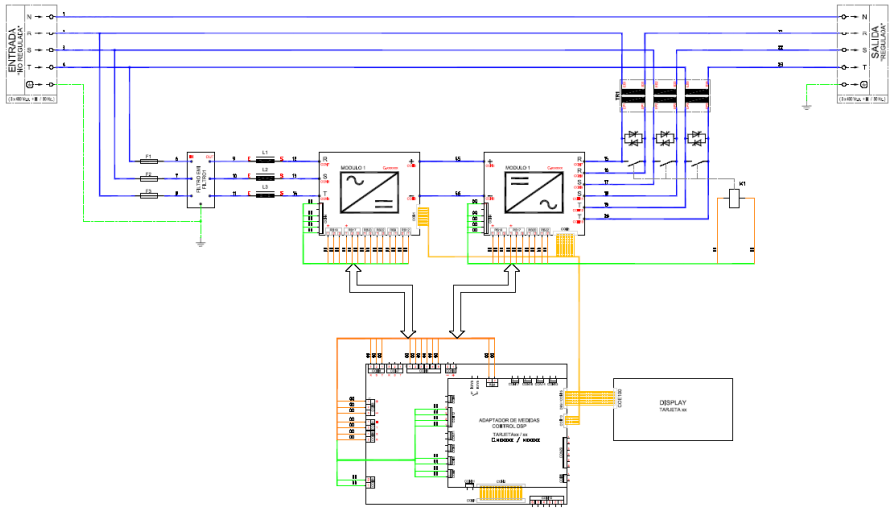
*Valve Regulated Lead Acid batteries VRLA.
*Nickel Cadmium batteries.

POWER QUALITY:

* Voltage sags compensation systems for high power industrial processes (SET DVR range).
* High Power UPS Systems for Total Immunisation of Industrial Processes (SEPEC range).
*Passive harmonic filter.
*Over voltage protectors.

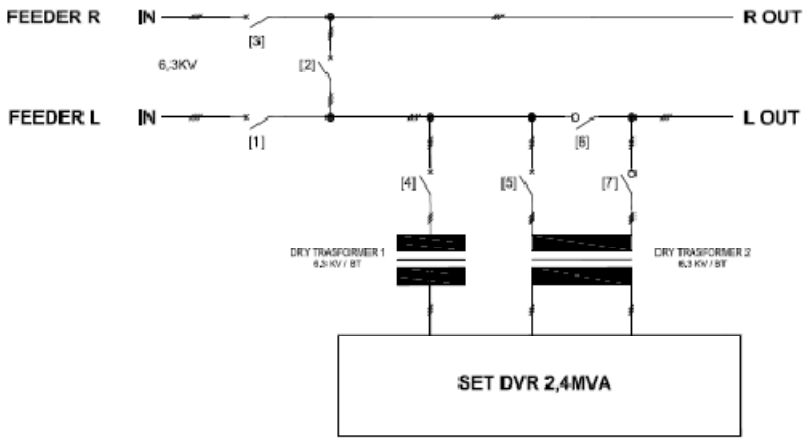
SET DVR LV ...series distributed

- MTBF EQUIVALENT TO FULL CONVERTER.
- HIGHER WIND FARM AVAILABILITY AGAINST CENTRALIZED ONE
- HIGH PERMANENT LOSSES, 3% - 6%, TRANSFORMER, FILTER & IGBT´s
- TECHNICALLY SUITABLE FOR THOSE MACHINES SENSITIVE TO FAST DISTURBANCES
- HIGHER COST COMPARED WITH OTHER TOPOLOGIES



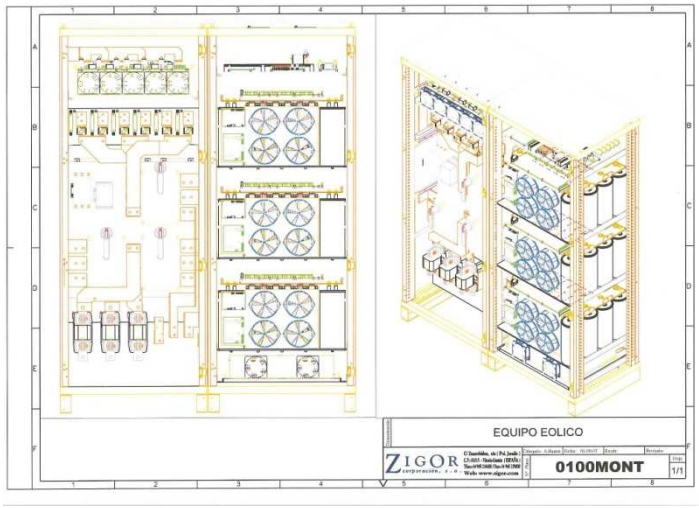
SET DVR MV …series centralized

- ENVIRONMENTAL IMPACT
- HIGH COST FOR HIGH YIELD & 0,2 P/U
- HIGH OVER CURRENTS (> 2Inom. -> + Cost or - Efficiency)
- MTBF EQUIVALENT TO FULL CONVERTER
- HIGHER AVAILABILITY IN DISTRIBUTED ARQUITECTURE THAN IN CENTRALIZAED ONE.
- HIGH PERMANENT LOSSES,
- 4%- 6% TRANFORMER,
- FILTER & IGBT´s



SET Q …parallel distributed

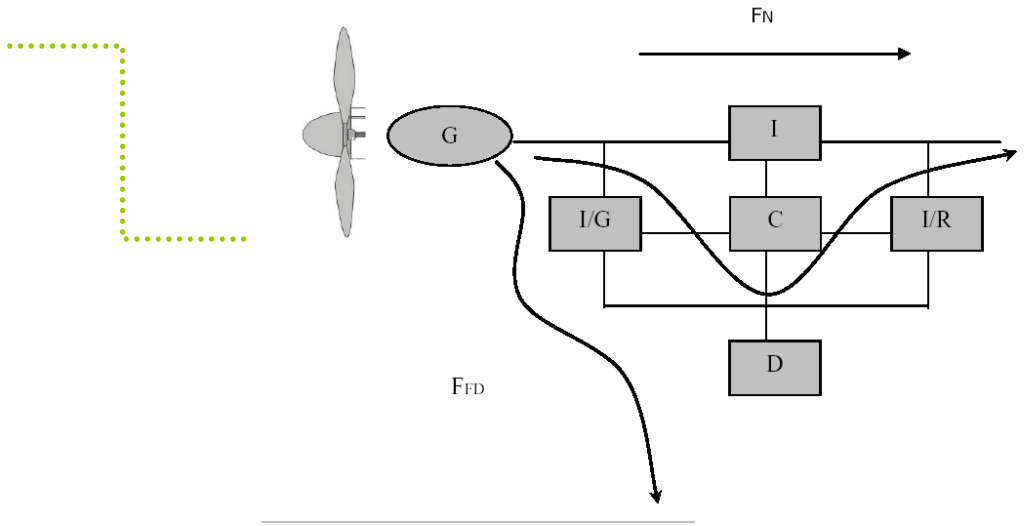
- MODE A: RISING THE GRID VOLTAGE
  - HIGH OVERCURRENTS: 13 TIMES THE NOMINAL
  - VERY HIGH POWER REQUIRED TO COMPLY WITH 0,2 PU
- MODE B: GENERATING THE REACTIVE POWER CONSUMED BY MACHINE DURING FAILURE
  - MECHANICAL AND ELECTRICAL TRANSIENTS
  - PROTECTIONS MUST BE UNSETTLE
  - UNPREDICTIBLE DESINCRONIZATION



SEPEC EOLICO …just optimal

- SEPEC EOLICO is interconnected between generator and network. In normal network regime it behaves like a closed switch. During the failure, it behaves as follows:
  1. With regard to the wind turbine, voltage voltage is supplied as if it came from network and the wind turbine is kept in normal operation.
  2. With regard to the network, an active and reactive pattern is generated in accordance to the needs of the network.
  3. During the failure, excess power is dissipated internally by **SEPEC EOLICO**.

Optional, SET Q can be fitted to adapt reactive power both during the gap and in permanent regime.

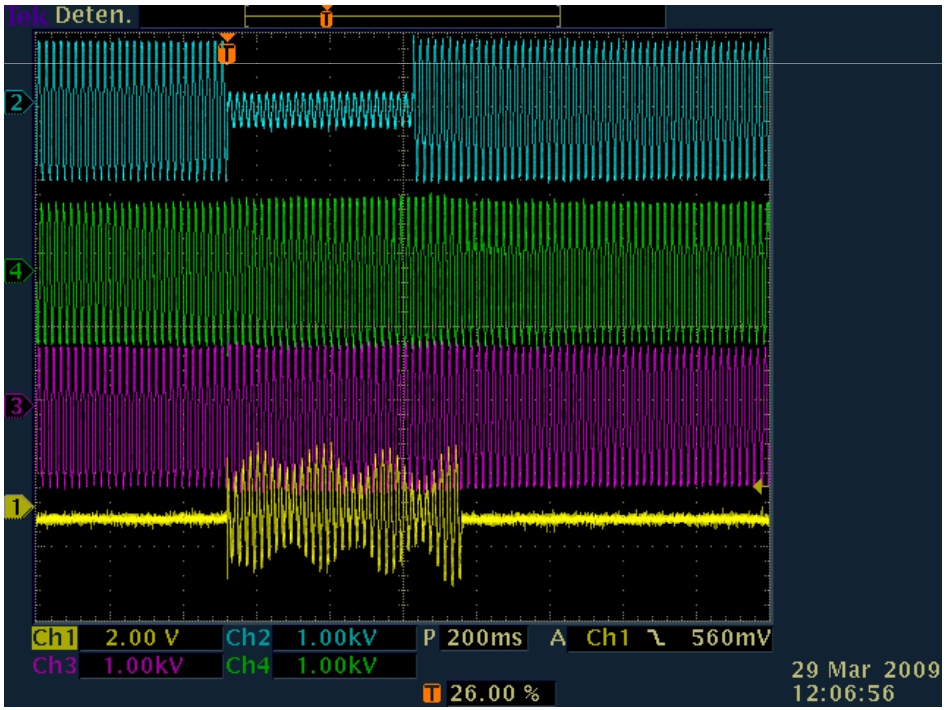


SEPEC EOLICO … protections =

- We do not disconnect wind turbine unnecessarily and provide the network with what it needs during the failure/sag.
- Sags no longer produce electrical/mechanical transients, thereby reducing the premature ageing of the machine. No need to unsettle the protections
- This allows the unit to operate with ant kind of wind turbine, irrespective if the technology and power of machine.

SEPEC EOLICO ... field test

- Field test usisng a sag generator in the NM750 turbines under different load conditions
- Following the PO 12.3 "procedimiento particular" for the Spanish Grid Code and its corresponding verification protocol.

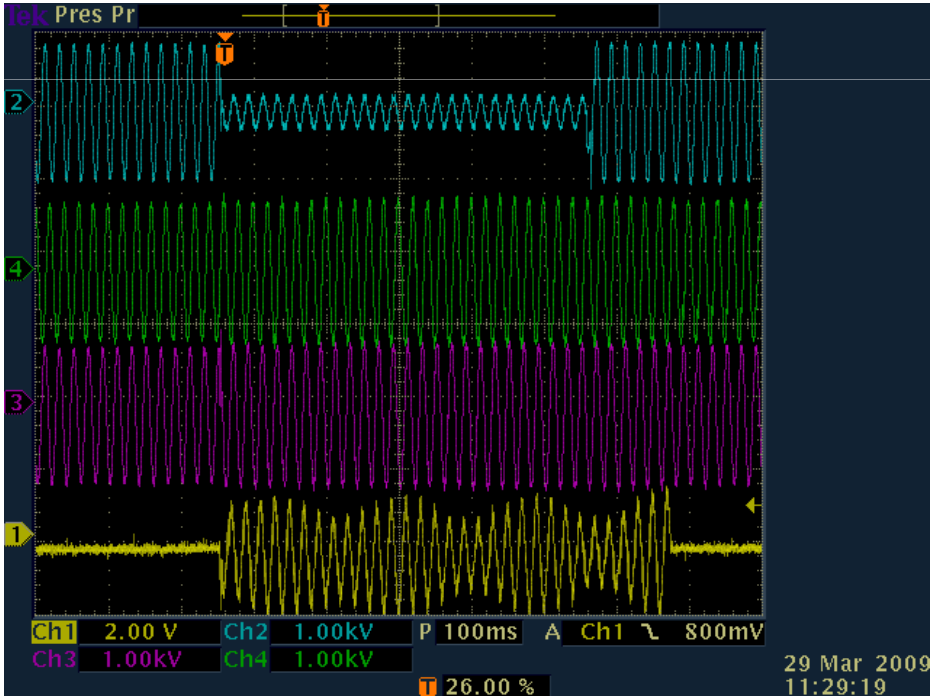


Successful test

SEPEC EOLICO Certificated

SEPEC EOLICO … field test

- No need to UNSETLE the Wind Turbine Protections since no Overcurrent occurs.
- The Wind Turbine do not suffer from overlvoltage.



1. **Transfer Time = 1 miliseocond**
2. **Voltage = Nominal One**
3. **No vercurrent**

CONCLUSIONS ...summary

- ZIGOR offers different solutions
  - SET DVR LV — *Distributed series*
  - SET DVR MV — *Centralized series*
  - SET Q (Stat Com style) — *Parallel Distributed*
  - SEPEC EOLICO — *Optimal distributed*

- For Wind Farms Ride Through: SEPEC **EOLICO** = OPTIMAL
  - Better TOPOLOGY and independence from the Machine
  - Better Efficiency and no unsettle of protections needed
  - Better MTBF
  - Better ROI Investment + Operating expenses
  - Compatible with 0 PU Grid Codes

CONCLUSIONS ...summary

Solution	Efficiency	Electrical Dynamic Stability	Mechanical Dynamic Stability	Investment	ROI	MTBF	MTTR	PO-14.3 Compliance *
ZIGOR SEPEC EOLICO	Good	Good	Good	Good	Good	Good	Good	Good
DOUBLE CONVERSION	Low	Good	Good	High	Low	Low	Low	Possible overvoltage after recovery failure
DVR	Global when used with transformer	Good	Good	Very high	Low	Level	Good	Virtually impossible to comply with 0 pu voltage in the case of three-phase failures
FACT	Good	Very difficult to avoid problems of synchronisation with low investment	Possibility of rapid mechanical ageing	High for adequate sizing	Good	Good	Good	Requires high investment

*** For Spanish Grid Code**

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SEPEC EOLICO

System designed to Adapt Wind turbines
(Irrespective of their Technology) to cope with voltage sags in order to guarantee continuous operation.

MANY THANKS FOR YOUR KIND ATTENTION