ELECTRONIC TEST & POWER SYSTEMS

RENTAL
G5-RSS

BIDIRECTIONAL DC SYSTEMS UP TO 216kW

POSITIVE PROBLEM SOLVING

With the ability to source or sink DC power up to high voltage and currents, the G5-RSS is ideal for cycling and emulating energy storage devices.

Each power dense module has an extensive feature set which includes programmable PID parameters and an inbuilt 8 channel recording scope. Adjustable power and resistance limits are provided. Analogue, ethernet, USB and high-speed CAN interfaces are provided with each system. The G5-RSS features an autoranging output, which allows for many more V/I combinations at nominal power. Modules are fitted into flight cases which feature isolation monitoring and an emergency stop.

- Programmable Voltage and Current Ripple
- Two Current Ranges for Higher Accuracy
- Battery Cycling and Emulation Software
- Function Generator with V/I Capability
- Sink/Source Voltages up to 2000V
- Ultra-Fast Dynamic Behaviour

CONTENTS

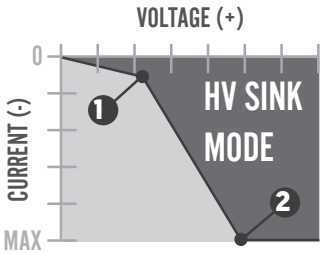
STANDARD MODELS

SELECTION TABLE

Part Number	Maximum Power	Q1 Source Voltage	Q4 Sink Voltage	Current Range	Internal Resistance Range
G5-RSS 54-1000-162-r	54kW	0 to 1000Vdc	5 to 1000Vdc[1]	0 to ±162A	0 to 12346mΩ
G5-RSS 108-1000-324-r	108kW	0 to 1000Vdc	5 to 1000Vdc[1]	0 to ±324A	0 to 6173mΩ
G5-RSS 108-2000-162-r	108kW	0 to 2000Vdc	10 to 2000Vdc[1,2]	0 to ±162A	0 to 24692mΩ
G5-RSS 162-1000-486-r	162kW	0 to 1000Vdc	5 to 1000Vdc[1]	0 to ±486A	0 to 4114mΩ
G5-RSS 162-1500-162-r	162kW	0 to 1500Vdc	15 to 1500Vdc[1]	0 to ±162A	0 to 37038mΩ
G5-RSS 216-1000-648-r	216kW	0 to 1000Vdc	5 to 1000Vdc[1]	0 to ±648A	0 to 3086mΩ
G5-RSS 216-2000-324-r	216kW	0 to 2000Vdc	10 to 2000Vdc[1,2]	0 to ±324A	0 to 49384mΩ

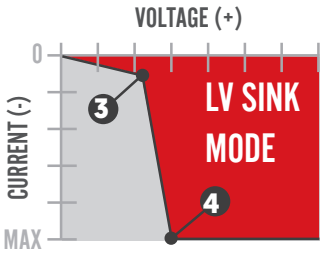
[1] The maximum current that can be taken derates as the voltage reduces beneath the lower level. Please see below for more details.
[2] A ±1000V voltage is created around a central earth connection (2000Vdc total). Without the centre earth configuration, maximum voltage is limited to 1500Vdc.

The maximum current that can be taken derates at low voltages. As standard the G5-RSS operates in HV Sink Mode when operating as a DC load. In this mode the user can sink full current from 3% V_{NOM} to 100% V_{NOM}, according to the maximum power. The HV Sink Mode operating range is indicated in dark grey.



Part Number	Point 1: 10% I_{MAX} (HV Mode)	Point 2: 100% I_{MAX} (HV Mode)
G5-RSS 54-1000-162-r	15V / -16.2A	30V / -162A
G5-RSS 108-1000-324-r	15V / -32.4A	30V / -324A
G5-RSS 108-2000-162-r	30V / -16.2A	60V / -162A
G5-RSS 162-1000-486-r	15V / -48.6A	30V / -486A
G5-RSS 162-1500-162-r	45V / -16.2A	90V / -162A
G5-RSS 216-1000-648-r	15V / -64.8A	30V / -648A
G5-RSS 216-2000-324-r	30V / -32.4A	60V / -324A

If you require to sink higher currents at lower voltages, then setting a maximum voltage between 10V to 166V switches the G5-RSS to Low Voltage mode. The values possible at 100% I_{MAX} and 10% I_{MAX} are provided below. Lower voltages are possible with further current derating. The LV Sink Mode operating range is indicated in red.



Part Number	Point 3: 10% I_{MAX} (LV Mode)	Point 4: 100% I_{MAX} (LV Mode)
G5-RSS 54-1000-162-r	2V / -16.2A	5V / -162A
G5-RSS 108-1000-324-r	2V / -32.4A	5V / -324A
G5-RSS 108-2000-162-r	4V / -16.2A	10V / -162A
G5-RSS 162-1000-486-r	2V / -48.6A	5V / -486A
G5-RSS 162-1500-162-r	6V / -16.2A	15V / -162A
G5-RSS 216-1000-648-r	2V / -64.8A	5V / -648A
G5-RSS 216-2000-324-r	4V / -32.4A	10V / -324A

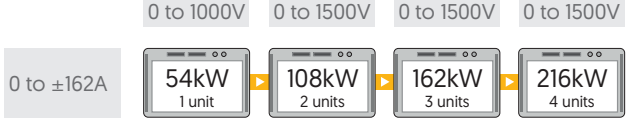
MODULARITY (MASTER/SLAVE)

Up to four G5-RSS 1000V modules are available in our rental range. These can be arranged in series, parallel or matrix configurations. Outputs up to 2000V are possible if you can connect the modules around a centre earth. Each module is able to operate independently, with inbuilt system comms allowing users to switch between various set-ups.

Our rental systems can be combined in in master/slave with any G5-RSS modules you have previously purchased, providing they have the same nominal outputs. This allows any short term requirements outside of usual operating ranges to be met.

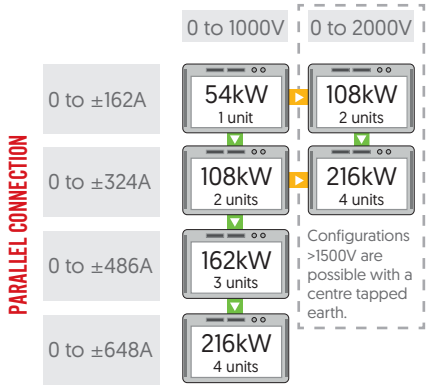
WITHOUT CENTRE EARTH

SERIES CONNECTION



WITH CENTRE EARTH

SERIES CONNECTION



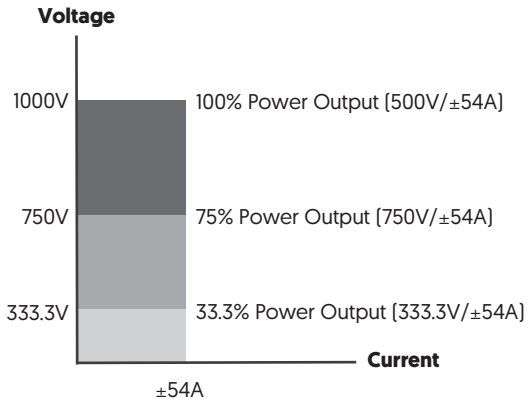
ELECTRONIC TEST & POWER SYSTEMS

AUTORANGING CAPABILITY

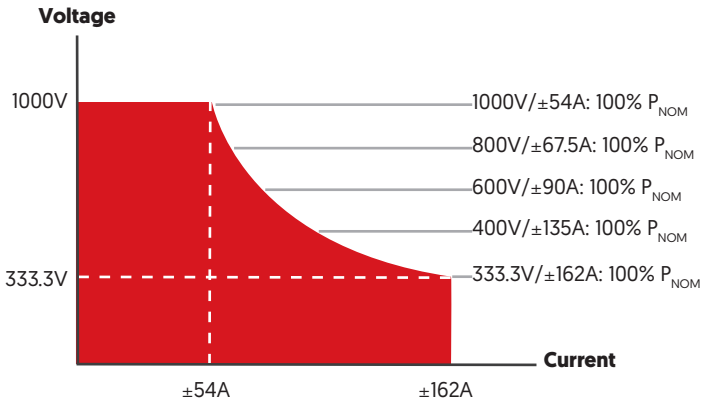
Every G5-RSS features an autoranging output. This allows many more voltage/current combinations at nominal power than a traditional bidirectional DC power system. An example of the difference is shown below using a single G5-RSS 54-1000-162 module.

Using one autoranging bidirectional PSU instead of several traditional power systems saves both cost and bench space. Despite the units offering such a large output range, they are still incredibly power dense. 54kW of output power is provided from 10U of rackmounting height.

TRADITIONAL 54kW/1000V SYSTEM



G5-RSS 54kW/1000V SYSTEM



FORM FACTOR AND ENCLOSURES

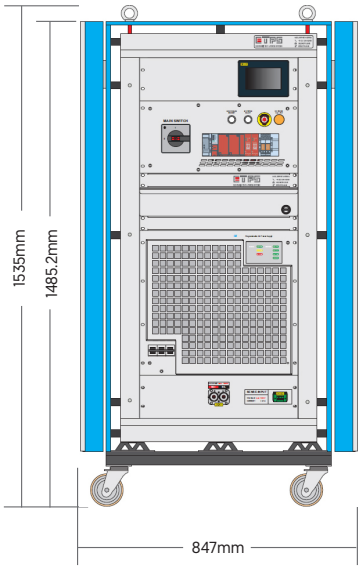
STANDARD FEATURES

TECHNICAL DATA	
Cabinet Dimensions	847mm × 1535mm × 1150mm (W × H × D) including castors
Cabinet Weight	Approx. 400kg
Basic Construction	IP 20

A series of cabinets are used to make deployment of G5-RSS rental modules simpler, quicker and safer. Among the cabinet safety features which most of the modules are installed in is a status indicator that alerts users of any residual energy on the DC link that is greater than 30V. This operates even if the mains power is turned off. Another indicator assesses the quality and correct rotation of the AC input voltage and illuminates if correct.

Key features of most cabinets include:

- All 4 Heavy Duty Castors with Locking Function
- Indication of Connected AC Line Voltage
- Passive Indication of DC Output Voltage
- 5m Amphenol DC Cable Set (1000V Configurations Only)
- Panel Mounted Emergency Stop
- CEE125 Plug with 5m AC Input Cable (3L + PE +N)



OPERATING RANGES AND FEATURES

STANDARD FEATURES

TECHNICAL DATA	
Remote Voltage Sense	Programmable (stability/drift: ≤0.01%FS[4] | temperature coefficient: 0.007%FS/°C)
Stability/Drift	Voltage: ≤0.01%FS[4] | Current: ≤0.01%FS[4]
Temperature Coefficient	Voltage: 0.005%FS/°C[5] | Current: 0.005%FS/°C[5]
Efficiency	Up to 96%
Rise/Fall Time[6]: Voltage Step (0 to 90% V_{MAX}/ 90% P_{MAX})	≤170µs
Rise/Fall Time[7]: Current Step (-90% to 90% I_{MAX} at 33% V_{MAX}) 10% to 90% of step/settling time	20µs/190µs
Transient Response Time[8] (CV, Recovery Within 0.5% of Set Voltage)	≤200µs
Transient Response Time[9] (CC, Recovery Within 2% of Set Current)	≤250µs
Voltage Drop While Load Switching On	≤2% FS (-90% to 90% P_{MAX} at 90% V_{MAX} in HighCap mode) ≤4% FS (-90% to 90% P_{MAX} at 33% V_{MAX} in HighCap mode)
Voltage Overshoot While Load Switching Off (90% to -90% P_{MAX} at 90% V_{MAX} in HighCap Mode)	≤2% FS
Voltage Overshoot While Load Switching Off (90% to -90% P_{MAX} at 33% V_{MAX} in HighCap Mode)	≤5% FS
Output Capacitance: X-capacitor LowCap	18µF
Output Capacitance: X-capacitor HighCap	333µF
Output Capacitance: Y-capacitor at DC	219nF
Ripple: Output Voltage Ripple (<1 MHz): Vrms, LowCap, Ohmic Load, 90% P_{MAX} 90% V_{MAX}, CV Mode	≤0.03% FS
Ripple: Output Voltage Ripple (<1 MHz): Vrms, HighCap, Ohmic Load, 90% P_{MAX}, 90% V_{MAX}, CV Mode	≤0.02% FS
Ripple: Output Current Ripple (<1MHz): Arms, LowCap, Ohmic Load, 90% P_{MAX}, 90% I_{MAX}, CC Mode	≤0.05% FS
Noise: (20kHz to 20MHz) : Vpp, LowCap, Ohmic Load, 90% P_{MAX}, 90% V_{MAX}, CV Mode	≤0.15% FS
Noise: (20kHz to 20MHz) : Vpp, HighCap, Ohmic Load, 90% P_{MAX}, 90% V_{MAX}, CV Mode	≤0.1% FS
HMI Touchpanel Meter Resolution	0.1V/0.01A
Output Discharge to <60V	Active discharge enabled: <1s | Active discharge disabled: <75s
Static Accuracy[10]: Power at I_{MAX} 1kHz Filter	0.03% typ. FS
Static Accuracy[10]: Voltage	0.01% typ. FS
Static Accuracy[10]: Current Full Range 1kHz Filter	0.025% typ. FS
Static Accuracy[10]: Current Low Range (-10% to 10% FS) 1kHz Filter	0.003% typ. FS
Static Accuracy[10]: Resistance at I_{MAX} 1kHz Filter	0.03% FS
Pulsating Load: HighCap	30% I_{MAX} at 3kHz, 26% I_{MAX} at ≥ 5kHz (max. load ripple current sine, max. amplitude)
Pulsating Load: LowCap	46% I_{MAX} at 3kHz, 17% I_{MAX} at ≥5kHz (max. load ripple current sine, max. amplitude)
Max. Ripple DC+ to PE / DC- to PE (Max. Allowed Ripple Vrms ≤1kHz: 1050 Vrms >1 kHz: [1.26×10⁶/f +5] Vrms)	≤1kHz: 1050Vrms 2kHz: 630Vrms 5kHz: 250Vrms 10kHz: 130Vrms 20kHz: 65Vrms 50kHz: 30Vrms 80kHz: 20Vrms
Small Signal Modulation (Voltage Controller LowCap Mode)	Frequency (CV, CC): 0 to 10kHz Max. output voltage RMS sine at 10kHz: 0 to 5% FS Attenuation at 5kHz/10kHz, operating point: 90% V_{NOM} +5% V_{NOM} amplitude: 0.4dB/-6dB Phase lag analogue input to voltage out: 130µs
Small Signal Modulation (Current Controller LowCap Mode)	Max. output amplitude current at 10kHz: 0 to 5% FS Attenuation at 5kHz/10kHz operating point: 90% I_{NOM} + 5% I_{NOM} amplitude: -1.8dB/-3.8dB Phase lag analogue input to current out: 110µs

[1] At 25°C ambient temperature, constant line conditions. [2] With a constant resistive load in LowCap mode.
[3] Constant voltage mode, recovery within 0.5% SetValue at 30% V_{MAX}/100% V_{MAX}, with a resistive load in HighCap mode.
[4] 8h after 1h warm up time at constant line input, load and temperature. [5] At constant line and load conditions.
[6] Voltage set-value step, constant resistance load, LowCap mode. [7] Current set-value step, constant voltage, LowCap mode.
[8] 0 to 90% P_{MAX} load step at 90% V_{MAX}. Assuming an ohmic load in HighCap mode. [9] 45 to 90% P_{MAX} load step at 90% I_{MAX}. Assuming an ohmic load in LowCap mode.
[10] At 25° ambient temperature, constant line/load conditions normal distribution (k=2).

OPERATING RANGES AND FEATURES

STANDARD FEATURES

TECHNICAL DATA	
Sense Input Impedance While Operational	1212kΩ
Sense Input Impedance - Voltage OFF (RPP Closed)	1212kΩ
Sense Input Impedance - Voltage OFF (Output Measurement Disconnected)	>10MΩ
Ballast Resistor DC Power Port at Voltage OFF (RPP Closed)	51kΩ
Ballast Resistor DC Power Port at Voltage OFF (Output Measurement Disconnected and Voltage OFF Deactivated)	1212kΩ
Ballast Resistor DC Power Port at Voltage OFF (Output Measurement Disconnected and Voltage OFF Activated)	>10MΩ

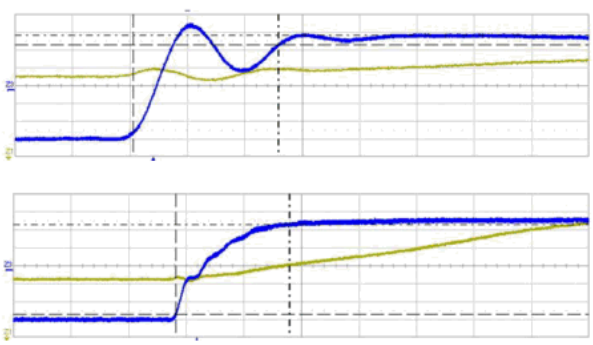
HIGHLIGHTED FEATURES

SENSE COMPENSATION

Sense plus terminals are built into the G5-RSS for the connection of sense wire which compensates for voltage drops in the load lines. This has a number of advantages over traditional sense. It is permitted to interrupt the load line during operation (voltage on). The maximum voltage drop compensation is adjustable. The voltage difference between G5-RSS output and sensing point is monitored. If a set limit is exceeded, the G5-RSS unit shuts off. This is particularly useful for applications with long cables often prone to unwanted voltage drops.

FAST DYNAMICS AND HIGH STABILITY

A current step between 90% sourcing to 90% sinking current can be as quick as 50µs, enabling high speed drives to be supplied. Advanced users have access to the controller settings enabling the response to be optimised for particular loads. This example shows a current step through quadrants. The upper trace shows the current transition is achieved in 50µs with a small overshoot before settling. The lower plot shows a more regulated response within 200µs. Voltage typically takes 100µs to recover within 0.5% of the set value. In multi-module systems the communication time between modules need to be considered.

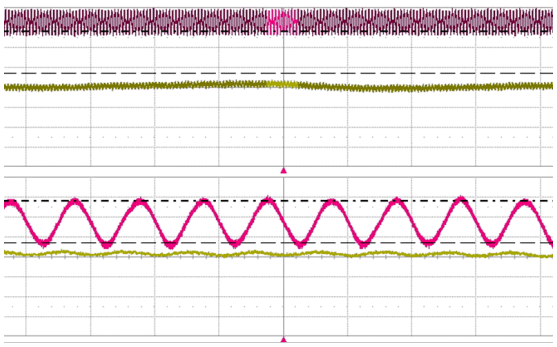


SWITCHABLE OUTPUT CAPACITANCE

Switchable capacitance is provided within each G5-RSS module as standard and is used to optimise the DC filter depending on the application in which the systems are used. A low capacitance level provides fast dynamics in constant current when charging/ discharging/ cycling energy storage devices. Switching to the higher cap value provides for smoother operation during hard load steps when operating in constant voltage. Typical applications include energy storage simulation for electric drive developments.

PROGRAMMABLE RIPPLE

By utilising the embedded function generator the user can set a current ripple at up to 10kHz. The magnitude can be up to 5% of the nominal system current. Depending on the impedance of the DUT the resulting voltage ripple can be calculated. The below example shows a 10kHz ripple generated using the function generator of the G5-RSS. A peak to peak current of 8A has been superimposed on a current of 100A. Alternatively, a ripple can be implemented from an external waveform generator via the analogue interface using a proportional 0-10V signal.



OPERATING MODES

STANDARD FEATURES

TECHNICAL DATA	
Operating Modes	Constant Voltage (0 to 100% of V_{MAX}) Constant Current (0 to ±100% of I_{MAX}) Constant Power (±5% to ±100% of P_{MAX})
Internal Resistance Range	0 to 12346Ω
Programmable Load (CR Mode: R_{MAX} at V_{MAX}, R_{MIN} at V_{MIN})	0.12 to 2222Ω
Standard Interfaces	Analogue, Ethernet (up to 800 × 16 bit/s), CANmp & USB (up to 450 × 16 bit/s)

HIGHLIGHTED FEATURE

INTERNAL RESISTANCE RANGE

Each module is built with a user programmable internal resistance range as standard. This makes the power supplies ideal for simulating the output of energy storage devices such as battery packs, fuel cell stacks and super capacitors.

INPUT

STANDARD FEATURES

TECHNICAL DATA	
AC Line Voltage	3 × 380VAC to 480VAC ±10%
Line Frequency	50Hz/60Hz
Cabinet Mains Connection Type	CEE125 plug with 5m cable (3L + PE +N)
Rated Current (per 54kW Module)	Nominal at 3 × 380VAC: 87ARMS | Nominal at 3 × 400VAC: 83ARMS | Nominal at 3 × 415VAC: 80ARMS Nominal at 3 × 440VAC: 75ARMS | Nominal at 3 × 460VAC: 72ARMS | Nominal at 3 × 480VAC: 69ARMS
Inrush Current (per 54kW Module)	<99ARMS
Power Factor	0.99 at P_{MAX}
THDi	≤0.03 at 90%P_{MAX}
Standby Power (per 54kW Module)	71W
Protective Earth Conductor Current at 50Hz	According to IEC 60990: <10mA
Input Filter Discharge to 60V	L-PE / L-L: <1s

HIGHLIGHTED FEATURE

ACTIVE POWER FACTOR CORRECTION

G5-RSS modules have Active Power Factor Correction (PFC) circuit integrated into the input stage as standard. This enhances the overall efficiency of the modules across the output power range when compared to a unit that does not have active PFC. In practice, this means a significant lower peak current value, a decrease of RMS value of the phase current and less perturbations of other equipment running on the same grid.

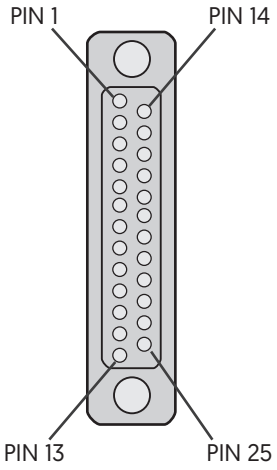
The inbuilt active PFC is also ideal for operating the power supply from a generator. Generators tend to be sensitive against high current peaks, and their voltage controllers may have some stability problems with non-sinusoidal load currents. The active PFC feature forms a lowpass filter and therefore, both the repetitive current peaks and also the harmonic content is enhanced. This will help the generator system maintain a stable and reliable output.

INTERFACES AND CONTROL

STANDARD ANALOGUE INTERFACE

An analogue interface is provided as standard which operates at 48kHz. The control port is configured as a Sub-D 25 female connector and is located on the rear panel. It allows output values to be set and read proportionally using a 0-10VDC analogue signal. Digital inputs and outputs enable various functions such as the interlock and output ON/OFF. A 10VDC reference is provided for analogue control. Digital functions are switched via a high/low signal. A 24VDC supply voltage is provided for these functions.

INPUT/OUTPUT DATA	
Number of Inputs/Outputs	4
Internal Resolution	16 bit
Input Accuracy	Bipolar range:±0.1%, Unipolar range: ±-0.2%
Output Accuracy	±0.2%
Input Filter	2nd order low pass filter, cut off frequency: 15kHz
Temperature Coefficient	0.02% FS/°C
Sampling/Update Rate	48kS/s
Output Settling Time	10µs (typical)
Input Voltage Range	-10V to +10V, -5V to +5V, 0V to 5V, 0V to 10V (selectable)
Absolute Max Input Voltage	±30VDC
Input Impedance	1MΩ (typical)
Output Voltage Range	-10V to +10V, -5V to +5V, 0V to 5V, 0V to 10V (selectable)
Max Output Current	20mA (short circuit proof)
Output Impedance	0.5Ω (typical)
Delay (Typical)	89µs (input to power out), 42µs (power out to analogue out)



PIN	SIGNAL	I/O	DESCRIPTION
1	AGND	Supp	Analogue ground for pins 2–4, 14–16
2	VREF	AI	Voltage setpoint input 0–10VDC
3	IREF	AI	Current setpoint input 0–10VDC
4	IACT	AO	Current feedback output 0–10VDC
5	PACT	AO	Power feedback output 0–10VDC
6	+10 VDC	AO	Analogue reference voltage
7	DGND	Supp	(Connected to pin 17) 0VDC DigIn; common ground for pins 8–9, 18–20, 24, 25
8	APP_DIGIO_4	DI/O	Digital input/ouput[3] 0-2VDC /10-28VDC Default function: Clear error
9	APP_DIGIN_6	DI	Digital input[3] 0-2VDC /10-28VDC Default function: Voltage ON
10	REL1_14	RO	Relay output 1 normally open
11	REL1_13	RO	Relay output 1 common
12	REL2_14	RO	Relay output 2 normally open
13	REL2_13	RO	Relay output 2 common

PIN	SIGNAL	I/O	DESCRIPTION
14	PREF	AI	Power limit analogue input 0–10VDC
15	RREF	AI	Ri-simulation analogue input 0–10 VDC
16	VACT	AO	Voltage feedback output 0–10VDC
17	DGND	Supp	(connected to pin 7) Common ground to pins 8–9, 18–20, 24, 25
18	APP_DIGIO_1	DI/O	Digital input/ouput[3] 0-2VDC/10–28VDC
19	APP_DIGIO_2	DI/O	Digital input/ouput[3] 0-2VDC/10–28VDC
20	APP_DIGIO_3	DI/O	Digital input/ouput[3] 0-2VDC/10–28VDC Default function: Analogue reference select
21	WARN_14	RO	Relay output 3 normally open
22	WARN_12	RO	Relay output 3 normally closed
23	WARN_11	RO	Relay output 3 common
24	APP_DIGIO_5	DI/O	Digital input/ouput[3] 0-2VDC/10–28VDC Default function: Soft interlock
25	+24 VDC	Supp	+24VDC I/O Aux power output 24VDC, max. 650mA

[1] Pin 5 (0 VDC) is used as the reference earth for pin 25 (24 VDC) and is connected internally to the equipotential bonding via a 1 kΩ resistor to earth.
[2] Maximum switching current: 1 A; maximum switching voltage: 24 V. [3] On request digital pins can be programmed for a specific application.

DIGITAL I/O	
Number of Digital Inputs/Outputs	6 (each can be used as input or output)
Output Voltage Supplied for Digital I/O	24VDC (-15%/+20%)
Digital Input Characteristic	IEC61131-2 Type 1
Digital Input Filter	3.2ms (10µs, 1ms and 10ms factory configurable)
Digital Output Switching Time	T_{ON}: 64-120µs, T_{OFF}: 90-170µs
Update Rate Digital Outputs	48kS/s

DIGITAL I/O	
Max Voltage Digital Inputs	30VDC
Sampling Rate Digital Inputs	48kS/s
Digital Output Type	High-side switch
Load Type	Ohmic, inductive, lamp load
Max Total Output Current (All Channels)	0.65A
Max Output Current Per Channel	0.625A (short circuit proof)

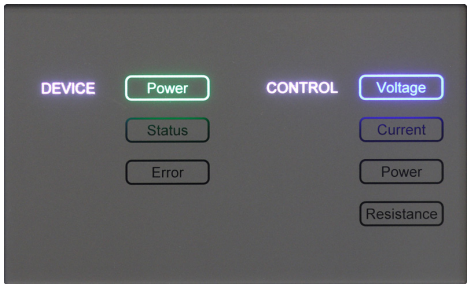
INTERFACES AND CONTROL

RELAY OUTPUTS	
Number of Relay Outputs	2 × SPST (NO), 1 × SPDT
Load Type	Ohmic, inductive, lamp load
Max Switching Voltage	30VDC
Max Switching Current	SPST: 3A, SPDT: 1A
Update Rate	48kHz

HIGHLIGHTED FEATURES

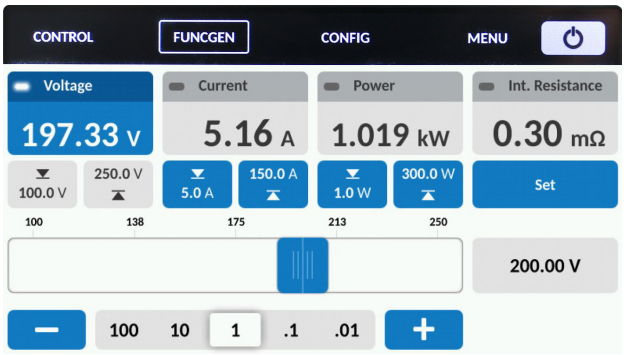
FRONT PANEL INDICATION

As standard the front panel of each modules has backlit indicators which illuminate to show which control mode the power system is operating in (CV, CC, CP, CR). When the G5-RSS has been successfully energised, the corresponding power light illuminates green to indicate this. An illumination is also provided to visually warn users of any status (yellow) or error (red) message.



TOUCHSCREEN HMI

The HMI at cabinet level provides a simple and intuitive way of control and measurement via a touchscreen panel. Users can directly access features such as the system's protections, warnings/errors and function generator without the use of a computer. A user defined passcode can be set to lock the touch screen, which prevents unauthorised access. When selected, the HMI replaces the front panel indicator.



CAN MULTI-PURPOSE INTERFACE (INSTALLED ON SELECTED MODULES)

CANmp is a high speed digital interface operating at 1kHz. The interface gives users the capability to customise the CAN protocol. Up to 50 messages are user configurable. Along with the CAN ID the data length code, byte order, start bit, data type and signal factor can be adjusted by the user. A DBC file is provided and messages can be easily configured within the standard windows software. Messages can be sent cyclically or upon receipt of a sync or syncID signal.

SOFTWARE/SOFT TOOLS

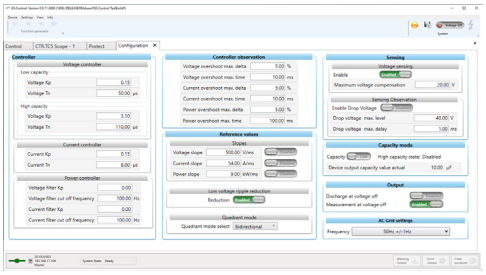
STANDARD G5.CONTROL GUI

All G5-RSS units come with a simple and intuitive G5.Control operating GUI as standard. Live values of the power system are displayed graphically along with any warning and error messages. The software provides a variety of second level parameters, ideal for users who like to optimise their test processes. In standard user mode the operator can remotely program set values, enable voltage output as well as the ability to analyse different variables including set and actual values via the integrated scope.

The scope function can simultaneously record up to 8 system variables. Recording can be started manually or by a defined trigger event from any variable of the system. All actual and set values (currents/voltages/power/internal resistance) can be recorded. Other recordable items include system temperatures, intermediate DC circuit, low voltage auxiliary power supplies, error related values and variables from the controller section.

A password protected section is available to the advanced user and service technician. In addition to the standard functions the authorised user is able to:

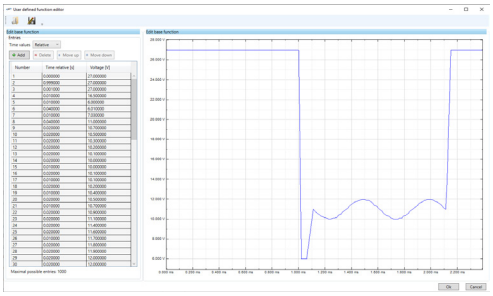
- Program linear ramp functions at start up and set value steps during operation
- Configure multi-unit operation
- Program the PID controller parameters
- Program the unit's limit values
- Calibrate and adjust values as necessary
- Update the firmware



HIGHLIGHTED SOFTWARE

FUNCTION GENERATOR (INSTALLED ON SELECTED MODULES)

Complex DC waveforms can be implemented through the embedded function generator. The highly programmable nature of the function generator allows users to plot out exact waveforms. This is often advantageous when emulating a power device with a very specific behaviour profile. For example, when quality testing fuel cell powered equipment, the specific behaviour of a discharging fuel cell can be programmed and replicated.

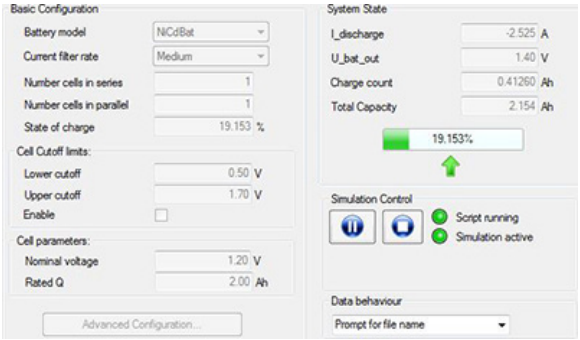


As well as custom shapes, standard square, sawtooth and sine waveforms can be plotted against time. Voltage/current and voltage/power relationships can also be programmed where necessary. Parametric programming is possible, where instead of the time axis, an input variable (V_{IN}, I_{IN} or P_{IN}) can be selected.

APPLICATION SPECIFIC GUIs

BATTERY SIMULATION (INSTALLED ON SELECTED MODULES)

BatSim is a battery emulation GUI for use with G5-RSS power systems. The GUI allows the power supplies to simulate real world behaviour of a battery pack.



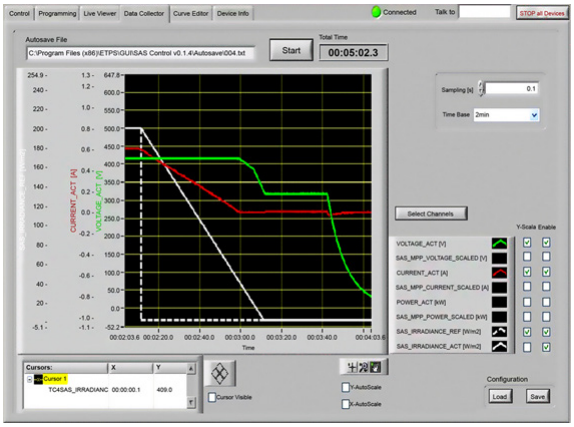
Emulating a battery pack allows specific sections of a circuit to be isolated and researched. Nearly all relevant electrical characteristics are programmable including number of cells, energy capacity, cut off limits, chemistry type and nominal voltage. The modularity of the power systems provides a convenient method to emulate different size battery stacks. Hard to replicate conditions, such as a cranking curve from a cold start can be programmed and repeated when used in conjunction with the function generator.

The multi-channel data logger provides live reporting and output to file (CSV) with timestamps. Previously recorded data can be imported, reviewed and compared in the analyser mode. Other features include:

- Adjustable internal resistance and discharge current
- Variation of exponential capacity and voltage levels
- Emulation of common battery chemistries
- Novel chemistries available on request
- Series/parallel configuration of cells

SOLAR ARRAY SIMULATION (INSTALLED ON SELECTED MODULES)

SASControl software has all EN 50530 tests pre-installed, with minor adaptations possible for particular inverter models. The GUI allows users to edit irradiance, temperature, amplitude values or input scaling with special commands.



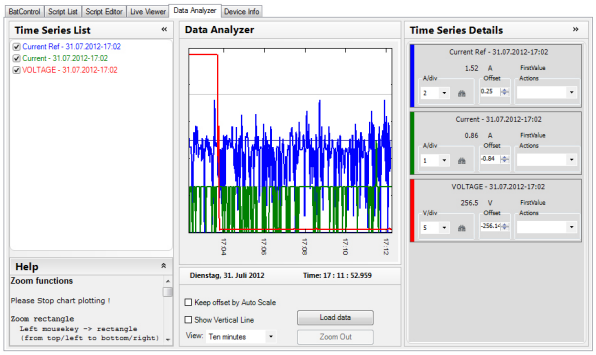
APPLICATION SPECIFIC GUIs

ELECTRIC DRIVE AND BATTERY CYCLING (INSTALLED ON SELECTED MODULES)

Drive cycle tests can be implemented using BatControl. The GUI's main screen provides an overview of the main test values for all BatControl operations. Live data from the connected power system is displayed, and setting/adjustment of primary values is possible.

Previous data obtained from a test track can be imported and recreated, allowing the G5-RSS to simulate a real world driving test inside a lab environment. Battery and capacitor charge/discharge profiles can also be implemented through the GUI. An internal charge counter allows users to view live data for Wh and Ah. Energy storage orientated tests which users can program include:

- Battery charge/discharge cycles
- Automated drive cycle loading and simulation
- Fuel cell loading
- Comparative studies
- Shot and burst overload tests
- System degradation tests
- Battery lifetime tests



ISOLATION

STANDARD FEATURES

TECHNICAL DATA	
DC+/DC- Output to PE	1500VDC
Input Isolation Test Voltage (Line to Case/Logic)	2500VDC (1s)
Output Isolation Test Voltage (Output to Case/Logic)	3330VDC (1s)
AC Terminals to PE	900VDC
AC to DC Terminals	1500VDC
Resistance (DC+/DC- output to PE)	X713 jumper inserted: 22MΩ, X713 jumper removed: open

MECHANICAL

STANDARD FEATURES

TECHNICAL DATA	
Cabinet AC Connection	CEE 125A (3P+N+PE)
Module AC Terminals	6 to 35 mm^2 wires, diameter ≤8.5mm
Cabinet DC Connection	Amphenol PowerLok300 with M8 cable lugs (installed on selected module cabinets)
Module DC Terminals	Output bars for M8 bolts
Cooling	Direct forced air, front to back
Operating Altitude	≤2000m above sea level (slight temperature derating possible above 1000m)
Operation Temperature	-5°C to +40°C (up to +50°C possible without air filter installed, contact ETPS with requirement)
Storage Temperature	-25°C to +70°C
Relative Humidity	0 to 95% (non condensing)
Vibration	IEC 60068-2-6 (Test Fc)
Acoustic Noise Level (1m From Front of Unit)	≤54dB (90% P_{MAX}/90% I_{MAX} at +25°C ambient)

SAFETY AND PROTECTION

STANDARD FEATURES

TECHNICAL DATA	
Over Voltage Protection	Programmable
Over Current Protection	Programmable
Over Power Protection	Programmable
Over Temperature Protection	Standard
Degree of Pollution	2 (EN 61010, EN 50178)
Overvoltage Category	Mains input, EN 61010: 3, other connections: 2
Safety of Machinery	EN ISO 13849-1:2015 PL e
Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use	EN 61010-1:2010
Electronic Equipment for Use in Power Installations	EN 50178:1997
Emission Standards for Industrial Environments	EN 61000-6-4:2007+A1:2011
Immunity Standards for Industrial Environments	EN 61000-6-2:2005
Electrical Equipment for Measurement, Control and Laboratory Use	EN 61326-1:2013 (industrial level A)
Restriction of Hazardous Substances	EN IEC 63000:2018

HIGHLIGHTED FEATURES

AUTOMATIC VOLTAGE MATCHING WITH RPP

When researching energy storage devices, Reverse Polarity Protection (RPP) is provided for devices without an automatic voltage matching circuit. With the G5-RSS energised but output off, the RPP senses the voltage of the connected energy storage device. A contactor is closed after matching the voltage, to prevent large inrush currents and arcing on start up. The sense lines of the G5-RSS are used to measure the battery voltage. A switched sense is also provided ensuring there is quiescent current draw at voltage off state.

INTEGRATED SAFETY RELAY

For additional safety, a mechanical interlock is provided for the mains input of the G5-RSS. The integrated safety relay provides shutdown safety according to EN 13849-1 category 2/3. The ISR is connected to the external safety switch loop. If the external loop is opened, the DC-output of the power system is powered down immediately.

NEW G5-RSS SYSTEMS

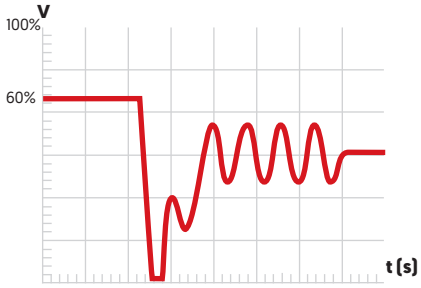
If you are looking to purchase a system, new G5-RSS modules can be found in our bidirectional DC range. A selection of options are available including integrated safety relays, various application specific GUIs, reverse polarity protection, as well as a high speed CAN interface.

Where necessary, units can be treated to a laboratory rack or flight case integration. Common options include mains cables, passive indication of any residual DC voltage, isolation monitoring of DC cables and a panel mounted emergency stop. Switch panels with removable DC links can be fitted to simplify reconfiguration between series, parallel or independent use.

COMMON G5-RSS APPLICATIONS

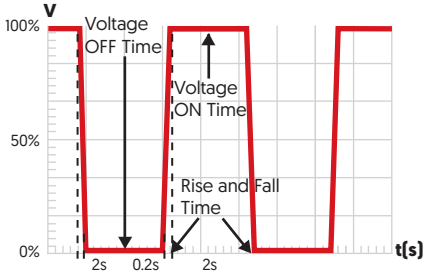
CRANKING CURVE TESTING

Electrical components within a vehicle's subsystem must be able to withstand a wide range of input voltage surges and drops during a start-up. The G5-RSS can accurately recreate these conditions within a lab environment. This increases reproducibility and accuracy of results when compared to using real batteries. Hard to replicate conditions such as voltage cranking during a cold start can be achieved. Voltage/current and voltage/power relationships can be programmed against time where necessary.



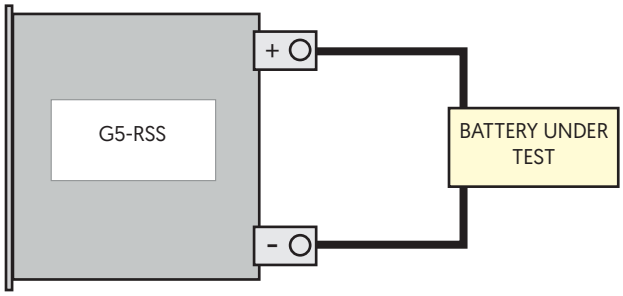
PULSED BATTERY CHARGING

Pulse charging interrupts the traditional DC charging curve with short relaxation periods. The technique is thought to improve battery discharge capacity and help facilitate longer cycle life. Some studies have shown that pulse charging is also helpful in eliminating concentration polarisation. The G5-RSS's embedded function generator allows the PSU to deliver short burst of highly concentrated energy at user defined time intervals. The technique can also be used for powering lasers, electromagnets and plasma generation.



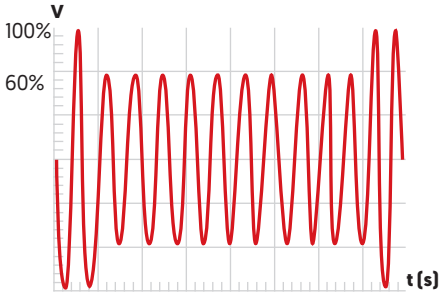
AC RIPPLE ON BATTERY LINK

A potential side effect of charger circuits that contain both AC and DC components is electrical noise. The ripple causes unwanted fluctuations in battery temperature, which results in deterioration of the battery's performance. By utilising the G5-RSS's embedded function generator the user can set a current ripple at up to 10kHz to simulate this phenomenon.



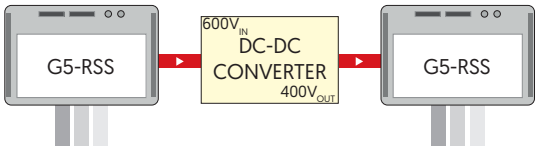
VOLTAGE DROPS & INTERRUPTS

In electronic systems sudden voltage interruptions may cause unexpected behaviour. Supply line disturbances may have several causes, including an additional switch on of large capacitive loads parallel to the supply line or a short circuit caused by loads sharing the supply. The G5-RSS can generate many complex DC waveforms to test devices under realistic conditions to identify any potential issues.



INVERTER/CONVERTER TESTING

The DC input of virtually any power conversion device can be replicated. The influence that variables, such as line voltage variation, have on performance can be isolated and tested. This allows optimum operating conditions to be characterised to improve efficiency and performance.



FUEL CELL EMULATION

The discharge behaviour of an FCEV's fuel cell is often irregular. By using the function generator, both conservative and aggressive driver profiles can be replicated. This allows the G5-RSS to perform effective quality testing of fuel cell powered components under all likely operating conditions.

“WE ARE POSITIVE PEOPLE”

ETPS engineer electronic power supply and testing systems. Our problem solving skills provide the spark of innovation to some of the world’s leading technology brands.

ETPS
ELECTRONIC TEST & POWER SYSTEMS

Tel: +44 (0) 1246 452909
Sales: 0800 612 95 75
sales@etps.co.uk
www.etps.co.uk

ETPS Ltd
Unit 14, The Bridge
Beresford Way, Chesterfield
S41 9FG

POSITIVE PROBLEM SOLVING