

TopCon TC.ACS

Full 4-quadrant grid simulators, 'HIL mode' 4-quadrant voltage amplifier,
Programmable RLC load mode

Field of Application

Due to the growing use of additional and regenerative energy systems such as solar, wind and biomass energy plants, the observance of strict grid feeding specifications is becoming more and more important for the manufacturers. By using Grid Simulators the various required power conditions as well as failures and interferences in the power system can be exactly generated. Already today detailed testing standards for power feedback units have been settled. We can expect these rules and standards to be expanded in the near future.



Figure 1: TC.ACS Grid Simulator

REGATRON TC.ACS Grid Simulators are based on the latest multi-level inverter technology and dispose of an open an upgradeable system architecture, allowing the possibility tp parametrize the system characteristics mainly by us

TC.ACS is offering a second highlight:The 4-quadrant amplifier mode. Apply your 'HIL' phase signals to the TC.ACS amplifier inputs and generate a 1 to 3-phase power grid on your intentions. HIL (hardware-in-the-loop) is a fast spreading method for real-time simulation of grid dynamic behaviour and 'smart grid' analyses.

The third application mode is the RLC-load mode: Program the impedance of your envisaged load and TC.ACS will behave like the equivalent circuit formed by real inductors and resistors. Of course, incidental power will be fed back to the mains grid with maximum efficiency.

Programmable testing parameters

The multi-level inverter technology common with a remarkable high switching frequency opens up the way to a wide base frequency range from DC up to 1000Hz and an exceptionally high modulation bandwidth of 5 kHz. Therefore, harmonic distortion up to the 100th harmonic @ 50 Hz or the 83th harmonic @ 60Hz can be exactly reproduced, assisted by a comfortable Fourier tool. Of course, the system can easily and comprehensively be adapted to the various tasks to be carried out within the fields of R+D, laboratory, end-of-line testing and education. By means of the application software ACSControl, the user is enabled to program the following parameters:

- variation of basic system voltages and frequency
- settings of phase relationship
- voltage drops in the whole network or individual drops per phase
- micro ruptures and flickers
- over- and under voltages
- voltage asymmetries
- superimposed harmonic and interharmonic voltage waveforms
- variation of phase angles
- special conditions for EMC testing
- transition from feeding to refeeding operation and vice versa
- analyses of energy flow



Figure 2: multitrack system
made by Regatron AG

Operation Modes

The state-of-the-art, modular concept of the TC.ACS allows much more than only to operate the unit as a programmable Grid Simulator as described above.

Due to the flexible firmware the user is enabled to additionally use the TC.ACS as a comprehensive 4 quadrant AC voltage amplifier with three independent phase inputs. Thus, the system can be integrated into a HIL "Hardware-in-the-loop"-circuitry by using an external Real-Time processor, permitting the user to run complex, high dynamic system analyses.

A third interesting way to operate the TC.ACS is the "RL load mode". In this mode, the operator can use the system as a programmable three-phase electronic load with programmable complex load RL impedance. This operation mode as well provides for an efficient feeding back of active energy into the public grid.

Hardware

The modular structure based on 30kVA or 50kVA units allows for a flexible adaptation to the customers power requirements. By simply connecting basic units in a parallel mode, systems of up to 1000kVA can be set up. The hardware is operating in all 4 quadrants and is able to fully refeed into the power system. Apart from testing power feedback units, the system also enables the operation of linear and nonlinear feeding systems for measuring and evaluation purposes. An operation in single phase mode is also possible down to DC mode.

User software ACSControl

The tailor made software tool ACSControl enables the operator either to manually operate the system or to program and run automated test sequences and to use the functionality of data acquisition of the system. Moreover the software offers some screens for parameterising, sequencing, visualising of the current system data and test results as well as for recording and documentation of test results. ACSControl provides also to switch over between the 'Simulator Mode', the 'Amplifier mode' and optionally the 'Load mode' of the system.

Application example: TC.ACS as an element of a Test Lab equipment

Comprehensive testing equipment for solar inverters, among others, integrates not only the grid simulation but also an additional simulation system for photovoltaic cells. The programmable TopCon Quadro DC power supplies together with the optional TC.LIN postprocessors in combination with the software tool SASControl form a finely graduated modular PV simulation environment. By using this testing equipment a PV inverter device can be comprehensively tested regarding the photovoltaic issue as well as in terms of the grid feed-in aspect.

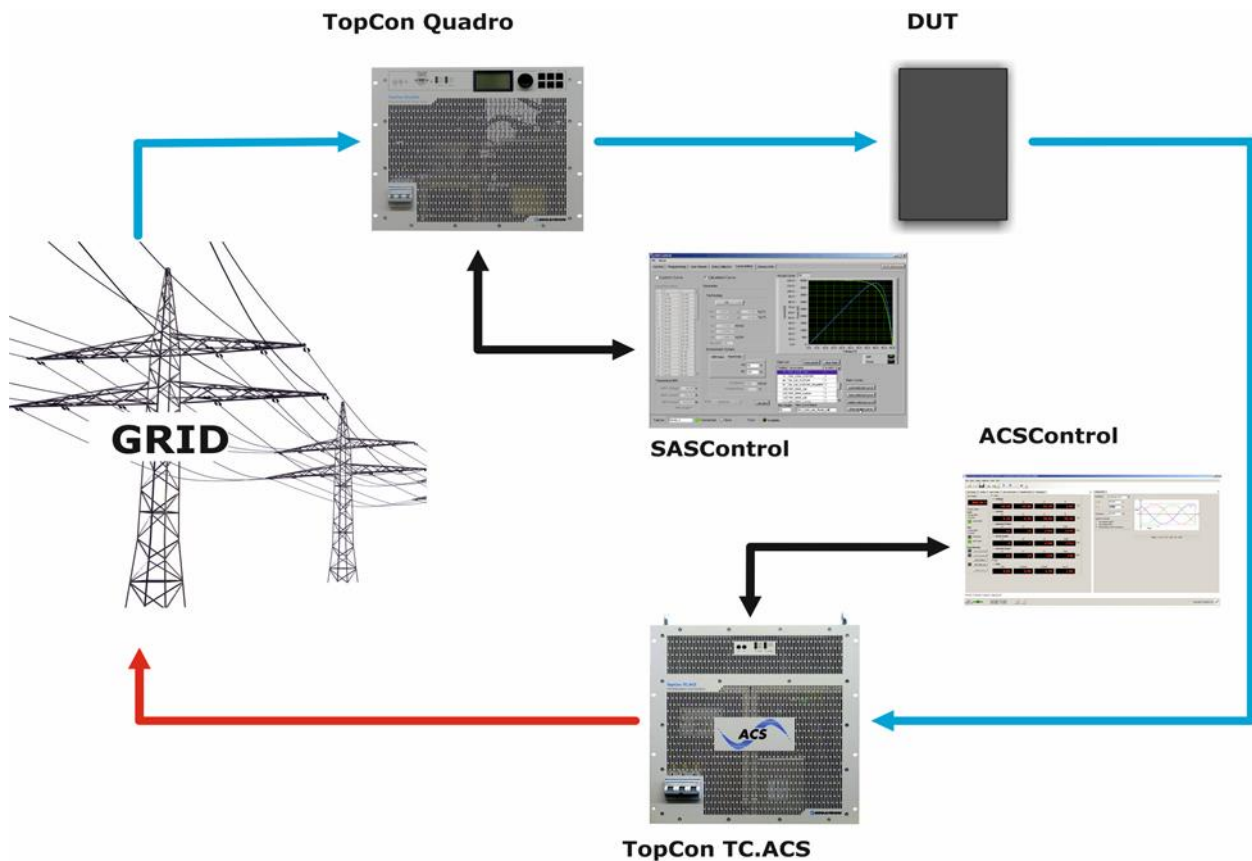


Figure 3: Example of a PV testing system with a TC.ACS grid simulator

Due to the fact that REGATRON solar simulation systems are set up on a fully modular basis covering voltages up to 1500 VDC, it is possible to assemble integral testing configurations within the range of a few kilowatts up to several megawatts. Therefore, the configurations can be adapted at any time in order to cope with any modified requirements or changed situations.

Both the high power TopCon.Quadro DC supplies as also the TC.ACS Grid Simulator provide outstanding efficiencies, therefore the power losses occurring are minor even in case of a very high activity of the system. The thus arising advantages do comprise not only a high exploitation of the mains energy but also a drastic reduction of criteria in terms of any requirements and standards regarding the infrastructure of buildings such as air conditioning and cooling systems.

Overview of the user's advantages

Most of today's grid simulators are based on the idea of analogue amplifiers intervening into the network branches. By this technique a high system dynamic range can undoubtedly be achieved but always in combination with a considerably high power loss. Using analogue systems implies a quite comprehensive infrastructure in terms of building technology. Moreover, for efficiency reasons, these systems are limited to a maximum load power of only few 10 kVA.

By developing the TC.ACS grid simulator, Regatron AG breaks new ground. The ACS offers microcomputer-controlled state-of-the-art circuit technology with a high switching frequency. Thus, it is possible to reach an energy efficiency

level being far beyond the comparatively old fashioned analogue technique while offering outstanding system dynamics and high-quality output currents. The user's advantages are as follows:

- compact and completely modular design
- high effectiveness in all operation modes, few requirements on building infrastructure
- ability to use an existing liquid cooling system directly
- optional matched liquid-to-air cooling unit TC.LAE available
- possibility of upgrading to systems of up to 1 MVA
- high level of system dynamics, ≤ 5 kHz modulation bandwidth
- non-restrictive capability of refeeding in the Q4 operation mode
- possibility of operating as an autonomous 4-Q and 3-phase quasi-analogue amplifier
- possibility of "Hardware-in-the loop"-operation (HIL mode)
- user friendly application software with pre-configured test patterns
- possibility of integrating into a complete SAS simulation and test system
- galvanic isolation available as an option without derating the simulator port data
- three different operation modes:
 - Programmable Grid Simulator
 - Remote operated 4Q AC voltage amplifier
 - Electronic AC-load featuring programmable RL load impedance

TC.ACS Grid Simulators made by Regatron AG can be operated as a self-contained system for the purpose of comprehensively testing solar and additive energy inverters. The high degree of programmability allows establishing all imaginable grid situations and representing therefore an ideal tool for all R + D and simulation work.

Technical data TC.ACS basic units	TC.ACS.30.528.4WR.S	TC.ACS.50.528.4WR.S
Grid input	3 x 360-528 VAC +PE (no neutral)	
Grid frequency range	48-62Hz	
Grid input phase current, feeding	3x52Arms @ full load	3x85 Arms @ full load
Grid input power factor	1	
Sim output topology	3L+active N (4 outputs)	
Sim output voltage	3 x 0-305 V _{rms} nominal (L-N)	
SIM output phase current (permanent, I_{nom})	3 x 0 - 43Arms nominal	3 x 0 – 72Arms nominal
Sim output frequency range	0-1000Hz; current derating between 0 and 16Hz	
Operation modes	4 quadrant generator / 4 quadrant amplifier / RLC load mode	
Module power	30kVA nominal	50kVA nominal
Overloadability	200% I _{nom} up to 1s every 60s 150% I _{nom} up to 10s every 600s	
Sim port power factor	0 ...1	
Modulation bandwidth	≤ 5 kHz (up to the 83th harmonic at 60Hz)	
Voltage control RMS @50/60Hz	< 0.05% FS	

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All product specifications information herein are subject to change without notification.