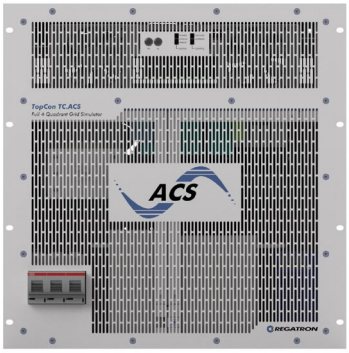
REGATRON programmable power supplies



TC.ACS.30.528.4WR.S.LC

Programmable Regenerative AC Power Supply

V02.50

Features

Scope of Application

The increasing number of alternative power sources like solar, wind driven or biological energy systems call for consistent and well demanding regulations for energy feed into the utility grid.
Manufacturers of such systems have to test and to prove the compliance of their equipment.
REGATRON TC.ACS represents the newest generation of fully programmable, regenerative grid simulation systems. Modular architecture and additional operation modes make them an ideal choice for test and R+D laboratories.

TC.ACS - Main Features

Each phase individually programmable
Variation of fundamental frequencies up to 1000 Hz
Variation/modulation of phase angles, amplitudes and frequency
Voltage drops either three phase or each single phase
Asymmetric three phase voltages
Micro-ruptures and flicker
Periodic and single shot under- and over-voltages
Superimposed harmonic and inter-harmonic voltages up to 5 kHz
Simulation of a real AC grid with Grid and Grid Impedance Simulation
Test Suite for EMC Testing according IEC/EN 61000-3-x/-4-x
Load Simulation with RLC Load Mode or Power Mode

The Grid Simulation System as a Building Block of a Complete Test Environment

Owing to the regenerative capability of the TC.ACS system, almost all AC power equipment can be tested with the appropriate test procedures. An integrated test environment for solar inverters is composed of a Solar Array Simulation block (SAS), the device under test (DUT) and the grid simulator system (ACS). While the REGATRON SAS components allow for precise simulation of a user-defined solar array of any order under arbitrary conditions, the ACS simultaneously defines the different test conditions with respect to the grid connection. Depending on the requirements, the ACS functionality may be tailored with various software options. In addition to the *Basic Waveform Generator Mode* and the *Amplifier Mode*, which are within the standard scope of delivery, the options *Full Waveform Generator Mode* with *Fourier Synthesis Tool* as well as *Datapoint Waveform Tool, Current controlled Amplifier Mode, Power Mode, Grid Impedance Simulation* and *Load Simulation Mode* are available.

Software

Grid Simulation

An intuitive application based software with various options allows for manual operation, programming and for automated test runs. With the optional *Full Waveform Generator Mode* (GridSim) a set of predefined voltage shapes – sine, cut sine, square, triangle, sawtooth, user defined - facilitates a quick and easy definition of specific grid situations. This software option also offers freely programmable modulations on each phase for amplitude, frequency and phase angle.

The combination of the two simulations grid impedance (*Grid Impedance Simulation)* and grid (*GridSim*) provides the possibility to emulate the behavior of a real AC grid and is a valuable tool for testing objects under real conditions.

Software (continued)

Load Simulation

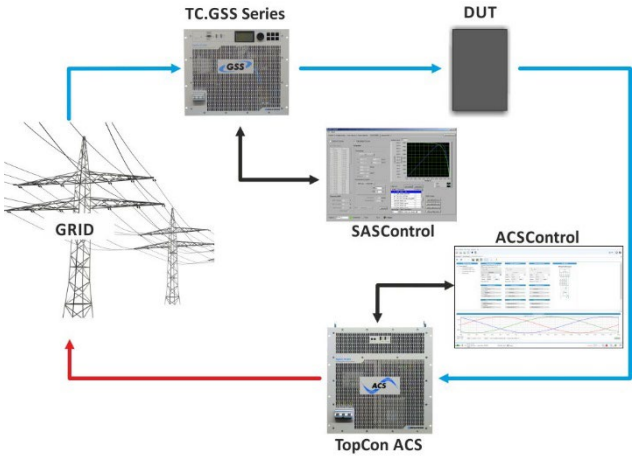
The *Power Mode* extends the existing *Load Simulation Mode* and offers the user the option of specifying the target values of apparent power, power factor cos(φ) or alternatively the active and reactive power inductively or capacitively. The current or voltage is controlled in order to keep the selected power and the phase shift between voltage and current constant.

Hardware

REGATRON grid simulator systems use a state of the art multilevel double inverter technology. The main advantages over existing linear power supplies are a substantial reduction of power losses, regenerative operation, very compact power units and the modular, cost-effective architecture. This allows the user to choose a system size that meets their requirements, including the possibility for future power expansions and/or splitting-up of the system into several stand-alone subsystems. The basic triphase power units of 30 kVA or 50 kVA may be expanded by simply paralleling further blocks even to big systems reaching 2000+ kVA.

With the availability of the active neutral string, any single phase or asymmetric condition can be simulated. Additionally, the neutral can be connected to Protective Earth (PE), if required.
The system will allow for all relevant testing according to the grid-feed-in regulations (CENELEC, DIN, IEC). Note the operation as a grid simulator, as triphase regenerative voltage amplifier and as a programmable electronic load are possible.

Application Example



By the addition of a bidirectional regenerative DC power supply TC.GSS or G5 to such a test environment, even the role of an energy storage pack within the setup may be experienced.
REGATRON offers complete and modular SAS systems based on the widespread, field-proven TopCon Quadro and the G5 power supplies on one hand as well as complete grid simulation on the other hand. Modern switched-mode technology ensures very compact and reliable systems with high overall efficiency.

Technical Data

Key Values

Programmable Regenerative AC Power Supply	
Power range	0...30 kVA
Voltage range	3 x 0...305 V_{RMS} (L-N)
Current range	3 x 0...43 A_{RMS}
Master-slave / multi-device configuration	parallel
Max. number of devices in system	up to 50
Case	19" / 11U

AC Lineside Ratings (X10)

Mains connection

Mains connection type		3L + PE (no neutral)
Line voltage		3 x 360...528 V_{RMS}
Input current		3 x 380 V_{RMS} / 51 A_{RMS}
		3 x 400 V_{RMS} / 48 A_{RMS}
		3 x 415 V_{RMS} / 47 A_{RMS}
		3 x 440 V_{RMS} / 45 A_{RMS}
		3 x 460 V_{RMS} / 43 A_{RMS}
		3 x 480 V_{RMS} / 41 A_{RMS}
Line frequency		48...62 Hz
Powerfactor @nominal power		1
Precharge unit provided. No excessive inrush current.		
THDi @90% P_{max}		<1.5%
Input filter discharge to <60 V		<20 s
	with option XCD	<1 s

Isolation

Working voltage	line L1, L2, L3 to PE	305 V_{RMS}
Working voltage	line L1, L2, L3 to PE	432 V_{DC}
Test voltage	line L1, L2, L3 to PE	2120 V_{DC} / 1 s

Loadside Ratings (X20)

Voltage controlled (CV) Mode

AC voltage operating range per phase	0...305 V_{RMS} (L-N)
DC voltage operating range per phase	0...415 V_{DC}
Static accuracy RMS-controller	≤0.05% FS
Static accuracy general	≤1.5 V
Slew rate	≤4 V/µs
Step 10%...90% FS (see Figure 8)	≤100 µs
Settling time @step 0...90% FS, error band ≤2% FS	≤300 µs
Voltage drop @full load step	≤100 V

Current controlled (CC) Mode

AC current operating range per phase	3...72 A_{RMS}
DC current operating range per phase	3...20 A_{DC}
Static accuracy general @0...500 Hz	≤2 A
Static accuracy general @500...1000 Hz	≤3 A
Slew rate	≤0.32 A/µs
Step 10%...90% step FS (see Figure 8)	≤180 µs
Settling time @step 0...90% FS, error band ≤2% FS	≤400 µs

Power controlled (CS/CP) Mode

AC power operating range per phase @230 V_{RMS}[1]	0.7...16.67 kVA
Static accuracy general @1...500 Hz	≤0.3 kVA
Static accuracy general @500...1000 Hz	≤0.45 kVA
Slew rate @230 V_{RMS}	≤70 VA/µs
Step 10%...90% FS @230 V_{RMS} (see Figure 8)	≤180 µs
Settling time @step 0...90% FS, error band ≤2% FS @230 V_{RMS}	≤400 µs

Loadside Ratings (X20, continued)

Frequency range (see Figure 2 to 4)	0...1000 Hz
Modulation bandwidth	5000 Hz
DC offset	≤10 mV
Efficiency @nominal power	90%
Output filter capacitance (L-N)	24.7 µF

Static Accuracy

Frequency	2 mHz
Phase Angle	1°

Measurement Precision

Voltage	±0.7% FS
Current	±2.4% FS

Setpoint Resolution

Voltage	0.1 V
Frequency	1 mHz
Phase	0.1°

Overloadability (see Figure 3 to 7)

Up to 10 s every 600 s	≤150%
Up to 1 s every 60 s	≤200%

DC ripple + noise

16 Hz...200 kHz	230 mV_{RMS}
9 kHz...20 MHz	700 mV_{PP}

Harmonic distortion @50 Hz (THDu)[3]

Linear loads	≤0.4%
Non linear loads	≤1.6%

Isolation

Working voltage	output L1, L2, L3 to PE	305 V_{RMS}
Working voltage	output L1, L2, L3 to PE	432 V_{DC}
Test voltage	output L1, L2, L3 to PE	2120 V_{DC} / 1 s

Grid Impedance Simulation

AC voltage operating range per phase	0...305 V_{RMS} (L-N)
DC voltage operating range per phase	0...415 V_{DC}
Frequency operating range for voltage and current	0...100 Hz
Modulation bandwith for voltage and current	0...100 Hz
Static accuracy @standard impedance values[2] (phase: 0.24 Ω , 477 µH; neutral: 0.16 Ω, 159 µH)	
Voltage (U) @50/60 Hz	≤0.7% @f_c = 500 Hz ≤0.7% @f_c = 700 Hz
Resistance (R) @50/60 Hz	≤8% @f_c = 500 Hz ≤6% @f_c = 700 Hz
Inductivity (L) @50/60 Hz	≤19% @f_c = 500 Hz ≤14% @f_c = 700 Hz
Voltage (U) @100 Hz	≤0.7% @f_c = 500 Hz ≤0.7% @f_c = 700 Hz
Resistance (R) @100 Hz	≤22% @f_c = 500 Hz ≤17% @f_c = 700 Hz
Inductivity (L) @100 Hz	≤21% @f_c = 500 Hz ≤15% @f_c = 700 Hz

1) The minimum power is calculated from the minimum CC limit (3 A) and the actual voltage
2) Static accuracy depends on the parameters used for the grid impedance simulation and the type of test object
3) Up to 290 V_{RMS} (L-N)

Technical Data (continued)

AC Loadside Ratings (X20)

Phase Connection '3L (AC/DC)': 3L + N (see Figure 3, 5, 9)

Power range	0...30 kVA
Voltage range	3 x 0...305 V_{RMS} (L-N)
Connection type	3L + N + PE
Current range 3Φ	3 x 0...43 A_{RMS}[1)]

Phase Connection '1L (AC/DC double current)': 1L + N (see Figure 4, 6, 10)

Power range	0...20 kVA[2)]
Voltage range	0...305 V_{RMS} (L-N)
Connection type	L1//L2 + L3//N + PE
Current range 1Φ	0...86 A_{RMS}[1)]

Phase Connection '2L (AC/DC double voltage/current)': 2L (see Figure 4, 7, 11)

Power range	0...30 kVA
Voltage range	0...610 V_{RMS} (L-L)
Connection type	L1//L2 + L3//N + PE
Current range 1Φ	0...86 A_{RMS}[1)]

DC Loadside Ratings (X20)

Phase Connection '2L (AC/DC double voltage/current)': 1 output (symmetric to PE)

Power range	0...±30 kW
Voltage range	0...±830 V_{DC}
Connection type	L1//L2 + L3//N
Current range	0...±40 A_{DC}

Phase Connection '1L (DC triple current)': 1 output (related to PE)

Power range	0...±25 kW
Voltage range	0...±415 V_{DC}
Connection type	L1//L2//L3 + N
Current range	0...±60 A_{DC}

Phase Connection '3L (AC/DC)': 2 independent outputs

Power range	0...±16 kW
Voltage range	0...±830 V_{DC}
Connection type	L1 + L2
Current range	0...±20 A_{DC}[3)]
Power range	0...±8 kW
Voltage range	0...±415 V_{DC}
Connection type	L3 + N
Current range	0...±20 A_{DC}[3)]

Phase Connection '3L (AC/DC)': 3 independent outputs (related to PE)

Power range	3 × 0...±8 kW
Voltage range	3 × 0...±415 V_{DC}
Connection type	L1 + N / L2 + N / L3 + N
Current range	3 × 0...±20 A_{DC}[3)]

Protection

Built-in Protection

Overvoltage protection	programmable
Overcurrent protection	programmable

Internal diagnostics

Line input conditions, internal current conditions, temperature conditions, system configuration, system communication, power semiconductor temperatures.

Type of Protection (according EN 60529)

Basic construction	IP 20
Mounted in cabinet	up to IP 54[4)]

Load side

Over voltage category (according to EN 62477-1)	1

NOTE: If overvoltage category 1 in accordance with EN 62477-1 cannot be met, surge protective devices (SPDs), inductors or transformers must be installed.

Safety Interface

ISR (integrated safety relay)

2-channel (2 x category 1, PL c according DIN EN ISO 13849-1:2015)

Read-back circuit with forcibly guided contacts

PL e possible with 2-channel and external safety relay (optional)

I/O Interfaces

Control Port Input Functions (X610 – X612)

Amplifier mode @scaling factor 1:	
Voltage setting L1: -432 V...+432 V	-10...+10 V
Voltage setting L2: -432 V...+432 V	-10...+10 V
Voltage setting L3: -432 V...+432 V	-10...+10 V
Current setting L1: -122 A...+122 A	-10...+10 V
Current setting L2: -122 A...+122 A	-10...+10 V
Current setting L3: -122 A...+122 A	-10...+10 V
Maximum input voltage	±30 V
Sampling rate	80 kHz
Time delay input to output	<70 µs
Isolation to electronics and earth	125 V_{RMS}
Input impedance	20.5 kΩ

Trigger ports BNC

Trigger Input X620 (Start)	TTL
Input impedance	10 kΩ
Trigger Output X621 (programmable)	TTL
Output impedance	560 Ω (short-circuit-proof)
Isolation to electronics and earth	250 V_{RMS}

Analog port 12-pin flush-type (X609)

4 Inputs for general usage	±9.5 V reference voltage
4 Outputs for general usage	±9.5 V reference voltage
Time delay power output to analog output	<50 µs
Output pins min. load impedance	2 kΩ
Input pins input impedance	330 kΩ
Sampling rate	80 kHz
Isolation to electronics and earth	250 V_{RMS}

1) Current according to the given power limit of the corresponding units
2) Power reduction due to internal limitations
3) Total current in N is limited to 20A
4) Slight temperature derating possible depending on ambient temperature inside cabinet.

Technical Data (continued)

Communication Interfaces

USB Type B (X607)

Integrated interface for remote control with the operation software ACSControl/API

Isolation to electronics and earth	250 V_{RMS}

Ethernet (X605)

Integrated interface for remote control with the operation software ACSControl/API

Isolation to electronics and earth	200 V_{RMS}

RS232 (X606)

Service interface

Isolation to electronics and earth	125 V_{RMS}

General Data

Weight & Dimension (see Figure 1)

Weight	150 kg / 331 lbs
Width housing	444 mm / 17 ½"
Height housing	489 mm / 11 U / 19 ¼"
Depth with output terminals	635 mm / 25"

Terminals

Screw terminals for 6...35mm² wires	d ≤8.5mm
AC lineside terminals	3L + PE
AC loadside terminals	3L + N + PE

Ambient

Operating temperature		5...40 °C
Storage temperature		-18...70 °C
Relative air humidity (non-condensing)		0...95%
Installation altitude		0...2000 m above sea level[1)]
Installation		in 19" switch cabinet
	IEC 60721-3-3	indoor, air-conditioned
Vibration	IEC 60068-2-6	Test Fc
Operating orientation		upright
Storage, transport orientation		upright
Acoustic noise level		≤74 dB @1 m

Liquid Cooling (LC) Specifications

(Air-cooling possible with optional TC.LAE)

Material	Al
Inlet/outlet on rear side size	G ½"
Liquid temperature inlet (non-condensing)	15...50 °C
Minimum flow rate	2.5 l/min
Recommended flow rate	5 l/min
Maximum inlet temperature	25 °C @2.5 l/min
	40 °C @5 l/min
	50 °C @8 l/min
Operation pressure max.	4 bar
Pressure drop	70 mbar @5 l/min
Use cooling liquid with a 30% share of Antifrogen N® within a closed circuit	

Standards

Protection class	I
Overvoltage category according to IEC 60664-1	
Line to Line	II
Line to PE	III
Degree of pollution	2
Area of application	industrial

Approval CE

Low Voltage Directive 2014/35/EU	
	EN 62477-1:2012 + A11 :2014 + A1 :2017 + A12 :2021
EMC Directive 2014/30/EU	
EMC immunity (industrial)	EN 61000-6-2:2005
EMC emission (industrial)	EN 61000-6-4:2007 + A1:2011
RoHS Directive 2011/65/EU	EN IEC 63000:2018

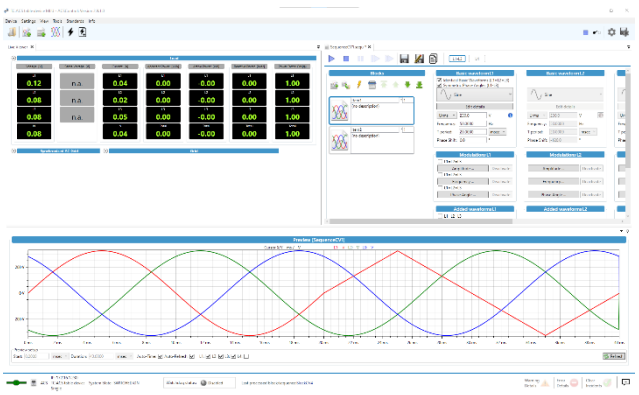
Approval UKCA

Electrical Equipment (Safety) Regulations 2016	
	BS EN 62477-1:2012 + A11 :2014 + A1 :2017 + A12 :2021
Electromagnetic Compatibility Regulations 2016	
EMC immunity (industrial)	BS EN 61000-6-2:2005
EMC emission (industrial)	BS EN 61000-6-4:2007 + A1:2011
The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012	
	BS EN IEC 63000:2018

1) Above 1000 m, slight temperature derating possible

User Software

Application Software ACSControl



Software Options

ACSControl integrated

Full Waveform Generator Mode (Phase Connections included)	GridSim
Grid Impedance Simulation	Grid Impedance Simulation
AC Load Simulation Mode	RLC-Load Mode
Power Controlled (CS/CP) Mode	Power Mode
Current Controlled Mode	Current Control Mode
Phase Connections (available in CV Mode only):	Phase Connections
1L (AC/DC double current)	
2L (AC/DC double voltage/current)	
1L (DC triple current)	

EMC Test Sequences, preprogrammed:

IEC/EN 61000-3-2	IEC/EN 61000-4-11
IEC/EN 61000-3-3	IEC/EN 61000-4-13
IEC/EN 61000-3-11	IEC/EN 61000-4-14
IEC/EN 61000-3-12	IEC/EN 61000-4-27
	IEC/EN 61000-4-28
	IEC/EN 61000-4-34

Hardware Options

Senseboard for RMS voltage drop compensation

With programmable transformer ratio

1500 V type, maximum input voltages:

L-L, L-N, L-PE:	1000 V_{RMS}, 1500 V_p
N-PE:	500 V_{RMS}, 750 V_p

750 V type, maximum input voltages:

L-L:	860 V_{RMS}, 1290 V_p
L-N:	500 V_{RMS}, 750 V_p
N-PE:	500 V_{RMS}, 750 V_p

500 V type, maximum input voltages:

L-L:	570 V_{RMS}, 860 V_p
L-N:	330 V_{RMS}, 500 V_p
N-PE:	500 V_{RMS}, 750 V_p

Digital I/O Interface

8 x Digital IN	24 V_{DC}
8 x Digital OUT	24 V_{DC}
4 x Relays	potential free SPDT

TC.ACS X609 Adapter (Analog I/O Adapter)

4 x Analog IN	±9.5 V_{DC}
4 x Analog OUT	±9.5 V_{DC}

TC.ACS.CANmp Interface

2 x D-Sub 9 pin male connector	CAN interface
8 x Digital IN	24 V_{DC}
8 x Digital OUT	24 V_{DC}

Air Cooling

External Liquid to Air Heat Exchanger (TC.LAE)

In addition to the internal Liquid Cooling (LC)

Full range of operating temperature	no derating

Dimensions

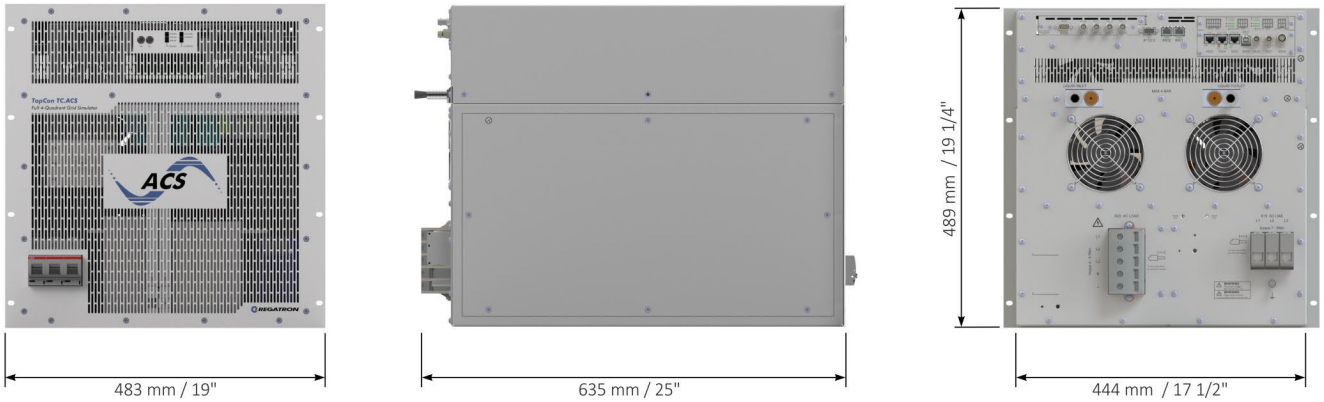


Figure 1: Front, right hand side and rear view. 19-inch module with 11 units in height.

Further Description Details

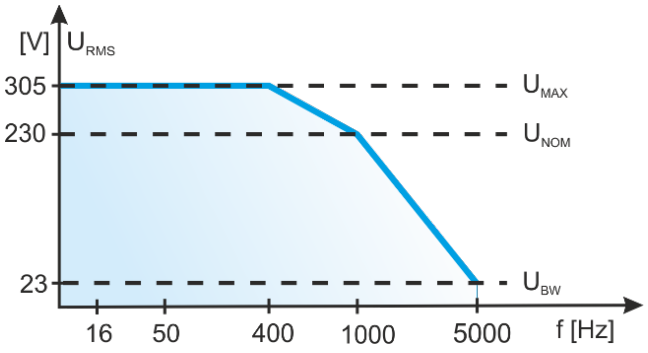


Figure 2: Output voltage vs. frequency

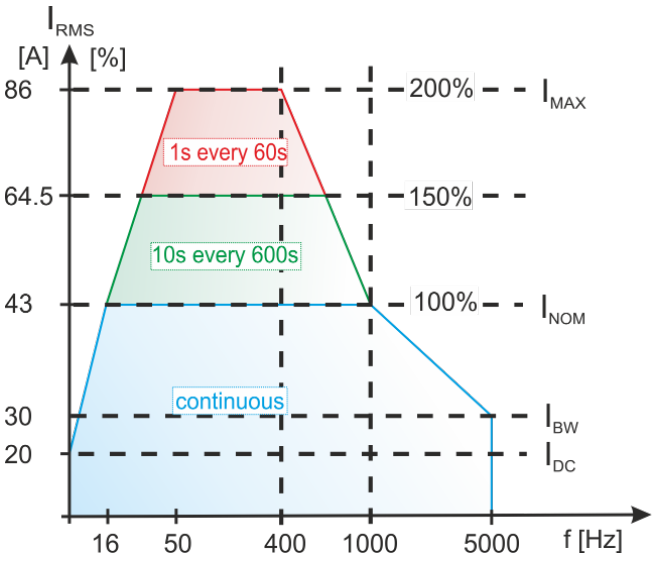


Figure 3: Overloadability vs. frequency (Phase Connection '3L (AC/DC)')

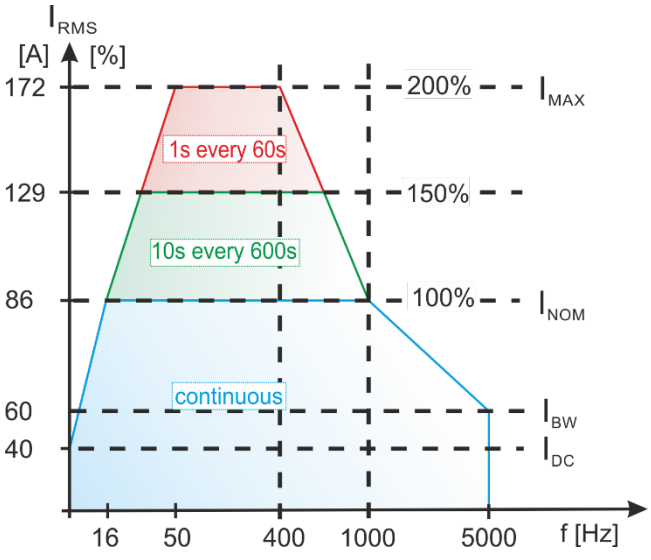


Figure 4: Overloadability vs. frequency
(Phase Connection '1L (AC/DC double current)'
and Phase Connection '2L (AC/DC double voltage/current)')

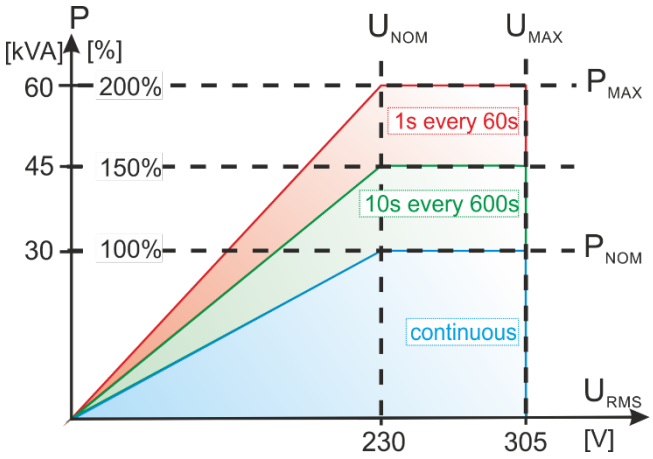


Figure 5: Overloadability vs. voltage (Phase Connection '3L (AC/DC)')

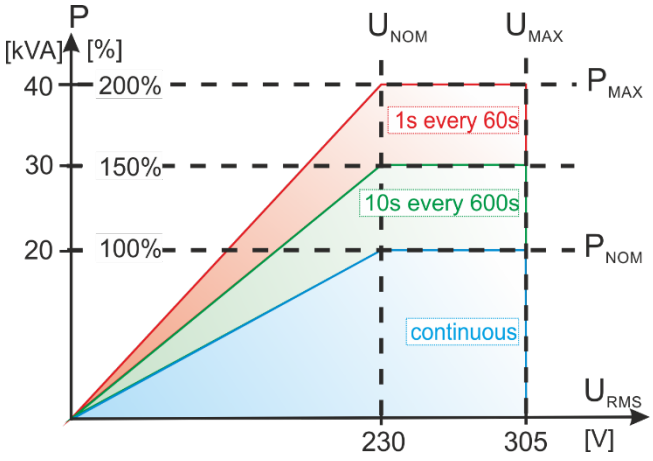


Figure 6: Overloadability vs. voltage
(Phase Connection '1L (AC/DC double current)')

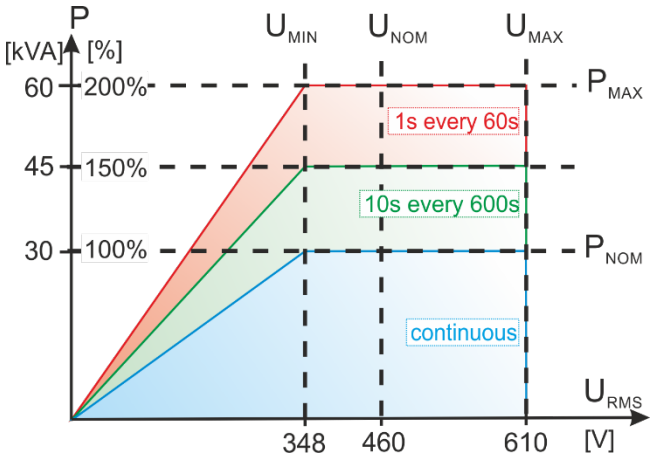
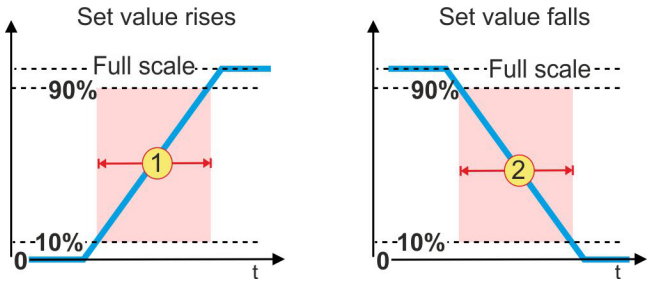


Figure 7: Overloadability vs. voltage
(Phase Connection '2L (AC/DC double voltage/current)')

Further Description Details (continued)



-1- rise time -2- fall time

Figure 8: Step 10...90% CV, CC, CS/CP

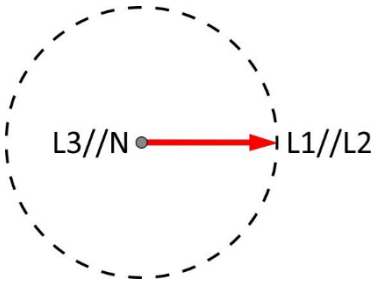


Figure 10: Phase Connection '1L (AC/DC double current)'

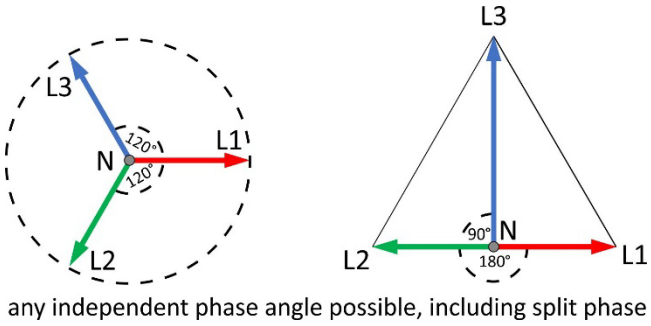


Figure 9: Phase Connection '3L (AC/DC)'

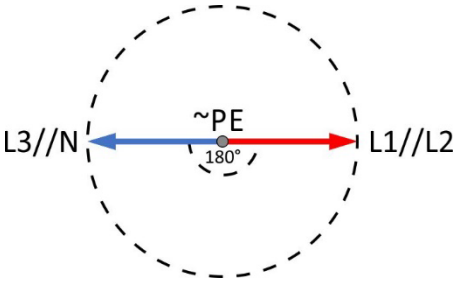


Figure 11: Phase Connection '2L (AC/DC double voltage/current)'

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

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

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Class: Project specific use only