



G5.UNV Universal Regenerative DC Source Sink Series

The G5.UNV series is bidirectional regenerative and can operate in CV, CC, CP, CR, or CR control modes with simulation of internal resistance in CV or internal conductance in CC mode. It is universally applicable and therefore suitable for all industrial and scientific applications in laboratories and on test benches. The modular and finely graded G5.UNV series is characterized by highly dynamic response times, adjustable filter time constants, and a wide current-voltage range with an auto-ranging factor 3. The G5.UNV devices are equipped with hard- and software modules for the simulation and testing of energy storage devices, solar arrays, and fuel cells. This gives the engineer a power supply that easily covers a wide range of applications.

Device Types

Voltage V	Power kW	Current A	Height U	Order Code
*0...80	9	-338...338	4	G5.UNV.9.80.338
*0...80	18	-676...676	4	G5.UNV.18.80.676
*0...80	27	-1014...1014	7	G5.UNV.27.80.1014
*0...80	36	-1352...1352	7	G5.UNV.36.80.1352
*0...80	45	-1690...1690	10	G5.UNV.45.80.1690
*0...80	54	-2028...2028	10	G5.UNV.54.80.2028
0...160	18	-338...338	4	G5.UNV.18.160.338
0...160	36	-676...676	7	G5.UNV.36.160.676
0...160	54	-1014...1014	10	G5.UNV.54.160.1014
0...240	27	-338...338	7	G5.UNV.27.240.338
0...240	54	-676...676	10	G5.UNV.54.240.676
0...320	36	-338...338	7	G5.UNV.36.320.338
0...500	9	-54...54	4	G5.UNV.9.500.54
0...500	18	-108...108	4	G5.UNV.18.500.108
0...500	27	-162...162	7	G5.UNV.27.500.162
0...500	36	-216...216	7	G5.UNV.36.500.216
0...500	45	-270...270	10	G5.UNV.45.500.270
0...500	54	-324...324	10	G5.UNV.54.500.324
0...1000	18	-54...54	4	G5.UNV.18.1000.54
0...1000	36	-108...108	7	G5.UNV.36.1000.108
0...1000	54	-162...162	10	G5.UNV.54.1000.162
0...1500	27	-54...54	7	G5.UNV.27.1500.54
0...1500	54	-108...108	10	G5.UNV.54.1500.108

*also as 60 V SELV version for single or parallel operation available, order code example: G5.UNV.9.**60**.338

Modular and Easily Scalable Systems

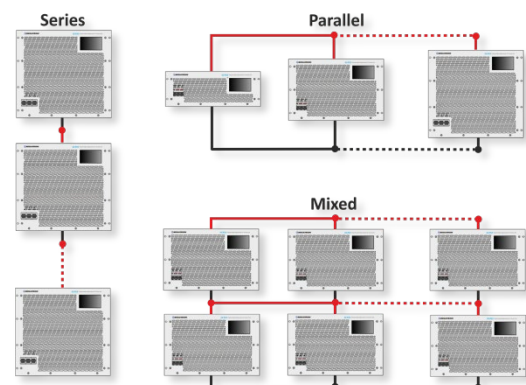


Figure 1: Modular concept for easy power and voltage increase by parallel, series, and mixed operation. The parallel configuration allows even an operation of different power levels, e.g., 18, 36, and 54 kW modules, in one system.

The output of an individual power supply is in the range from 0...9 kW to 0...2000+ kW, up to 3000 VDC. The advantageous modularity of REGATRON power supply solutions allows the system to be easily adapted to ever-changing test requirements.

It is possible to reconfigure between parallel, series, and mixed operation. Moreover, the system can be expanded with additional power supply units or may be split into smaller units.

Whether for single devices or powerful multi-device multi-unit systems, REGATRON also offers turnkey cabinet solutions or project-specific system integration according to customer specifications.

Therefore, the purchase of a REGATRON power supply is a solid investment for the future.

Applications and Features

The G5.UNV series is the fully equipped all-rounder! It contains all necessary functions and software modules for the simulation of energy storage devices and solar arrays as well as for the testing and evaluation of batteries and fuel cells.

Various features such as switchable filter time constants and adjustable controller settings as well as the integrated powerful 8-channel digital scope assist the user in quickly and easily achieving optimal system behavior for a special application requirement.

Simplified and safe operation can be provided by pre-programmed overvoltage protection and digital fuses with immediate and I2t triggering. Different protection levels for different DUTs can be either programmed by the user's automation test system via various interfaces or activated manually by digital input signals or even more conveniently wired to different switch positions.

The G5.UNV series also offers the possibility to store, edit, and recall any device configuration on board the power supply.

Time-Based Function Generator

The TFE time-based function generator allows programming either through G5.Control operating software, HMI touch display, or various interfaces.

- Time-dependent functions $U = f(t)$, $I = f(t)$, $P = f(t)$: sine, triangle, or square as well as user-defined data points. Import and export through CSV files supported
- Ramp function for amplitude and offset changes
- Small signal modulation up to 10 kHz

Sweep functionality for TFE

As an add-on to the TFE time-based function generator, the sweep mode allows for continuous or stepwise sweeping of the amplitude and the frequency of a programmed function. Both the amplitude and the frequency may be swept linearly or exponentially.

This sweep function together with the high modulation bandwidth of 10 kHz makes devices well suited to electrochemical impedance spectroscopy (EIS) of batteries, fuel cells, and electrolyzers.

Solar Array Simulation

As a PV simulator the G5.UNV series features especially low capacitance values in the output filter stage, switchable earth leakage resistors, and the versatile application software SASControl. The powerful platform for R+D and testing of PV inverters fully complies with the efficiency measurement procedures for maximum power point tracking (MPPT) in inverters as described in EN 50530. The core of the application software SASControl is a versatile script programming system that allows the easy implementation of individual programming sequences. Report generation of measured data is included.

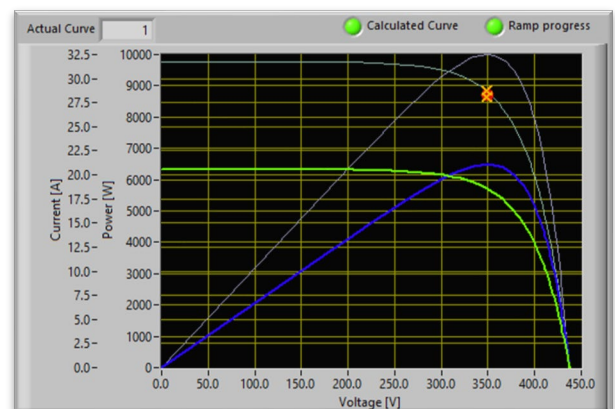


Figure 2: SASControl Live Viewer – always up to date.

Battery Simulation

As a battery simulator the G5.UNV series realistically and dynamically simulate both the electrochemical and electrical properties of a battery type in charge and discharge mode. Other features include high data resolution and options for meeting high safety standards for operators. The real-time computing process of the application software BatSim perfectly matches the internal timing of the DC power supply. Therefore, an optimum computing rate is achieved leading to very short response times even in cases of steep changes in charge/discharge currents. Each battery type reacts in a specific manner to charge and discharge currents in terms of state of charge, cell voltage, ohmic and parametric losses, and polarization effects. These dependencies are considered by specific mathematical models used in the REGATRON BatSim software/firmware. The operator can fine-tune the model with several well-defined parameters to adjust the simulation to a user's requirement.

Models of the following battery types are available for configuration: Li-ion, lead-acid, NiMH, and NiCd.

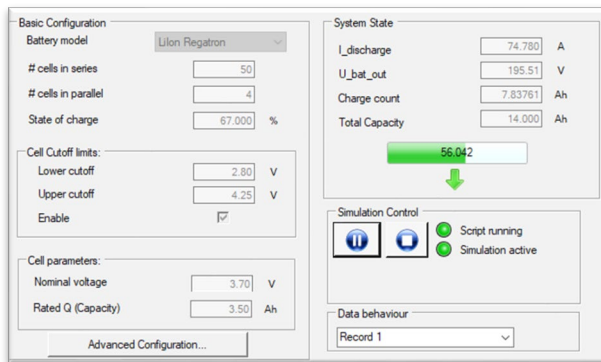


Figure 3: BATSim configuration – a few clicks away from the required battery simulation.

Battery Module / Pack-Testing Features

As a battery tester the G5.UNV series has an exceptional electrical performance that offers several advantages for battery testing applications:

- Voltage accuracy of <0.01...0.02% FS
- Current accuracy in the range 0.03...0.09% FS depending on model
- Additional high-resolution current measurement range from -10 to 10% FS with an accuracy of <0.005% FS
- Current rise time in the 50...200 μ s range
- Parameterizable to avoid overshoot
- Current ripple modulation up to 10 kHz

In addition, the G5.UNV provides important features for user safety, power supply, and battery protection. It avoids:

- Reverse-polarity problems
- Arcing and high inrush current when connecting the battery to the DC terminals even at unmatched voltage levels
- Deep battery discharge at voltage off state (DC port impedance >10 M Ω)

The application software BatControl allows selecting and running so-called BatScripts. These scripts automate the manually given commands to the G5 Battery Tester and allow the running of these commands according to defined schedules.

- Define charge and discharge algorithms
- Run drive cycles (according to own or already defined standards)
- Repeat previously recorded discharge/charge data

G5.UNV Series as P-HIL Power Amplifier

Power-hardware-in-the-loop (P-HIL) simulation integrates physical hardware and software models in a closed-loop simulation, offering versatile opportunities to investigate the behavior of complex systems at different parameter settings.

A typical P-HIL setup includes a fast real-time computer driving a power amplifier. The G5.UNV series is best suited for this purpose due to its high dynamics and fast analog port. Time analog-in to power output is typically 90 μ s.

Fuel Cell Simulation

For use as a fuel cell simulator the G5.UNV series utilizes the integrated AAP function. The AAP application area programming feature allows to set the DC output voltage or current or power as a function of any of the input values I_{DC} , U_{DC} , or P_{DC} . The functional relationship is given by a user-defined curve whose values are managed by CSV import/export. In this way, a wide variety of nonlinear electrical two-pole networks can be defined, e.g., photovoltaic arrays or fuel cell curves. As an example, Figure 4 shows the typical fuel cell characteristics with a voltage/current dependence. Embedded calculation on board the G5.UNV assures real-time simulation.

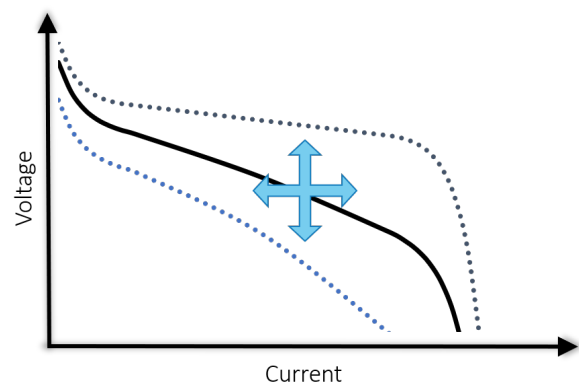


Figure 4: AAP curve with fuel cell characteristic $U = f(I)$.

Dynamics

Maximum speed or minimum overshoot? Figure 5 shows that the dynamic parameters of the G5.UNV series can be easily adapted to a specific task.

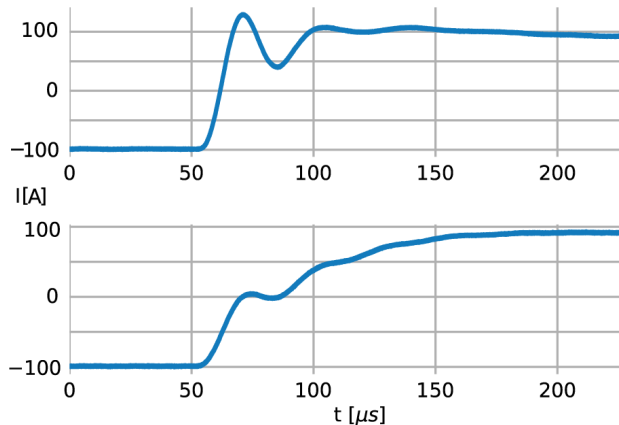


Figure 5: Parameterization example: of a 36 kW, 1000 V, 108 A device: Set-value step current -97...97 A@333VDC in <50 μs with overshoot (top), in <200 μs w/o overshoot (bottom). This dynamic behavior is characteristic for all G5 devices.

General Dynamic Data

rise/fall time	voltage 0...90%	150...220 μs
set-value step	current -90...90%	35...70 μs
response time	CV, recovery within	50...290 μs
load step	0.5% set value	

Accuracy

The G5.UNV series has an exceptional voltage accuracy of 0.01...0.02% FS. The current accuracy is in the range of 0.03...0.09% FS depending on the model. There is even an additional high-resolution current measurement range from -10 to 10% FS with an accuracy of better than 0.005% FS.

Control Modes

CV	constant voltage
CC	constant current
CP	constant power
CR	constant resistance
Ri	internal resistance simulation in CV
Gi	internal conductance simulation in CC

Interfaces

Ethernet and USB

To connect with:

- G5.Control, the operating and maintenance software
- SASControl, the application software for PV simulation
- BatSim, the application software for battery simulation
- BatControl, the application software for battery testing
- API .NET programming, e.g., by LabView, Python, Matlab
- WebAPI (REST) interface via the optional HMI or RCU

I/O port

The I/O interface features analog and digital signals used for set and actual values or operating states. Integrated into the user's control system it is possible to set dynamically changing limits, to use enable signals, or trigger in- or outputs. The possibility to activate up to 4 user-defined parameter sets using digital inputs means that the system can be adapted to different EUTs. For example, predefined digital fuses and voltage limits can be set.

Grid Connection

The wide-band AC input accepts all common AC grid systems and has an active power factor correction.

AC Grid	380...480 VAC $\pm 10\%$ at 50/60 Hz
PF	0.99
Efficiency	94...95%, depending on model

Options

Software and Control

HMI / RCU

The HMI built into the front panel allows comprehensive and convenient operation of the power supply via touch display or the WebAPI (REST) interface.

With the remote control unit (RCU) it is possible to control the device or system from a distant location in the same manner as with the HMI.

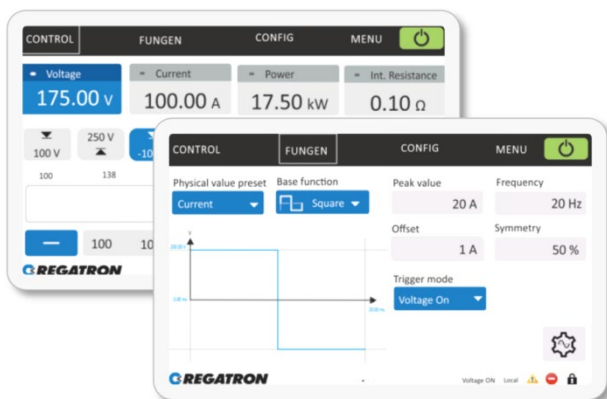


Figure 6: Intuitive control by HMI touch display. Everything you need at a glance.

CAN Interface

The CAN multi-protocol (CANmp) interface has a 1 kHz data rate, a 16-bit resolution, and is adaptable to any proprietary CAN bus. In addition, it supports dbc file handling.

EtherCAT Interface

The EtherCAT slave interface (ECAT) supports configuration by ESI file and communicates in a 1 kHz cycle. It transmits the entire process data in the same cycle, i.e. commands, actual states, and actual values. Acyclic communication via mailbox for device configuration is also possible.

SCPI Interface

SCPI, Standard Commands for Programmable Instruments, are ASCII strings, that are sent to the device over TCP/IP using the LAN socket. They can perform set operations or query operations.

User Safety

- Integrated safety relay (ISR) for increased emergency stop reliability, supporting performance level PL c / PL e according to EN ISO 13849

- Discharging of the AC filter (XCD), is mandatory when using the device with a plug connection. XCD ensures a discharge time of the AC filter <1 s as required by EN 62477-1
- Based on the 80 V models, also a 60 V SELV version is available
- Various terminal protection covers

The different protective covers are designed for integration into 19" rack systems or for use as a tabletop device. The cover for cabinet integration provides protection against accidental contact, whereas the cover for the tabletop version requires touch-proof protection in accordance with standard EN 62477-1.

Voltage V	Power kW	DC-cover acc. contact	DC-cover touch-proof	AC-cover touch-proof	Tabletop use allowed	Order Code
60...160	≤18	●	○	○	✓	G5.PAC.DCAC.1
60...320	≥27	●	—	—	—	—
500...1000	≤18	—	●	○	✓	G5.PAC.AC.1
500...1500	≥27	—	●	○	✓	G5.PAC.AC.2

● included
○ optional, mandatory for tabletop use

Environmental Conditions

- Front-panel-mounted air filter (AirFilter), recommended for use in dusty environments and with IP20 cabinets
- Higher degree of protection up to IP54 available on cabinet level
- Liquid cooling of the G5 devices at system level as shown in Figure 8. The Regatron solution allows to take the entire dissipated heat of the power supply out of the test bench and reuse it as process heat in the facility if possible

Rack-Integrated System Solutions

- Mobile rack solutions on castors up to 162 kW
- IP54 protection for air or liquid-cooled systems
- Third-party product integration and numerous safety options
- Insulation monitoring: remote activation of the insulation measurement, actual insulation value, and warning/error status are provided by the CANmp interface or by optional display
- Easy reconfiguration between parallel, series, and mixed operation



Figure 7: REGATRON's rack-integrated turn-key system solutions for various power levels e.g. 72 kW (left) and 162 kW (right). Various types of AC/DC connectors and cables allow for comfortable handling.



Figure 8: REGATRON's liquid-cooled system solutions up to IP54 with various power levels e.g. 54...162 kW (left) and 216...324 kW (right). The remote control unit RCU, indicator lights, emergency stop button, and main switch allow the user to operate the system on the enclosure's front door.

Important Features of the G5.UNV Series

Technology

- Technologically advanced, fast-switching, compact 19-inch power supplies
- High control dynamics in the 100...200 μ s range – even at higher power levels up to 2000+ kW
- Exceptional accuracy and an additional high-resolution measurement range
- Wide current-voltage range with an auto-ranging factor 3
- CV, CC, CP, CR, and Ri/Gi-Sim control modes
- Regenerative and highly efficient, resulting in a significant reduction of energy consumption and heat dissipation

System Control and Options

- Operating software, extended analysis, parameterization options, and calibration
- Application software with visualization, programming, and data logger
- Powerful application programming interfaces (APIs)

System Capability

- Modular and easily scalable systems
- Parallel, series, and mixed operation with a digital high-speed bus
- Simple multi-unit configuration with the operating software
- Easy rack mounting
- Liquid cooled systems in IP54 available
- Optional safety features such as 2-channel safety interface and insulation monitoring
- Turn-key cabinet solutions or project-specific system integration according to customer specification

This product is developed, produced, and tested according to ISO 9001 by REGATRON.

For detailed technical information, contact REGATRON or your local sales partner.

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