ETPS
ELECTRONIC TEST & POWER SYSTEMS

EAC-ACS-4Q
GRID-TIED 4 QUADRANT POWER SUPPLIES

POSITIVE PROBLEM SOLVING +=

The EAC-ACS-4Q is a modular grid emulator with full 4 quadrant operation in just 11U of height. Each unit has the ability to sink and source both AC and DC power.

The module's active neutral string allows for any single phase or asymmetric condition to be accurately simulated. All three of the unit's phases are individually programmable for voltage, frequency, phase angles and superimposed harmonics. Current control is also optionally possible. GUIs are available to simulate a variety of grid and impedance conditions. An optional Fourier tool can create virtually any conceivable periodic waveform, with superimposed harmonics and inter-harmonic voltages up to 5000Hz.

+ Mains Regeneration of AC/DC Sink Energy
+ Simulated Impedance Software
+ Outputs to 2.5MVA Possible
+ Frequencies up to 5000Hz
+ Full 4 Quadrant Operation
+ Grid Simulation GUI

CONTENTS

STANDARD MODELS

SELECTION TABLE

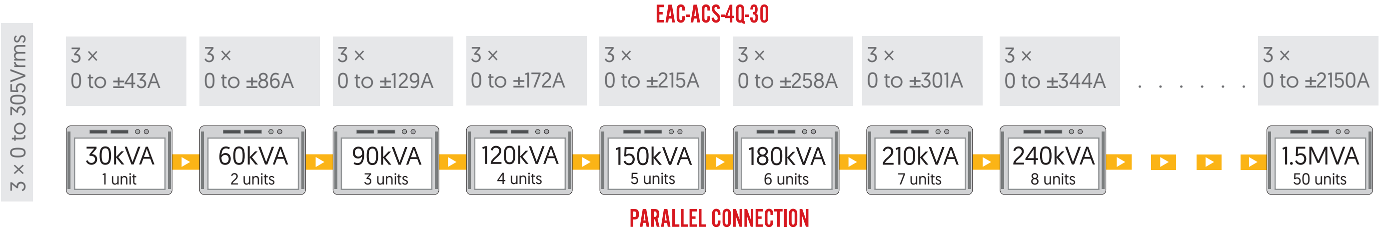
Part Number	Maximum Power	Voltage Range	Current Range	Dimensions (W × H × D)
EAC-ACS-4Q-30	30kVA	3 × 0 to 305Vrms (L - N)	3 × 0 to ±43A	19" × 11U × 635mm*
EAC-ACS-4Q-50	50kVA	3 × 0 to 305Vrms (L - N)	3 × 0 to ±72A	19" × 11U × 635mm*

*A full cabinet integration service is available on request

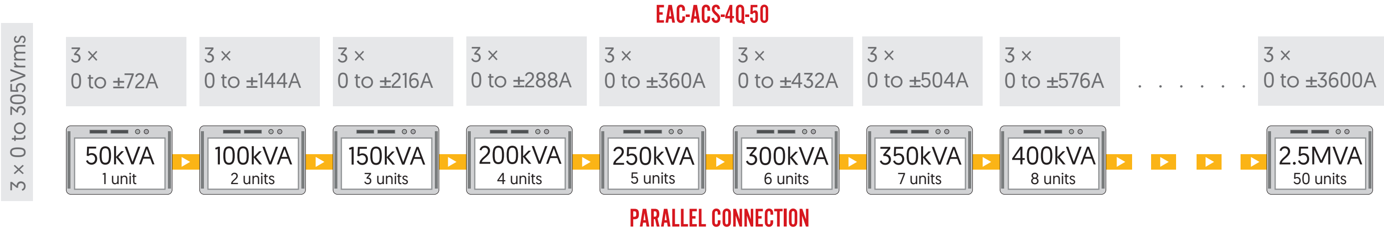
MODULARITY (MASTER/SLAVE)

Up to fifty EAC-ACS-4Q modules can be arranged in parallel. Each PSU is able to operate independently, so that systems can be expanded or broken up as needs dictate. The modular approach is useful for test houses and research labs which regularly test different sized power devices. Individual units can be used for the day to day testing of multiple small devices, then grouped together for larger projects. The diagram shows some possible parallel configurations using multiple modules.

EAC-ACS-4Q-30



EAC-ACS-4Q-50



FORM FACTOR AND ENCLOSURES

Each module is built into a 19" rackmounting case as standard. On request units can be treated to a laboratory rack or flight case integration. Having a programmable power system mounted into a flight case on castors is often advantageous, especially when several departments or test cells share the same equipment.

Multiple power systems can be fitted into the same flight case. Door hangers are fitted for convenience. Existing ETPS systems can also be retrospectively integrated into new flight cases where requested.

OPTIONS TABLE

OPTIONS

CODE	DESCRIPTION
	FORM FACTOR AND ENCLOSURES
/LR	Integration into a 19" lab rack
/FC	Integration into a flightcase
	SOFTWARE/SOFT TOOLS
/GRIDSIM	Full waveform mode with adjustable parameters, ideal for simulating grid characteristics
/RLCLOAD	Full 4 quadrant RLC load simulation mode
/I-CONTROL	Full 4 quadrant amplifier mode with current control
/POWERMODE	Constant power mode with user adjustable apparent power and cos(phi), or active power and reactive power
	EMC TESTING
/EMC-XXX	GUI to implement individual EMC standards, please specify which standard(s) you require to test to
/VSE	Voltage slope enabling for fast voltage slopes <5µs and current peaks up to 1000A
	INTERFACES AND CONTROL
/CANMP	Integrated CANmp interface
/IO	Digital I/O interface: 8 × Digital IN 24V, 8 × Digital OUT 24V, 4 × Relays, potential free SPDT
	SAFETY AND PROTECTION
/XCD	A safety discharge circuit which quickly removes a residual voltage hazard from the module within 1s, should the plug be accidentally removed while the EAC-ACS-4Q is energised
	LIQUID TO AIR HEAT EXCHANGER
/LAE-5-400	Additional 4U liquid to air heat exchange module with 380 - 480VAC input for cooling of the power stage
/LAE-5-230	Additional 4U liquid to air heat exchange module with 100 - 240VAC input for cooling of the power stage
	SENSEBOARD
/SENSEBOARD	Senseboard with programmable transformer ratio for RMS voltage drop compensation at 50/60Hz. The senseboard allows users to measure the voltage directly at the load, so the voltage can be controlled more accurately and the voltage drop over the load cables can be compensated. Maximum input voltages: L-L: 1000 VRMS, 1500 Vp L-N: 1000 VRMS, 1500 Vp N-PE: 500 VRMS, 750 Vp

LINESIDE

STANDARD FEATURES

TECHNICAL DATA	
AC Line Voltage	3 × 360-528VAC_{rms}
Line Frequency	50Hz ± 0.5Hz for UK (48 - 62Hz possible)
Mains Connection Type	3L + PE (no neutral)
Input Current	Nominal at 3 × 360VAC_{rms}: 54ARMS (30kVA modules) | 90ARMS (50kVA modules) Nominal at 3 × 400VAC_{rms}: 48ARMS (30kVA modules) | 81ARMS (50kVA modules) Nominal at 3 × 440VAC_{rms}: 45ARMS (30kVA modules) | 74ARMS (50kVA modules) Nominal at 3 × 480VAC_{rms}: 41ARMS (30kVA modules) | 68ARMS (50kVA modules)
Inrush Current	Built-in precharge circuit (no excessive inrush current)
Powerfactor	1 (at nominal power)
THDi	≤1.5% at 90%P_{MAX} (30kVA modules) | ≤1% at 90%P_{MAX} (50kVA modules)
Input Filter Discharge to 60V	<20s (standard) | <1s (with option /XCD)

HIGHLIGHTED FEATURE

POWER RECYCLING

When functioning as a load, the EAC-ACS-4Q has an inbuilt monitoring system that synchronises with grid conditions. This recycles the AC/DC sink energy from the loadside back to the three phase mains.

ISOLATION

STANDARD FEATURES

TECHNICAL DATA	
Power to PE (L1/L2/L3)	305VAC_{RMS} (working voltage)
Power to PE (L1/L2/L3)	432VDC (working voltage)
Power to Case/Logic	2120VDC/1s (test voltage)

LOADSIDE

STANDARD FEATURES

TECHNICAL DATA	
Standard Operating Modes	Constant Voltage Amplifier Mode and an ACSControl GUI for voltage/frequency adjustment (see page 8)
Optional Operating Modes	Grid Simulation Mode RLC Load Simulation Mode Constant Current Amplifier Mode
Connection Type	3L + N + PE (dependent on configuration, see page 6)
Frequency Range (at Reduced Current)	0 - 5000 Hz (see operational diagram on page 7)
Frequency (P_{MAX})	16 - 1000 Hz (see operational diagram on page 7)
Voltage Slew Rate	≤4V / µs
Voltage Slew Rate (10 - 90% step of full scale)	≤100µs
Harmonic Distortion at 50Hz[1]	≤0.4% (linear), ≤1.6% (non-linear)
Overloadability	≤150% up to 10s every 600s, ≤200% up to 1s every 60s (see operational diagrams)
Modulation Bandwidth	5kHz
DC Offset	≤10mV
DC Ripple and Noise	16Hz - 200kHz: 230mVrms | 9kHz - 20MHz: 700mV_{p-p}
Efficiency	90% (at nominal power)
Static Accuracy Voltage (RMS Controller)	0.05% F.S.
Static Accuracy Voltage (General)	<1.5V
Static Accuracy Frequency	2mHz
Static Accuracy Phase Angle	1°
Setpoint Resolution Voltage	0.1V
Setpoint Resolution Frequency	1mHz
Setpoint Resolution Phase	0.1°
Measurement Precision Voltage	±0.7% F.S.
Measurement Precision Current	±1.4% F.S.

[1] (THDu) up to 290Vrms (L-N)

HIGHLIGHTED FEATURES

INDIVIDUALLY PROGRAMMABLE PHASES

All three of the EAC-ACS-4Q's individual phases are independently adjustable. This provides up to three power systems from one unit. Using the optional GridSim GUI, it is possible to program each phase for: voltage, frequency, phase angle, as well as superimposed harmonic and inter-harmonic voltages up to 5kHz. Different voltage waveforms per phase are also possible in amplifier mode.

HARDWARE IN LOOP COMPATIBILITY

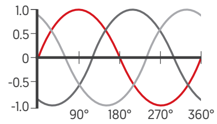
When operating in voltage amplifier mode, the EAC-ACS-4Q operates as a full 4-quadrant three phase amplifier. The drive signals are fed into the power system via analogue inputs from external sources. This is ideal for hardware in the loop (HIL) applications driven by a real time computer. A current amplifier mode is optionally available.

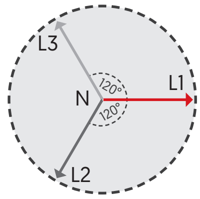
LOADSIDE CONFIGURATIONS

Each of the EAC-ACS-4Q's three phases are individually programmable for voltage, frequency, phase angles and superimposed harmonics. Below are configurations example using a single 30kVA or 50kVA module. Larger systems are possible from 60kVA to 1MVA.

AC CONFIGURATIONS

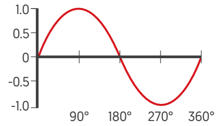
1. 3Φ OUTPUT (3L + N)	
Connection Type	3L + N + PE
EAC-ACS-4Q-30 Ranges	Each Phase Individually Programmable: + 30kVA / 3× 305Vrms (L-N) / 3× 43A
EAC-ACS-4Q-50 Ranges	Each Phase Individually Programmable: + 50kVA / 3× 305Vrms (L-N) / 3× 72A

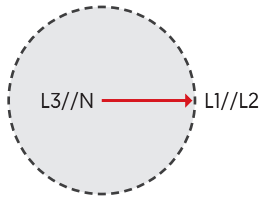




2. 1Φ OUTPUT (1L + N)*	
Connection Type	L1‖L2 + L3‖N + PE
EAC-ACS-4Q-30 Ranges	+ 20kVA / 305Vrms (L-N) / 86A
EAC-ACS-4Q-50 Ranges	+ 20kVA / 305Vrms (L-N) / 144A

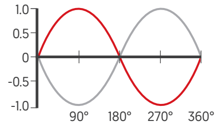
*A firmware update needs to be provided from ETPS to implement this configuration.

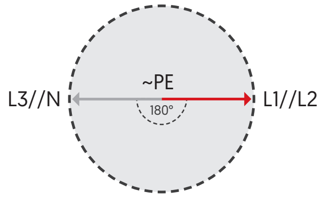




3. 1Φ3W / SPLIT PHASE OUTPUT*	
Connection Type	L1‖L2 + L3‖N + PE
EAC-ACS-4Q-30 Ranges	+ 30kVA / 610Vrms (L-L) / 86A
EAC-ACS-4Q-50 Ranges	+ 50kVA / 610Vrms (L-L) / 144A

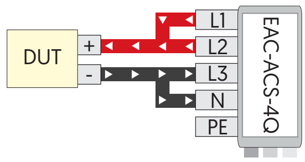
*A firmware update needs to be provided from ETPS to implement this configuration.



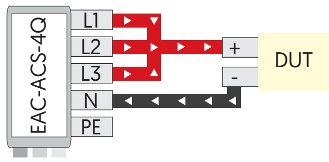


DC CONFIGURATIONS

4. 1× OUTPUT (SYMMETRIC TO PE)	
Connection Type	L1‖L2 + L3‖N
EAC-ACS-4Q-30 Ranges	+ ±30kW / ±830Vdc / ±40A
EAC-ACS-4Q-50 Ranges	+ ±33kW / ±830Vdc / ±40A

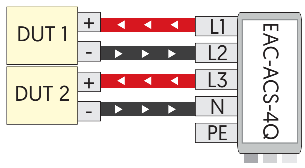


5. 1× OUTPUT (RELATED TO PE)	
Connection Type	L1‖L2‖L3 + N
EAC-ACS-4Q-30 Ranges	+ ±25kW / ±415Vdc / ±60A
EAC-ACS-4Q-50 Ranges	+ ±25kW / ±415Vdc / ±60A



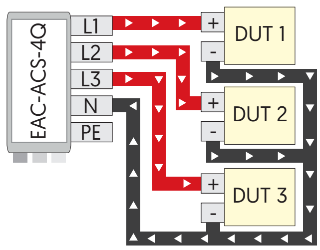
6. 2× INDEPENDENT OUTPUTS	
Connection Type	Output 1: L1 + L2, Output 2: L3 + N
EAC-ACS-4Q-30 Ranges	+ Output 1: ±16kW / ±830Vdc / ±20A* + Output 2: ±8kW / ±415Vdc / ±20A*
EAC-ACS-4Q-50 Ranges	+ Output 1: ±16kW / ±830Vdc / ±20A* + Output 2: ±8kW / ±415Vdc / ±20A*

*Total current to neutral limited to ≤20A



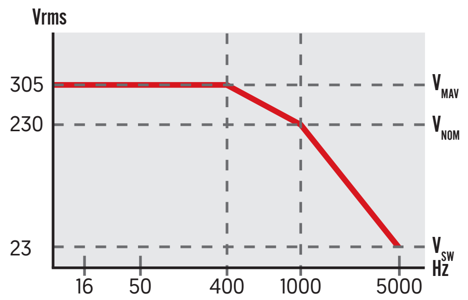
7. 3× INDEPENDENT OUTPUTS (RELATED TO PE)	
Connection Type	L1 + N, L2 + N, L3 + N
EAC-ACS-4Q-30 Ranges	+ Each independent output: ±8kW / ±415Vdc / ±20A*
EAC-ACS-4Q-50 Ranges	+ Each independent output: ±8kW / ±415Vdc / ±20A*

*Total current to neutral limited to ≤20A

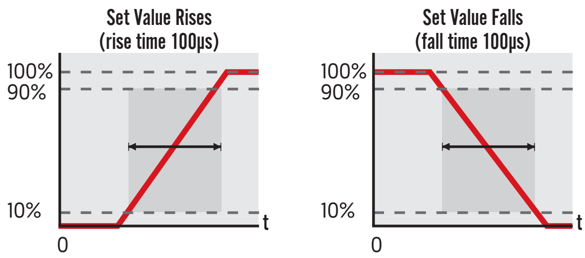


OPERATIONAL DIAGRAMS

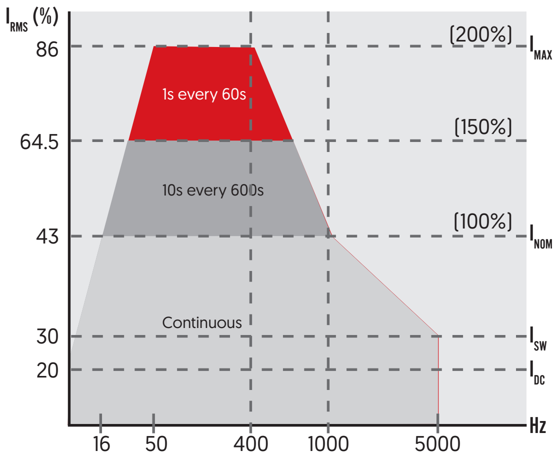
OUTPUT VOLTAGE VERSUS FREQUENCY



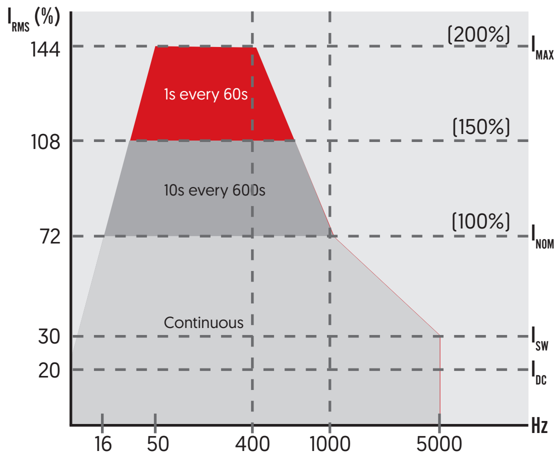
SLEW RATE AT A RESISTIVE LOAD



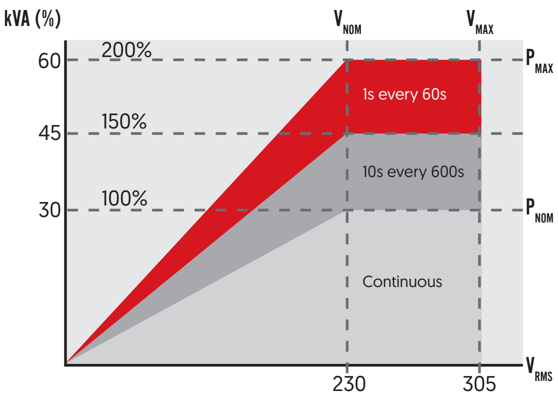
OVERLOADABILITY VERSUS FREQUENCY (30KVA MODULES)



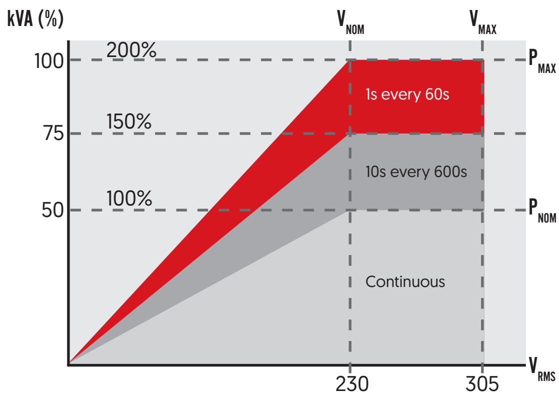
OVERLOADABILITY VERSUS FREQUENCY (50KVA MODULES)



OVERLOADABILITY VERSUS VOLTAGE (30KVA MODULES)



OVERLOADABILITY VERSUS VOLTAGE (50KVA MODULES)



SOFTWARE/SOFT TOOLS

STANDARD ACSCONTROL GUI

All EAC-ACS-4Q units come with a simple and intuitive ACSControl operating GUI as standard. The module is connected to a PC via the standard Ethernet or USB interface. Live values of the power supply are displayed graphically along with any warning and error messages. Input values to the EAC-ACS-4Q from the local grid are also displayed, including: input current, reactive power, active power and Cosφ (Figure 8.1). The software allows protection levels to be set on both the lineside and loadside of the system.

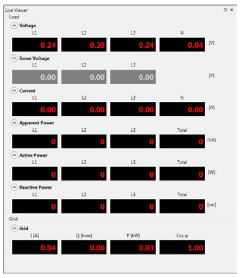


FIGURE 8.1

As standard, ACSControl comes with a basic waveform generator mode (Figure 8.2). This allows users to implement sinewaves and edit parameters such as frequency and voltage (either L-N or L-L), as well as choosing the number of output phases (two or three). For more complex programming requirements, the optional GridSim GUI provides users with much greater functionality than standard ACSControl.

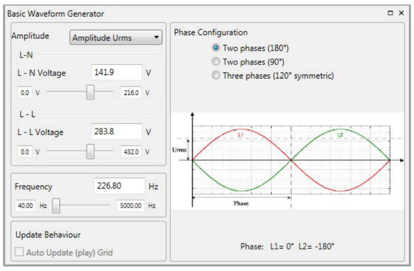


FIGURE 8.2

HIGHLIGHTED FEATURE

VOLTAGE AMPLIFIER MODE

ACSControl also features a voltage amplifier mode as standard. The module receives external signals via an analogue input for each phase. To achieve a desired output on the loadside of the module, the signals can be either amplified or reduced by a user defined scaling factor. Different waveforms are possible per phase.

Any device which creates -10 to +10V can be used as an external signal generator. This functionality is particularly useful for hardware in the loop applications. Users also have the ability to discharge the EAC-ACS-4Q module through the amplifier mode.

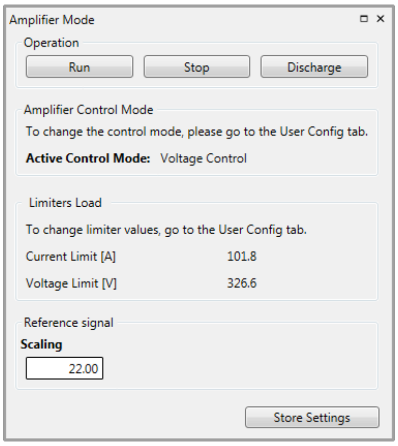


FIGURE 8.3

OPTIONAL SOFTWARE

CODE	DESCRIPTION
/GRIDSIM	Full waveform mode with adjustable parameters, ideal for simulating grid characteristics
/RLCLOAD	Full 4 quadrant RLC load simulation mode
/I-CONTROL	Full 4 quadrant amplifier mode with current control
/POWERMODE	Constant power mode with user adjustable apparent power and cos(phi), or active power and reactive power

HIGHLIGHTED OPTION

CURRENT CONTROL MODE (/I-CONTROL)

For applications where you need to actively control the output current of the EAC-ACS-4Q, an additional current controlled amplifier mode is available. For example, a 10V input is equal to 124A for the 50kVA modules. So if you want an output of 62A, then a factor of 0.5 (62/124) is entered into the scaling field.

HIGHLIGHTED OPTION

RLC LOAD MODE (/RLCLOAD)

The optional RLC load mode {Resistance (R), Inductance (L), Capacitance (C)} enables the user to set apparent (VA) and reactive power (VAR). It also allows the power factor (cos phi) to be adjusted. The simulated impedance is particularly useful for users who design, research and develop renewable systems which feed energy to the public grid.

ANTI-ISLANDING TESTING

The software allows the EAC-ACS-4Q to test against anti-islanding regulations for grid-tied power systems. These regulations prevent safety risks and define the operating limits at which power equipment goes out of tolerance. If the equipment exceeds these tolerance levels, it needs to detect the condition and disconnect from the grid.

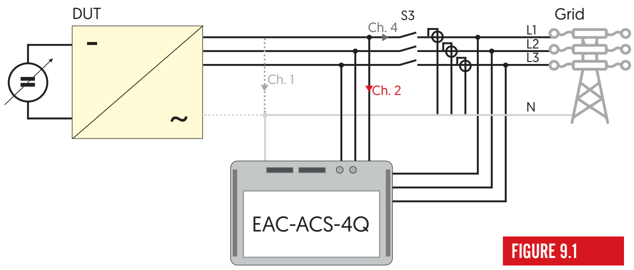


FIGURE 9.1

As the EAC-ACS-4Q simulates impedance for these regulatory tests, users do not have to use real components. This drastically reduces set up time and minimises the possibility of human error within the setup of the test circuit. It also eliminates the need to buy lots of different high power components for multiple tests, which can often prove very expensive. The difference between using real components and the EAC-ACS-4Q is illustrated in Figure 9.2.

Figure 9.1 illustrates a test set-up using the EAC-ACS-4Q's simulated impedance. For the detection of islanding, the switch S3 is closed and the module is operated in RLC simulation mode. The S3 switch is reopened again to test the DUT's behaviour while in an islanding condition.

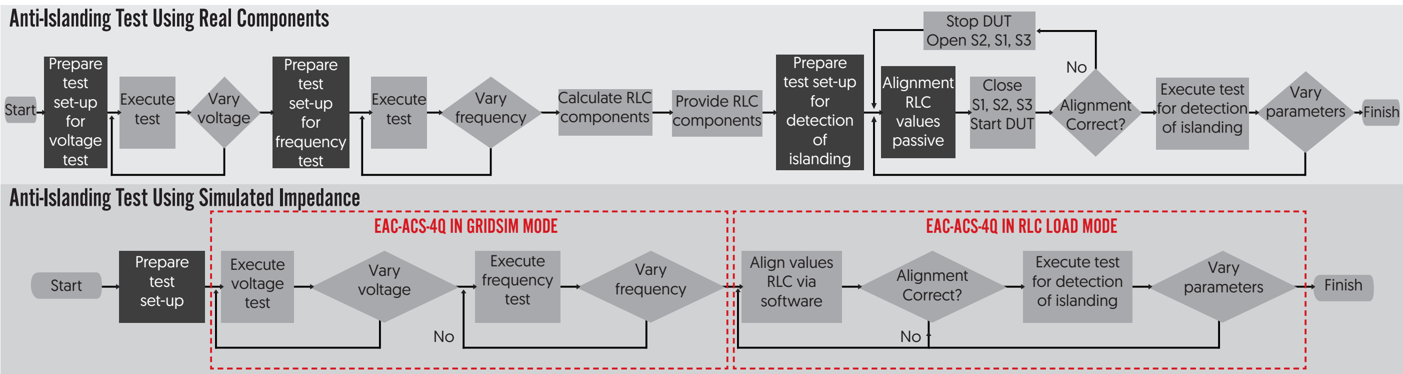


FIGURE 9.2

CONFIGURING AN RLC CIRCUIT

Users can select between 12 different types of topology within the software (Figure 9.4). Each loadside phase can have its own RLC topology, as shown in Figure 9.3.

Individual parameters of each topology circuit can be set to customise the test to your specific requirements. The settable values are listed in Figure 9.5.

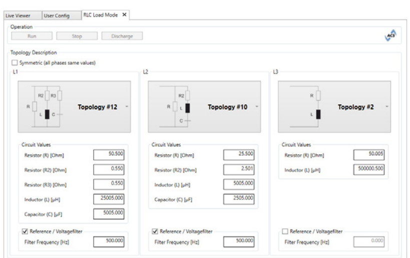


FIGURE 9.3

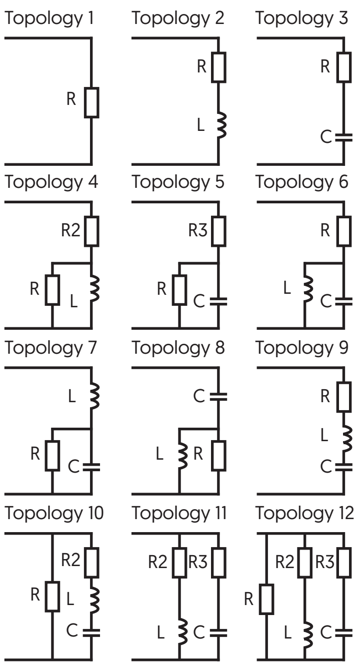


FIGURE 9.4

POSSIBLE VALUE RANGES OF RLC CIRCUIT

Topology	Range of Values	Topology	Range of Values
1	R: 0.001Ω to 10000Ω	7	R: 0.001Ω to 100Ω L: 1μH to 100mH C: 1μF to 100mF
2	R: 0.01Ω to 100Ω L: 1μH to 1000mH	8	R: 0.1Ω to 100Ω L: 1μH to 50mH C: 1μF to 50mF
3	R: 0.001Ω to 100Ω C: 1μF to 1000mF	9	R: 0.001Ω to 100Ω L: 1μH to 100mH C: 1μF to 100mF
4	R: 0.1Ω to 100Ω R2: 0.1Ω to 100Ω L: 1μH to 1000mH	10	R: 1Ω to 50Ω R2: 0.001Ω to 5Ω L: 10μH to 10mH C: 10μF to 5mF
5	R: 0.001Ω to 100Ω R3: 0.001Ω to 10Ω C: 1μF to 100mF	11	R2: 0.1Ω to 1Ω R3: 0.001Ω to 1Ω L: 1μH to 50mH C: 1μF to 10mF
6	R: 0.001Ω to 3.2Ω L: 1μH to 10mH C: 1μF to 10mF	12	R: 1Ω to 100Ω R2: 0.1Ω to 1Ω R3: 0.2Ω to 1Ω L: 10μH to 50mH C: 10μF to 10mF

FIGURE 9.5

HIGHLIGHTED OPTION

FULL WAVEFORM GENERATOR MODE (/GRIDSIM)

Where more advanced testing is required, the optional GridSim GUI provides users with a selection of advanced features. The software allows for manual operation and programming, as well as automated test runs to be configured with ease. A set of predefined periodic waveforms are available including sine, clipped sine, square, triangle, sawtooth. User defined waveforms are also possible.

FOURIER TOOL

A Fourier tool is provided that can create virtually any conceivable periodic waveform. Superimposed harmonic and inter-harmonic voltages are programmable up to 5000Hz. The Fourier mathematics required to generate such waveforms is already built into the tool, meaning there is no need to manually figure out the complex equations that are required for advanced waveforms. This saves time when configuring a test setup, as well as reducing the possibility of any human errors.

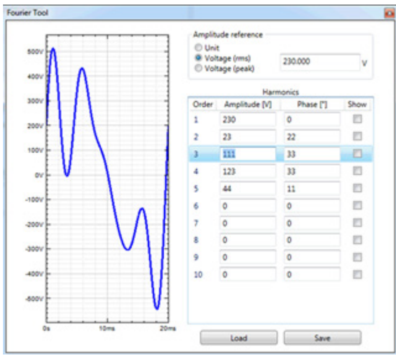


FIGURE 10.1

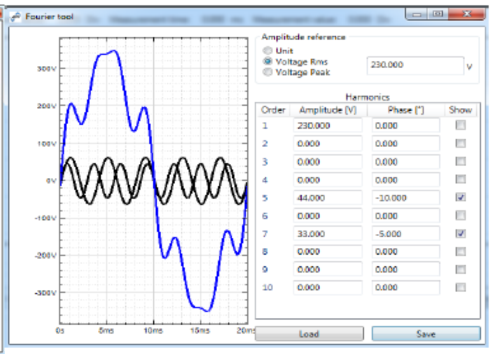


FIGURE 10.2

Individual waveforms, as well as the final synthesised waveform, are represented graphically within the software. As shown above, the synthesised waveform is shown in blue and the individual waveforms are shown in black.

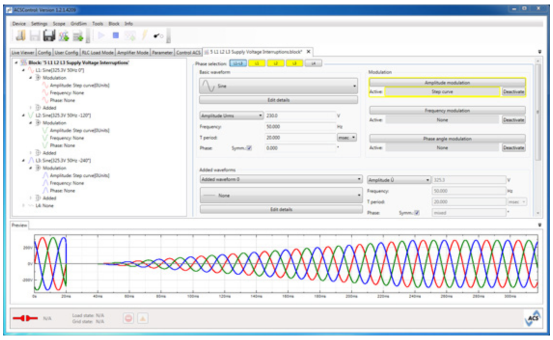


FIGURE 10.3

GRID SIMULATION

A bidirectional circuit can be formed between the DUT(s) and the EAC-ACS-4Q to emulate a grid network. Typical grid conditions can be created in the GUI to investigate how changes to the mains voltage affect a power system's behaviour.

Common conditions such as voltage dips, short interruptions and voltage spikes can be recreated. An example of a voltage interruption is shown in Figure 10.3. Each of the system's three output phases can be used independently to simulate the balancing of a grid to meet changing demands.

Both user defined and automated tests can be implemented, with the ability to record and recall data. Relevant grid feed-in regulations can be programmed into the software. This is particularly useful for testing renewable energy generation devices.

ADDITIONAL FUNCTIONALITY

Non-periodic waveforms such as voltage ramps, DC straight lines (either positive or negative), step curves and exponential curves can also be programmed within GridSim. This allows virtually any conceivable waveform to be generated that is within the unit's dynamic capabilities.

Specific phase imbalance conditions can be user programmed, which is particularly useful when testing three phase induction AC motors under various conditions.

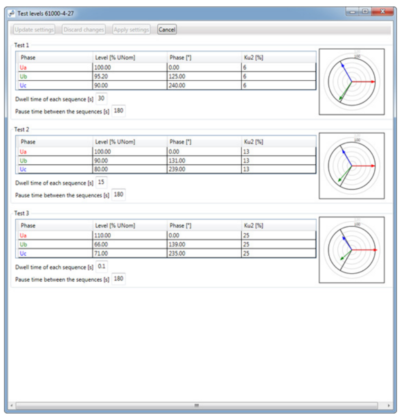


FIGURE 10.4

EMC TESTING

OPTIONS

CODE	DESCRIPTION
/EMC-XXX	GUI to implement individual EMC standards, please specify which standard(s) you require to test to
/VSE	Voltage slope enabling for fast voltage slopes <5µs and current peaks up to 1000A

SOFTWARE

Specific EMC test standards listed below are individually available to execute from the EAC-ACS-4Q's operating software. The GUI features a separate test interface for each standard and provides waveform visualisation, tracing, and verification capabilities. Automatic generation of test reports is also provided.

Each test consists of multiple sequences, which can be executed as a whole or as individually selected blocks. EMC classes 1 to 4 predefined by a specific standard are user selectable. There is also a class X available, where relevant variables are programmable. Example variables include dip deepness, harmonic content, and frequency shift.

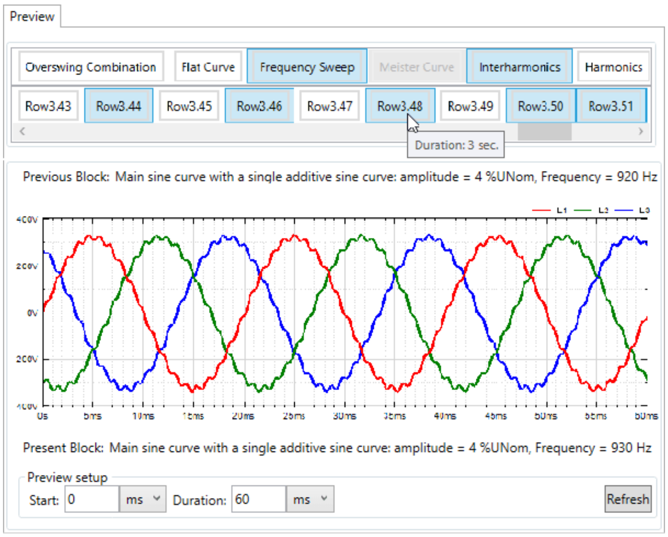


FIGURE 11.1

Trigger signals are generated by the EAC-ACS-4Q for external measurements with a power analyser. To guarantee the conformity of the standard test, the voltage accuracy of the EAC-ACS-4Q can be verified by calibrated external measurement tools before executing the test procedure. If the accuracy is not within the limits according to the particular standard, calibration and adjustments can be implemented via the ACSControl GUI.

EMC STANDARD	DESCRIPTION
EN 61000-4-11:2004*	Voltage dips, short interruptions, and voltage variations immunity tests up to 16A per phase
EN 61000-4-13:2002 + A1:2009	Harmonics and interharmonics immunity tests
EN 61000-4-14:1999 + A1:2001 + A2:2009	Voltage fluctuation immunity test
EN 61000-4-27:2000 + A1:2009*	Unbalance, immunity test up to 16A per phase
EN 61000-4-28 + A1:2004 + A2:2009	Variation of power frequency, immunity test
EN 61000-4-34:2005 + A1:2009*	Voltage dips, short interruptions, and voltage variations immunity tests more than 16A per phase

* Full compliance testing to this standard requires additional VSE hardware.

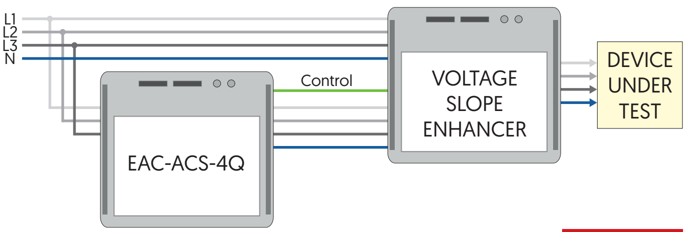


FIGURE 11.2

VOLTAGE SLOPE ENHANCER (/VSE)

The standards highlighted with asterisks above require the execution of voltage drops, short interruptions, and voltage variations. Switching at any time is mandatory, not only at zero crossing of the voltage.

To achieve this an additional VSE (voltage slope enhancer) is available. The hardware allows for fast voltage slopes <5µs and current peaks up to 1000A, and for two different voltage sources to be switched between (e.g. AC grid and EAC-ACS-4Q), as shown in Figure 11.2.

INTERFACES & CONTROL

STANDARD INTERFACES

1. SAFETY AND MULTI-MODULE OPERATION	
X112-2	ISR interface (must be terminated with the dummy plug X112, if not used)
X601/X602	Preset distribution interfaces, only used for multi-module systems (NOTE: In single device use one of these interfaces must be terminated with 100 ohms)

2. CONTROL PORT OUTPUT FUNCTIONS	
X603	EtherCAT input interface (only used for multi-module systems)
X604	EtherCAT output interface (only used for multi-module systems)
X605	LAN interface for remote control through ACSControl/API; 200Vrms isolation to electronics and earth
X607	USB type B interface for remote control through ACSControl/API; 250Vrms isolation to electronics and earth
X608	Micro SD card slot (for service only)
X609	Analogue input and output for general usage, 12 pin flush-type, mating connector: Phoenix Contact (1430048) 4 Inputs for general usage, ±9.5V reference voltage; 4 Outputs for general usage, ±9.5V reference voltage Time delay power output to analogue output: <50µs; 80kHz Sampling rate; 250Vrms isolation to electronics and earth; 330kΩ input pins input impedance; 2kΩ output pins min. load impedance
X620	Trigger input port BNC (start) TTL; 250Vrms isolation to electronics and earth; 10kΩ input impedance
X621	Trigger output port BNC (programmable) TTL; 250Vrms isolation to electronics and earth; 560Ω output impedance (short circuit proof)

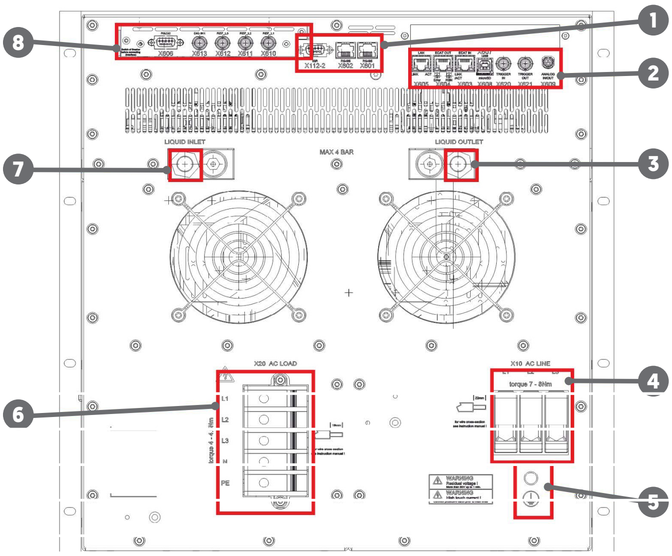
3. OUTPUT INTERFACE FOR COOLING CIRCUIT	
Thread	G½″ with connection fitting

4. AC LINE INPUT TERMINAL	
X10	L1, L2, L3

5. EARTHING STUD FOR ADDITIONAL EARTH CONNECTION	
Diameter and Thread	Diameter: M10, thread length: 28mm

6. AC LOAD OUTPUT TERMINAL	
X20	L1, L2, L3, N, PE

7. INPUT INTERFACE FOR LIQUID COOLING CIRCUIT*	
Thread	G½″ with connection fitting
Material	Aluminium
Liquid Temperature	15 - 50°C
Flow Rate	2.5l/min (min), 5l/min (recommended)
Max. Inlet Temperature	25°C at 2.5l/min, 40°C at 5l/min, 50°C at 8l/min
Maximum Pressure	4 bar
Pressure Drop	70mbar at 5l/min



*Use cooling liquid with a 30% share of Antifrogen N® within a closed circuit

8. CONTROL PORT INPUT FUNCTIONS FOR AMPLIFIER MODE (X610 - X612)	
X606	RS-232 interface (for service only); 125Vrms isolation to electronics and earth
X610	Signal input for phase L1 on the load side; voltage setting -432V to +432V (-10V to +10V)
X611	Signal input for phase L2 on the load side; voltage setting -432V to +432V (-10V to +10V)
X612	Signal input for phase L3 on the load side; voltage setting -432V to +432V (-10V to +10V)
Maximum Input Voltage	±30V
Sampling Rate	80kHz
Time Delay Input to Output	Typically <70µs
Isolation to Electronics and Earth	125 Vrms
Input Impedance	20.5kΩ

OPTIONAL INTERFACES

CODE	DESCRIPTION
/CANMP	Integrated CANmp interface
/IO	Digital I/O interface: 8 × Digital IN 24V, 8 × Digital OUT 24V, 4 × Relays, potential free SPDT

SAFETY & PROTECTION

STANDARD FEATURES

TECHNICAL DATA	
Overvoltage and Overcurrent Protection	Programmable
Ingress Protection (According to EN 60529)	Basic construction to IP20; mounted in cabinet up to IP54
Safety Interfaces	The energy transfer between the line side and the load side will be disconnected via integrated safety relays. The interface provides a connection to an external safety circuit.
Internal Diagnostics	Line input conditions, internal current conditions, temperature conditions, system configuration, system communication, power semiconductor temperatures
Protection Class	1
Degree of Pollution	2
Overvoltage Category	III
Low Voltage Directive 2014/35/EU	EN 62477-1:2012 + A11:2014 + A1:2017 + A12:2021
Electrical Equipment (Safety) Regulations 2016	BS EN 62477-1:2012+ A11:2014 + A1:2017 + A12:2021
Directive 2014/30/EU EMC Immunity (Industrial)	EN 61000-6-2:2005
Directive 2014/30/EU EMC Emission (Industrial)	EN 61000-6-4:2007+A1:2011
Electromagnetic Compatibility Regulations 2016 EMC Immunity (Industrial)	BS EN 61000-6-2:2005
Electromagnetic Compatibility Regulations 2016 EMC Emission (Industrial)	BS EN 61000-6-4:2007+A1:2011
RoHS Directive 2011/65/EU	EN IEC 63000:2018
The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012	BS EN IEC 63000:2018

HIGHLIGHTED FEATURE

INTEGRATED SAFETY RELAY (/ISR)

For additional safety, contactors are provided on both the lineside and the loadside of the EAC-ACS-4Q. These integrated safety relays provide a safe shutdown 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 EAC-ACS-4Q is powered down immediately.

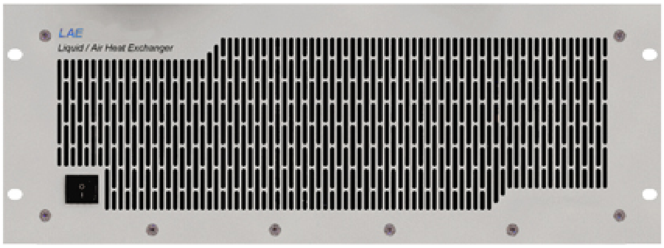
MECHANICAL

STANDARD FEATURES

TECHNICAL DATA	
AC Lineside Terminals	Screw terminals 6 to 35 mm² wires, diameter ≤8.5mm (3L + PE)
AC Loadside Terminals	Screw terminals 6 to 35 mm² wires, diameter ≤8.5mm (3LN + PE)
Weight	Approx. 150kg
Noise	≤74dB at 1m
Cooling	Liquid cooled (optional liquid to air heat exchanger)
Operating Temperature (30kVA Modules)	5 to 40°C
Operating Temperature (50kVA Modules)	5 to 40°C (when a liquid to air heat exchanger is installed, then the module's maximum power is limited to 45kVA between 32 to 35°C and 35kVA between 35 to 40°C)
Storage Temperature	-18 to 70°C
Relative Air Humidity	0 to 95% (non-condensing)
Installation Altitude	0 - 2000m above sea level (slight temperature derating possible above 1000m)
Vibration	IEC 60068-2-6 (Test Fc)

OPTIONAL LIQUID TO AIR HEAT EXCHANGER

Each unit has a liquid cooling circuit, which allows the 4 quadrant modules to be built into their compact 19" × 11U case. Should it not be feasible to connect the unit to an external cooling loop, then a separate module is optionally available to provide a liquid to air heat exchanger.



MODEL OPTIONS

CODE	DESCRIPTION
/LAE-5-400	Additional 4U liquid to air heat exchange module with 380 - 480VAC input for cooling of the power stage
/LAE-5-230	Additional 4U liquid to air heat exchange module with 100 - 240VAC input for cooling of the power stage

/LAE SPECIFICATIONS

	/LAE-5-400	/LAE-5-230
Line Voltage	380 - 480VAC	100 - 240VAC
Voltage Tolerance	± 10%	± 10%
Line Frequency	48 - 62Hz	48 - 62Hz
Input Power	200VA	200VA
Mains Connection Type	2x L + PE	L + N + PE
Power Factor	≥0.98	≥0.98
Current	0.5A	
Leakage Current L to PE	<10mA	
Heat Exchanger Material	Aluminium	
Inlet / Outlet on Rear Size	G½"	
Storage Temperature[1]	-18 to 70°C	
Cooling Air Temperature in Operation	0 to 40°C	
Atmospheric Humidity	0 to 90%, non-condensing	
Cooling Power[2]	5kW at 20°C	
Flow Rate (Max)	10 l/min	
Pressure Difference $\Delta P = P_{OUT} - P_{IN}$	250mbar	
Weight	25kg	
Dimensions (W × H × D)	19" × 4U × 649mm	

[1] With full filled ethylene glycol based coolant in a mixture of 30%

[2] Cooling power at ambient temperature

SENSEBOARD

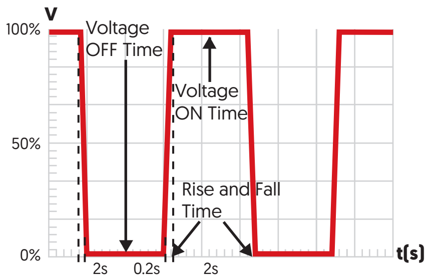
OPTION

CODE	DESCRIPTION
/SENSEBOARD	Senseboard with programmable transformer ratio for RMS voltage drop compensation at 50/60Hz. The senseboard allows users to measure the voltage directly at the load, so the voltage can be controlled more accurately and the voltage drop over the load cables can be compensated. Maximum input voltages: L-L: 1000 VRMS, 1500 Vp L-N: 1000 VRMS, 1500 Vp N-PE: 500 VRMS, 750 Vp

COMMON EAC-ACS-4Q APPLICATIONS

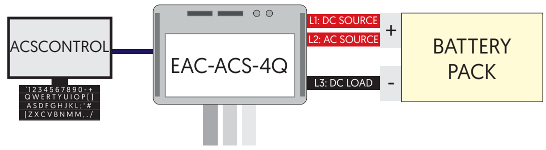
SMART GRID RESEARCH

A bidirectional circuit can be formed between devices under test and the EAC-ACS-4Q. By using each of the unit's phases as an AC source, the balancing of a smart grid to meet demand can be accurately simulated. The grid feed-in regulations can be programmed into the optional GridSim GUI, to ensure any device which generates energy to the mains is compliant to local standards.



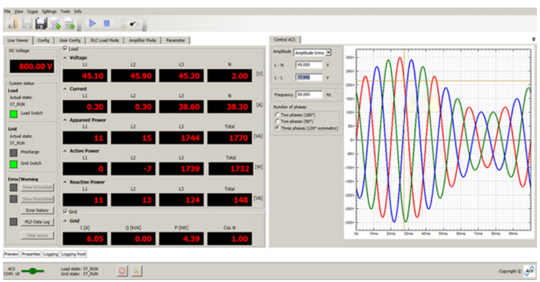
AC RIPPLE ON BATTERY LINK

A potential side effect of charger circuits that contain both AC and DC components is electrical noise. The AC ripple causes unwanted fluctuations in battery temperature, which results in deterioration of the battery's performance. Two separate phases of the EAC-ACS-4Q can be used to emulate a high frequency AC ripple over a DC battery link. By charging the battery with one phase, another phase can be used to superimpose an AC ripple of up to 5kHz on the battery link.



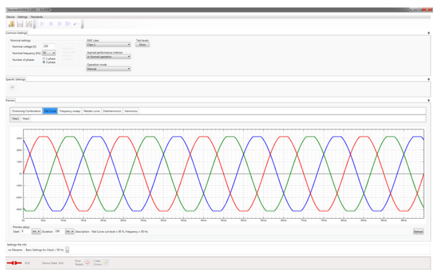
AC MOTOR IMBALANCES

The EAC-ACS-4Q can be used to simulate three phase motor imbalances. Using the optional GridSim GUI, each of the unit's output phases are individually programmable for phase angle, voltage, current and frequency. The GridSim GUI provides users with a convenient way to program specific phase imbalance conditions.



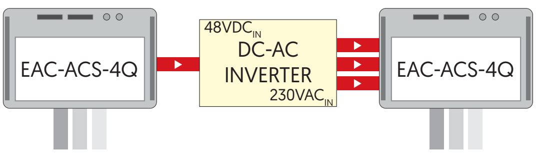
EMC TESTING

Automated EMC tests can be programmed into the optional GridSim GUI. The power system is capable of testing against standards for voltage fluctuations, power frequency variations and short interruptions among others. Each EAC-ACS-4Q has an incredibly high peak current capability. When combined with additional hardware, 50kVA modules are able to produce up to 1000A and simulate a voltage drop (phase loss) within 5μs.



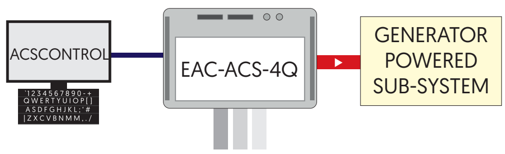
INVERTER/CONVERTER TESTING

The AC or DC input/output 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.



TESTING MORE ELECTRIC AIRCRAFT

The EAC-ACS-4Q is able to provide frequencies up to 1kHz, with superimposed harmonics up to 5kHz. This allows virtually any conceivable power condition to be recreated, such as the wide frequency range required for replicating an aircraft's variable frequency generator.



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

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