



Why REGATRON Switzerland – Programmable Power Equipment

Versatile Solution Provided by Regatron AG

Keywords

Programmable Solar Array Simulation, Bidirectional DC Power Source for Electrical Energy Storage Testing and Simulation, EM (Electro Mobility), Drive Train Testing and Simulation, TC.ACS Programmable Bidirectional AC Grid Simulation, Simulation and Research on Smart Grid Structures, HIL (Hardware-In-The-Loop), Investigations and Research on Complex Physical Grid Structures.

Why REGATRON Switzerland – the Challenge

During the last 15 years, the situation in the field of Electric Power changed dramatically. The usual big power plants were more and more competed by so-called additive energy sources like solar, wind-based and biological energy sources. By this, the structure and dynamic behaviour of electric grids became more complex, new regulations became necessary in order to warrant for a trouble-free operation of power distribution.

Because of their partly “anticyclic” comportment, additive energy sources called for storage technologies to preserve temporary energy excesses for periods of high demands.

At the same time, electric power was introduced successful as drive technology within the automotive market as well. Hybrid, mini-hybrid and full range electrical drives entered the mobility market and caused an immense technology leap.

The above given facts created a number of completely new challenges within the field of electrical equipment development, testing and application:

- Simulation of small and big power solar arrays under a wide variety of environmental conditions in order to enable the developers for optimum hard- and software concepts
- Test equipment for solar inverters on the AC grid side: Powerful grid simulators able to reproduce any grid situation in terms of frequency, phase angle, AC voltage, islanding situations, low voltage ride-through, flicker and voltage drops
- Test equipment for any kind of electrical storage elements and complete storage arrays
- Simulation of electrical storage technologies like batteries, high density capacitors, EDLC's as also of unidirectional power sources like fuel cell stacks
- Test equipment for electrical drive trains and their components – capable of sourcing and sinking of the energy flow and recuperate the energy back into the grid with very high efficiency
- Powerful software packages for dedicated application and processes

REGATRON Switzerland was first on the world's market introducing all-digital fully programmable electrical Power Supplies and attended the market since many decades very closely. The REGATRON product portfolio therefore is well matched to the market's requirements and offers among other features one prominent quality: The modular power topology. Ingenious data link techniques allow not only to operate individual units in parallel in order to extend the power system up to MW levels, but even mixed-mode of serial connected units in parallel arrays and vice-versa is possible. By this, a maximum flexibility with respect to changing requirements and future expansion is given.

Why REGATRON Switzerland – the Reasons

1. Well proven, thousand fold established power supply technologies
2. Maximum flexibility by in-deep and comprehensive programming functionality
3. Unrivalled adaptability by series, parallel and mixed-mode connectivity
4. Maximum customer's benefit by modular concept: full functionality from high power configuration down to each individual power supply unit
5. Swiss quality – in-house development, manufacturing and product testing
6. Proverbial excellent customer support by specialized Field Application Engineering Division
7. Specialized application software packages for dedicated operational fields

Application Examples

Solar Array Simulation



TopCon Quadro as also bidirectional TC.GSS power supplies provide full Solar Array Simulation capability alongside with all relevant DC applications. Note especially, that on the contrary to the most competitors REGATRON DC power supplies are processing relevant SAS data in real-time on-board of the power supply.

This of course prevents clearly all disadvantages of the current method using a PC/Laptop as an external data processing system. As PC's are far away from real-time processing, unwanted and randomly occurring transmission time delays degrade the dynamic response of the simulated system in a distinct manner.

The powerful SASControl application software enables the user for well documented programmable Solar Inverter tests and all R&D activities.

Relevant industry sector:

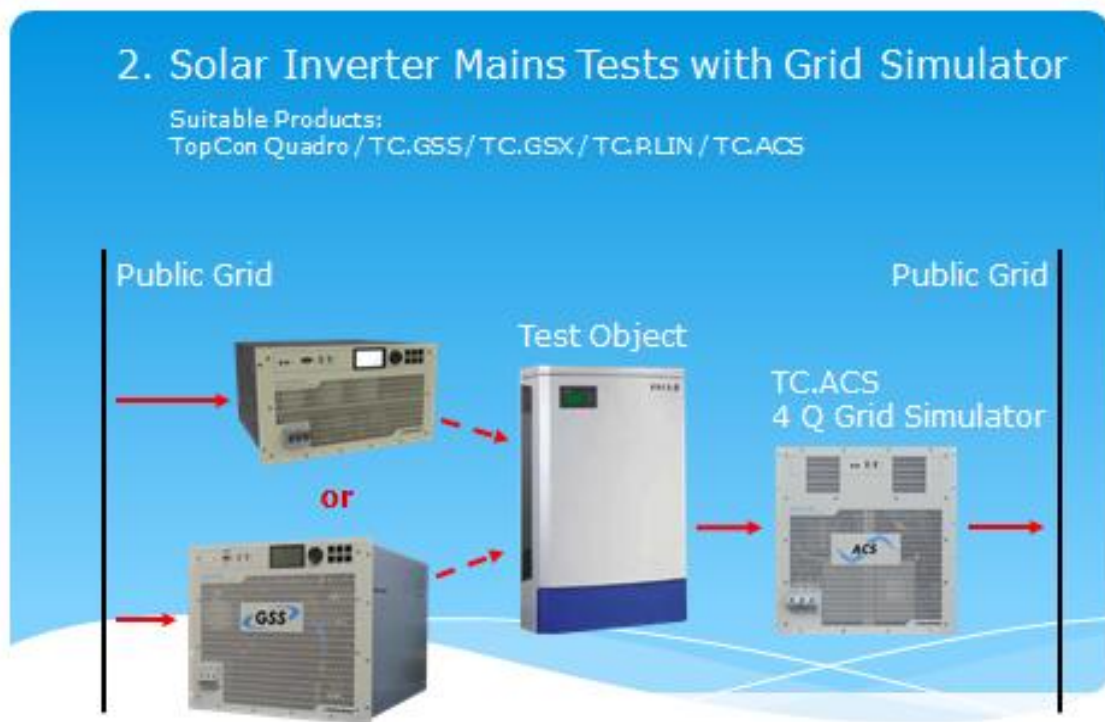
- Solar inverter manufacturers worldwide
- University level power conversion laboratories
- Solar energy R+D institutes and companies
- Test- and qualification institutes and centres
- Institutional authority laboratories

Some of REGATRON's customers (short extract):

SMA, DANFOSS, ABB, FRONIUS, SOLAR EDGE, KACO, AIT, FRAUNHOFER ISE, EUROTEST.

Solar/Wind Grid-tied Inverter Test Including Grid Simulation

The full 4-quadrant **grid simulator TC.ACS** complements the solar array simulation as a universal tool for all relevant grid anomaly test sequences. TC.ACS enables energy to flow in both directions with full rated power and represents therefore an ideal grid simulator for normal energy consuming loads as also for energy feeding elements like grid tied inverters.



All relevant test procedures according to IEEE- and VDE- can be performed, the high degree of programmability gives room for any kind of later extensions. As all REGATRON power supplies, TC.ACS units may be paralleled in order to have full bidirectional power systems up to the MW-range.

Relevant industry sector:

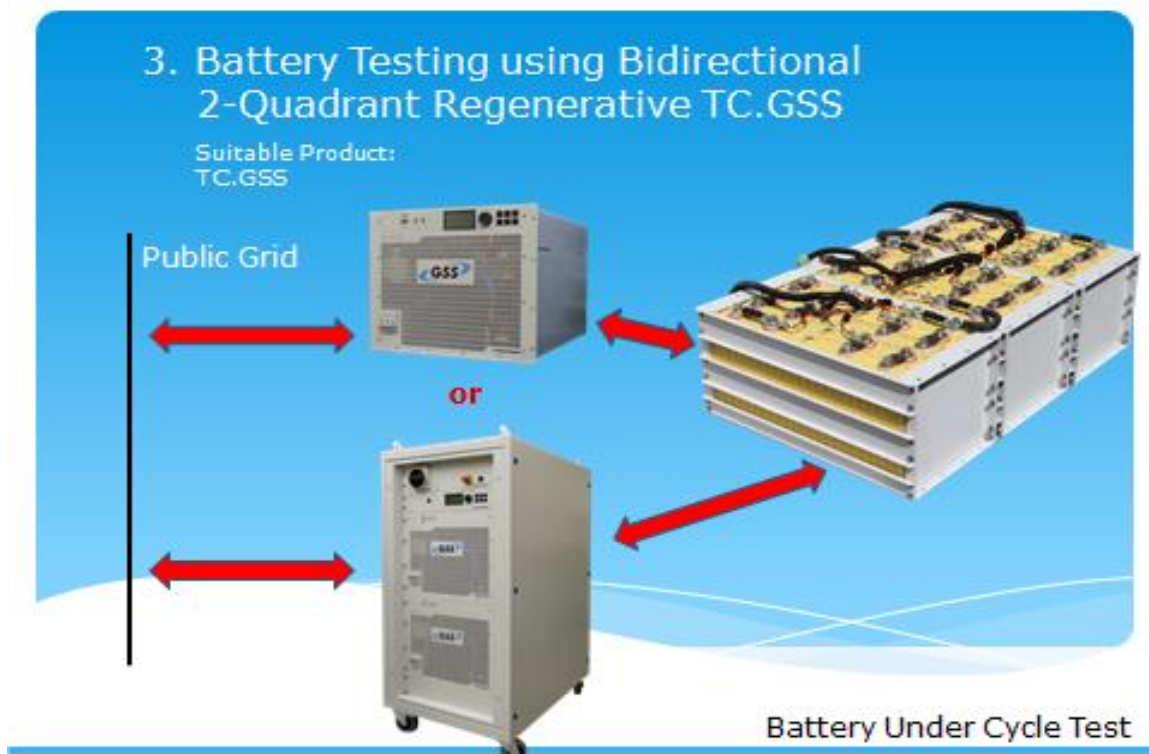
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Some of REGATRON's customers (short extract)

DANFOSS, ABB, FRONIUS, AIT, ENEL, FRAUNHOFER, various universities, IBERDROLA.

Battery Test and Simulation

Bidirectional **TopCon TC.GSS** power supplies are the choice for all source/sink processes to be cycled and tested. Thanks to a state-of-the-art IGBT-technology, reversing the energy flow from sourcing to sinking state lasts only 1 millisecond at full rated power!



Regenerated energy is reinjected into the public grid with a very high efficiency and a perfect power factor.

Again, due to a very high degree of programmability, TC.GSS offer a quite multifunctional tool in the hand of the test engineer.

REGATRON bidirectional power supplies TC.GSS series allow for testing and simulation of all kind of electrical storage elements like batteries, capacitors, EDLC's (SuperCaps).

Of course, also fuel cells may be tested while fully regenerating the energy back to the grid.

Under the control of specialized REGATRON **Battery simulation software**, TC.GSS is the best choice to feed battery alimented Drive Train Systems. The behaviour of different battery types as also variation of relevant battery parameters such as ageing, temperature and internal cell resistance may be varied within wide ranges and allow therefore the simulation of a wide variety of operational conditions.



Relevant industry sectors:

- Automotive drive tests
- Drive train development
- Drive technology R+D
- Battery cell and stack development and tests
- Battery and stack cycle tests
- Electrical storage system tests (capacitors, EDLC's, batteries)
- Airborne on-board supply system tests
- Marine on-board supply system tests and simulation

Some of REGATRON's customers:

AUDI, BMW, BENTLEY, Bombardier, BOSCH, BRUSA, VOLVO, DAIMLER, PORSCHE, FRAUNHOFER, HYUNDAI, JAGUAR, Lotus F1, MAN Trucks, Rolls Royce, SIEMENS, SAMSUNG, Vossloh, Williams F1, ZF, various universities.

General Grid Simulation

TopCon TC.ACS allows for establishing of all imaginable grid situations for R&D and simulation work on generating and regenerating electrical equipment.

Versatile software tools like a programmable sequencer, a Fourier tool or the 3-phase amplifier mode widens up the field of operations within the laboratory.



Relevant industry sectors:

- Electrical equipment manufacturers
- Regenerating product manufacturers and developers
- Test and certificate institutions
- Technical universities and research institutes
- Power distribution authorities and providers
- National electrical power laboratories
- Electrical drive manufacturers and suppliers

Some of REGATRON's customers:

ENEL, Berner Fachhochschule, DANFOSS, FRAUNHOFER, AIT AUSTRIA, ALSTOM, QUALCOMM, KONE, various universities.

Smart Grid Simulation

By combining Regatron DC power supplies with a grid simulator, a complete model of a Smart Grid can be built up. Thus, intensive studies on the dynamic behaviour of grids are made possible.

Within such a system, **TopCon unidirectional DC power sources** take over the role of “additive” energy sources like wind-, solar-, hydro- and biological power generators as also of fuel cells and on. **TopCon bidirectional DC power sources** are best suited for the role of electrical power storage elements as also as simulators for power consumption.

As a third element, the grid tied path may be equipped with **TC.ACS 4-quadrant Grid Simulator**, which is able to simulate various public grid situations up to the ultimate situation of a so-called “Islanding Situation”.



Relevant industry/education sectors:

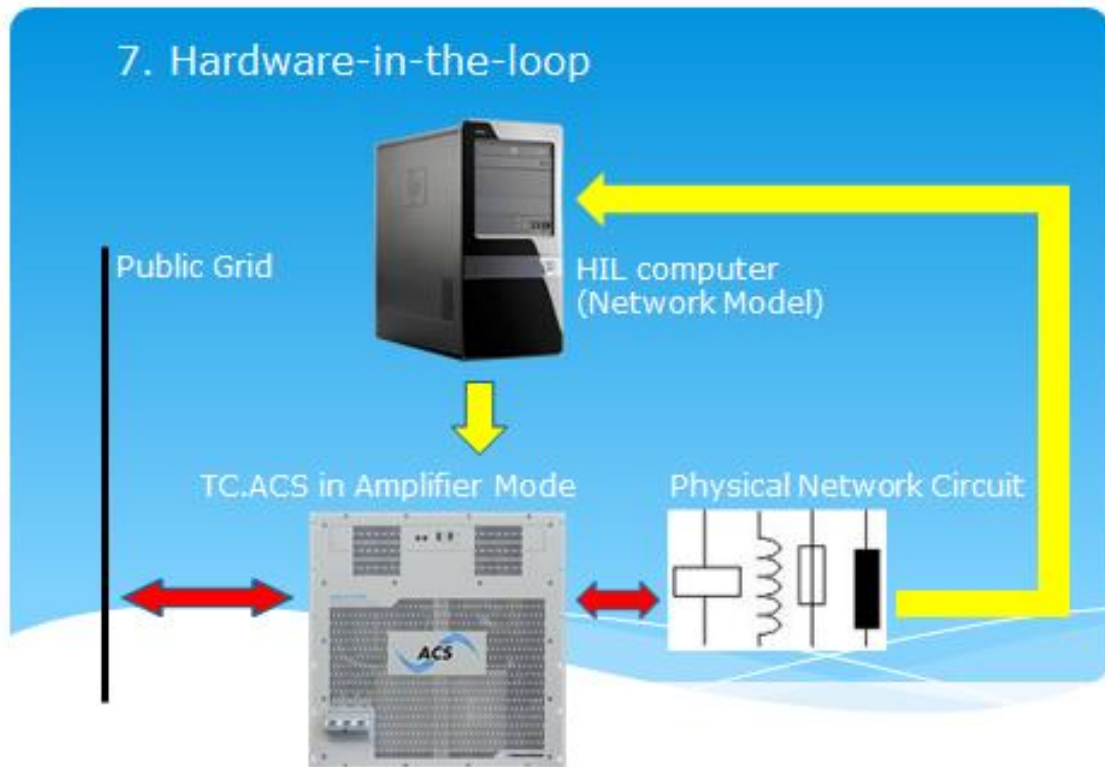
- Technical universities
- Electrical energy providers
- National and international electrical engineering R+D
- “Additive energy” R+D institutes
- Specialized electrical system manufacturers

Some of REGATRON’s customers:

ENEL, University New South Wales, KONE, Aalto University, DANFOSS, ABB, AIT AUSTRIA, FRAUNHOFER IISB, ENPHASE ENERGY, ALSTOM, GENERAL ELECTRIC, QUALCOMM, Hochschule Ulm, Aalborg University, Fachhochschule Würzburg, CNRS France, ETH Lausanne, TÜV Rheinland, LUXCO, Universidad de Oviedo, Sardegna Ricerche, IBERDROLA Formacion, Berner Fachhochschule, Ohmini, Beijing Jiaotong University

HIL - Hardware-in-the-loop

The universal grid simulator TC.ACS may also be operated in an 'Amplifier Mode' and behaves like a 3-phase power voltage amplifier. The exceptionally high modulation bandwidth makes the TC.ACS ideally suited for high dynamic processes. By this, real-time computer-generated data may be fed directly into the three amplifier inputs of the TC.ACS in order to generate high dynamic 3-phase output voltage feeding a dedicated physical network as an example. This allows the user to simulate complex network response to examine the dynamic characteristics of the given network structure.



Relevant industry/education sectors:

- Technical universities and associated educational sites
- Electrical grid providers
- National and international electrical engineering R+D
- "Additive energy" test and R+D institutes
- Specialized electrical system manufacturers

Some of REGATRON's customers:

ENEL, University New South Wales, AVL, KONE, Aalto University, DANFOSS, ABB, AIT AUSTRIA, FRAUNHOFER IISB, ENPHASE ENERGY, ALSTOM, GENERAL ELECTRIC, QUALCOMM, Hochschule Ulm, Aalborg University, Fachhochschule Würzburg, CNRS France, ETH Lausanne, TÜV Rheinland, LUXCO, Universidad de Oviedo, Sardegna Ricerche, IBERDROLA, Berner Fachhochschule, Ohmini, Beijing Jiaotong University

Conclusion

Regatron power supplies are an ideal solution for general laboratory use up to highly complex industrial and research applications. Due to the exceptional functionality, not only the usual laboratory work is covered. The high degree of programmability allows for a wide field of more complex applications, mainly supported by specialized application software.

Contrary to many other power supply manufacturers, Regatron power supplies are specially designed for modular use:

- enhance your system power at a later time upon your needs
- connect the power modules either in parallel, in serial or even in a mixed-mode
- establish a multi-load system by controlling multiple individual loads with a single set value
- use the built-in programmable function generator TFE to modulate or 'dynamize' the output
- reach within the MegaWatt range by controlling big TopCon arrays with one MAC-controller
- stay open for future challenges with an updateable and fully parameter-controlled system

A proposal for a basic power level equipment

For a multitude of lab setups the following power level will be a good choice, without supposing significant electrical environment complexity in terms of grid capacity, laboratory air management and installations:

64 kW/1000V / TopCon Programmable DC power: 2 x TC.P.32.500.400 as DC source

- gives a 1000VDC/80A source for powerful central inverter tests (series connection)
- gives a 500VDC/160A source for central inverters high current types (parallel operation)

64 kW/400V / TopCon TC.GSS Bidirectional power: 2 x TC.GSS.32.400.400 bidirectional DC source

- gives a 800VDC/100A bidirectional source for drive trains, battery simulation and tests
- gives a 400VDC/200A bidirectional source for drive trains, battery simulation and tests

50 kVA/3x400VAC Grid Simulation: 1 x TC.ACS.50.480.400

- gives a 50kVA full 3-phase grid simulator with up to 72 Arms each phase
- may act as an asymmetric 1- or 2-phase load
- may act as DC power source at reduced power level
- may be operated as a 3-phase bidirectional power amplifier

By adding modules, the power level may be increased selectively step by step upon the customers' needs.