CSU200-1GAMP6-HV

DATASHEET

KEY FEATURES

- Output power: 200 kW
- DC, 1-ph or 3-ph AC output
- Four-quadrant operation
- Regenerative
- Scalable up to 1,2 MW & 3000 V DC
- AC output voltage L-L: 485 V RMS
- AC output current: 240 A RMS
- DC output voltage: 820 V
- DC output current: 840 A
- Large-signal BW: 5 kHz
- Small-signal BW: 15 kHz
- Programmable V and I limits
- Voltage accuracy: 0,1%
- Current accuracy: 0,56%
- Peak efficiency: 95%
- Frequency accuracy: 1 mHz
- Meets IEEE 1547.1
- CE Certified

PHIL
GRID
RENEWABLE ENERGY
E-MOBILITY
AEROSPACE
MARINE
ACADEMIC RESEARCH
TESTING

SYSTEM INTRODUCTION

CSU200-1GAMP6-HV (COMPISO System Unit 200 – one Group of six Amplifiers – High Voltage) is a galvanically isolated bidirectional 200 kW emulation and test system with six independent bidirectional switched-mode power amplifiers capable of operating in several predefined AC and DC operation modes as well as a wide range of user-defined Hardware-in-the-loop (HIL)-based modes. The system can operate in current-control, voltage-control or mixed mode and is capable of acting as a source or sink with seamless transition between sourcing power and regenerating power back to the supply grid. Featuring large-signal bandwidth of 5 kHz and small-signal bandwidth of 15 kHz, the system can generate harmonics up to the 100th order and interharmonics up to 15 kHz for smooth frequency sweeps. The CSU200-1GAMP6-HV is controlled by an EGSTON Real-Time (RT) Processor or external HIL systems via fast optic fiber (SFP-Small Form Factor Pluggable) or analog interface.

The optional 4QAC Source software application enables generation of arbitrary periodic waveforms whose amplitude, frequency, phase (time shift) and DC offset can be changed every 1 ms. The active and reactive power can be changed separately in each phase every 1 ms, enabling more complex test scenarios such as Low Voltage Ride Through, High Voltage Ride Through, and frequency drift.

The optional 4QDC Source software application can execute various DC tests, ranging from constant-current, constant-voltage or constant-power operation to more advanced scenarios such as emulation of PV arrays and batteries modelled on I-V curves.

The optional PowerSCOPE can be used to monitor system setpoints and generated output voltages and currents. It supports visualization and storage of up to 64 input channels with a sample rate of 250 kS/s per channel.

SYSTEM DESCRIPTION & OPERATION MODES

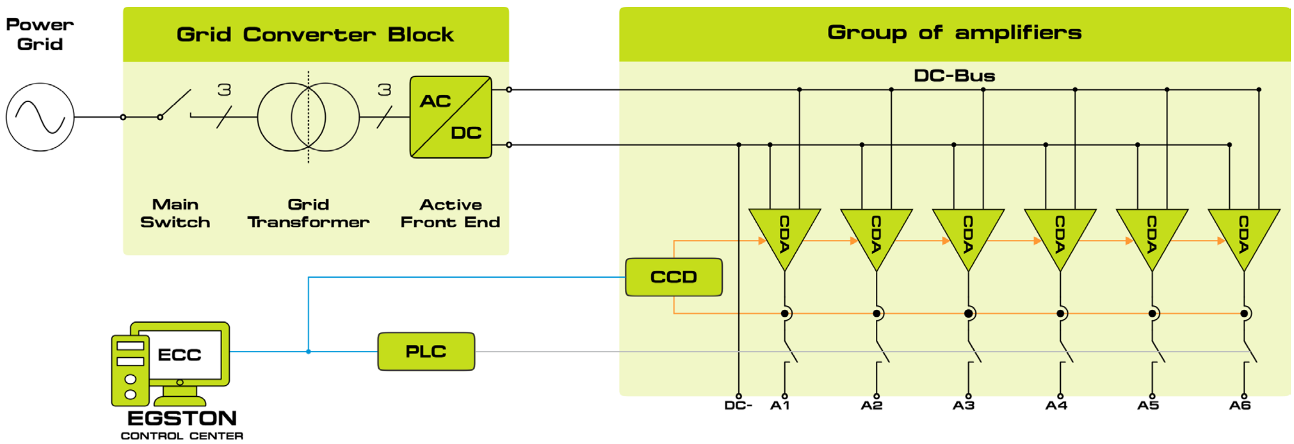


Figure 1. Simplified block diagram of the CSU200-1GAMP6-HV system.

The CSU200-1GAMP6-HV connects to a three-phase + N power grid (three-phase four wire system) via a galvanic isolation transformer. A protective earth (PE) connection providing adequate grounding must also be available. The system can be adapted to any three-phase power grid voltage from 400–690 V at 50 or 60 Hz. The transformer feeds a bidirectional Active Front End (AFE) that converts the grid's AC voltage to a controlled DC-link voltage of 850 V. The maximum active power that can be sourced from or regenerated to the grid is 200 kVA. The CSU200-1GAMP6-HV consists of six COMPISO Digital Amplifiers (CDAs). This amplifier group is controlled by one COMPISO Control Device (CCD) and one Programable Logic Controller (PLC). The output voltage and current of each amplifier are measured at its output terminal.

The CSU200-1GAMP6-HV system consists of four cabinets and a desktop PC with EGSTON Control Center (ECC) software used to monitor, configure and control the system operating in any of the standard operation modes illustrated in Figure 2

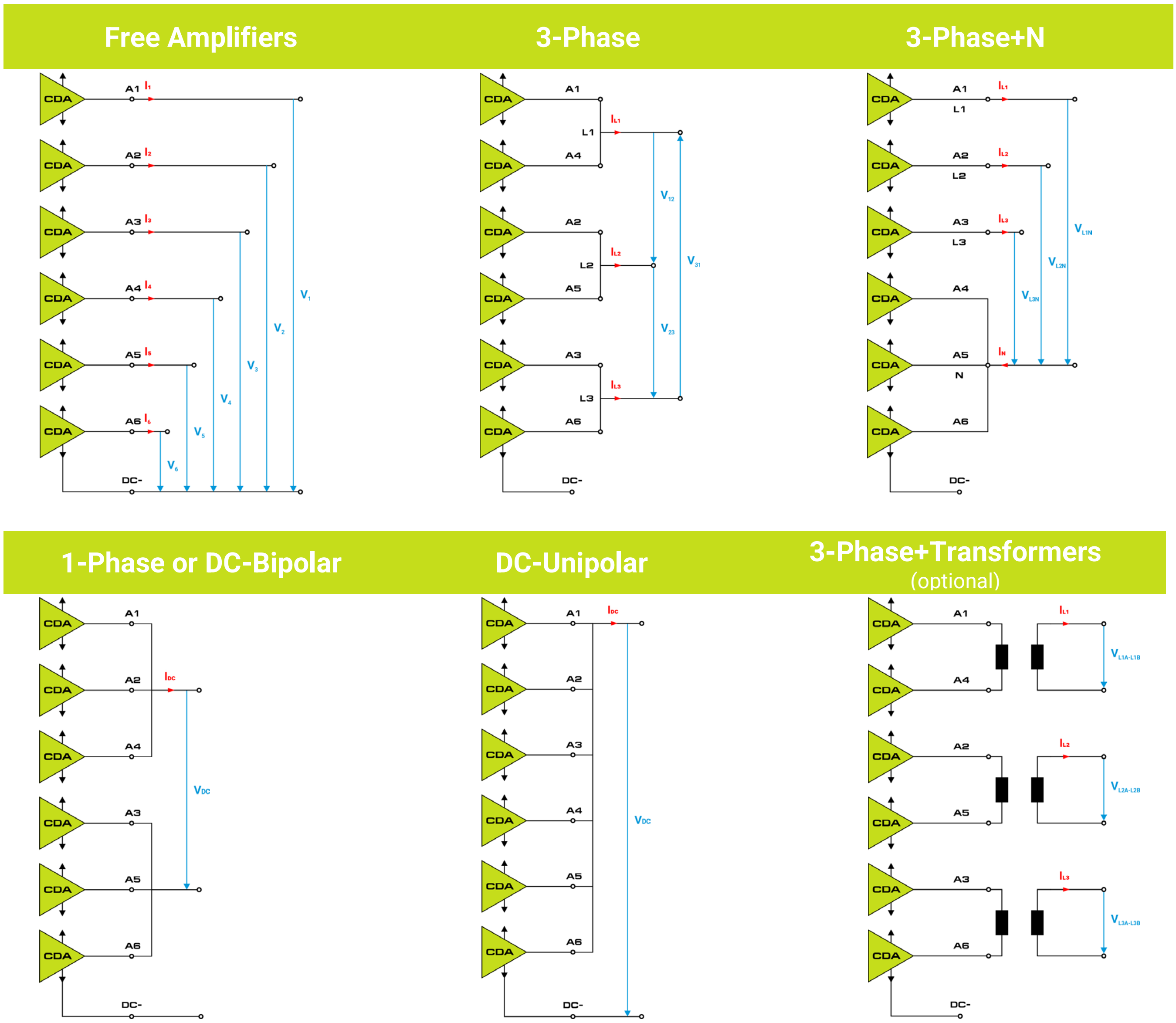


Figure 2. CSU200-1GAMP6-HV operation modes.

The available voltage, current, and power range in each operation mode are listed in Table 1. In each operation mode, the system can either operate as a power source or regenerate power back to the grid. The values listed in Table 1 are valid for both directions. In order to increase the output voltage in three-phase operation modes, with or without the neutral terminal, a third harmonic injection can be used. Output power is limited to 200kW in DC bipolar and DC unipolar operation modes by voltage or current derating, as illustrated in Figure 3.

Table 1. Available voltage, current and power range in each operation mode.

Operation mode: Free amplifiers (all values are per CDA)		
AC mode[1]		
DC offset voltage	V_{DC}	420 V_{DC}
Minimum AC voltage	V_{min}	0 V_{RMS}
Maximum AC voltage	V_{max}	280 V_{RMS}
Minimum AC current	I_{min}	0 A_{RMS}
Maximum AC current	I_{max}	120 A_{RMS}
Maximum active power	P_{max}	34,0 kW
Maximum apparent power	S_{max}	34,0 kVA
DC mode (unipolar)		
Minimum DC voltage	V_{min}	20 V_{DC}
Maximum DC voltage	V_{max}	820 V_{DC}
Minimum DC current	I_{min}	-140 A_{DC}
Maximum DC current	I_{max}	140 A_{DC}
Maximum power	P_{max}	100 kW
Operation mode: Three-phase + N		
Minimum LL voltage	$V_{LL\ min}$	0 V_{RMS}
Maximum LL voltage	$V_{LL\ max}$	485 V_{RMS}
Maximum LN voltage	$V_{LN\ max}$	280 V_{RMS}
Minimum current	$I_{L\ min}$	0 A_{RMS}
Maximum current	$I_{L\ max}$	120 A_{RMS}
Maximum active power	P_{max}	100 kW
Maximum apparent power	S_{max}	100 kVA
Operation mode: Three-phase		
Minimum LL voltage	$V_{LL\ min}$	0 V_{RMS}
Maximum LL voltage	$V_{LL\ max}$	485 V_{RMS}
Minimum current	$I_{L\ min}$	0 A_{RMS}
Maximum current	$I_{L\ max}$	240 A_{RMS}
Maximum active power	P_{max}	200 kW
Maximum apparent power	S_{max}	200 kVA

Table 1. (continued)

Operation mode: Three-phase + N (with 3rd harmonic injected)		
Minimum LL voltage	$V_{LL\ min}$	0 V_{RMS}
Maximum LL voltage	$V_{LL\ max}$	555 V_{RMS}
Maximum LN voltage	$V_{LN\ max}$	320 V_{RMS}
Minimum current	$I_{L\ min}$	0 A_{RMS}
Maximum current	$I_{L\ max}$	120 A_{RMS}
Maximum active power	P_{max}	115 kW
Maximum apparent power	S_{max}	115kVA
Operation mode: Three-phase (with 3rd harmonic injected)		
Minimum LL voltage	$V_{LL\ min}$	0 V_{RMS}
Maximum LL voltage	$V_{LL\ max}$	555 V_{RMS}
Minimum current	$I_{L\ min}$	0 A_{RMS}
Maximum current	$I_{L\ max}$	240 A_{RMS}
Maximum active power	P_{max}	200 kW
Maximum apparent power	S_{max}	230 kVA
Operation mode: Three-phase + transformers (n = V_s/V_p; x = 1, 2, 3)		
Minimum voltage	V_{Lx}	0 V
Maximum voltage	$V_{Lx\ max}$	n×565 V
Minimum current	$I_{Lx\ min}$	0 A
Maximum current	$I_{Lx\ max}$	(1/n)x120 A
Maximum power	S_{max}	200 kVA
Operation mode: Single-phase[2]		
Minimum voltage	V_{min}	0 V_{RMS}
Maximum voltage	V_{max}	565 V_{RMS}
Maximum current	I_{max}	360 A_{RMS}
Maximum active power	P_{max}	200 kW
Maximum apparent power	S_{max}	200 kVA
Operation mode: DC bipolar		
Minimum voltage	V_{min}	-800 V
Maximum voltage	V_{max}	800 V
Minimum current	I_{min}	-420 A
Maximum current	I_{max}	420 A
Maximum power	P_{max}	200 kW
Operation mode: DC unipolar		
Minimum voltage	V_{min}	20 V
Maximum voltage	V_{max}	820 V
Minimum current	I_{min}	-840 A
Maximum current	I_{max}	840 A
Maximum power	P_{max}	200 kW

[1] The CDA output voltage has a DC offset of 420 V (with respect to the DC- terminal).
[2] Due to single-phase load on the AFE, power derating applies if the output voltage frequency is less than 100 Hz, as shown in Figure 8

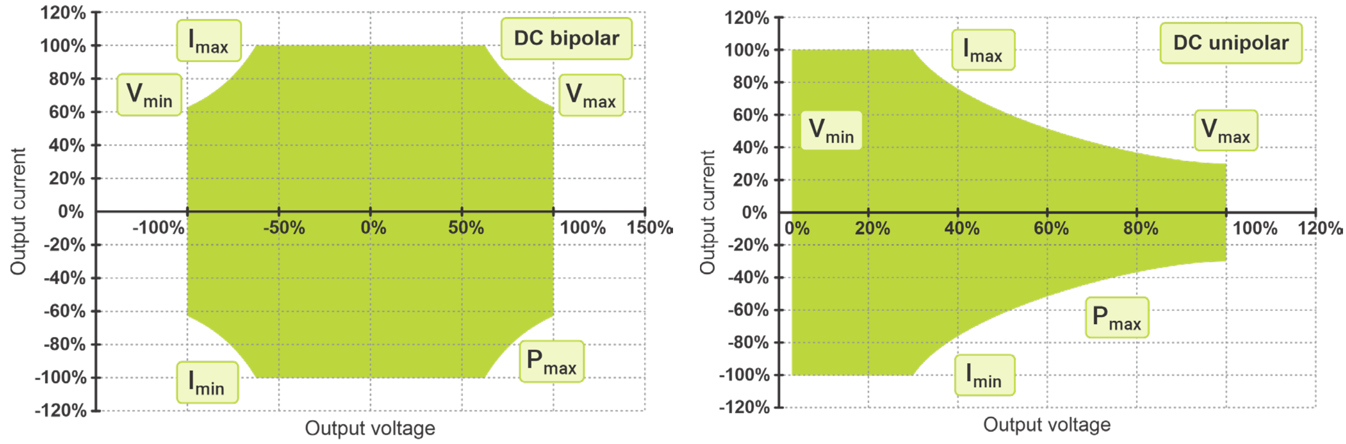


Figure 3. Power limits for DC bipolar and DC unipolar operation modes.

For all AC operation modes, the maximum available output voltage is reduced at higher output frequencies as illustrated in Figure 4 (for resistive loads) and Figure 5 (for inductive loads). This reduction is due to an increased voltage drop across the internal output filter at higher output frequencies. Output voltage derating additionally applies at frequencies above 5 kHz to avoid overheating the output filter capacitors, as illustrated in Figure 6, and output current derating at higher frequencies is necessary to avoid overheating the internal output inductor, as illustrated in Figure 7.

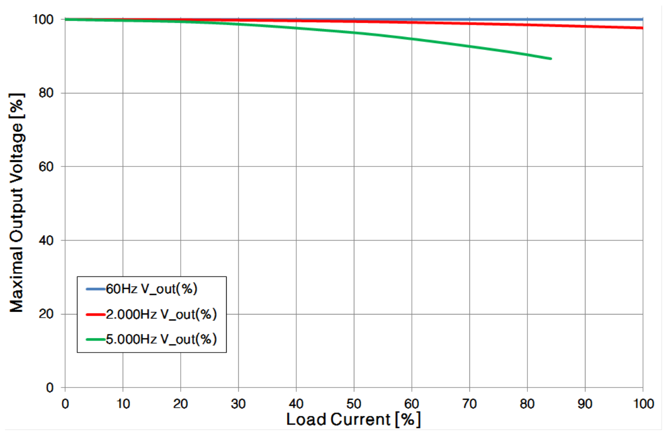


Figure 4. Maximum AC output voltage VS resistive load current

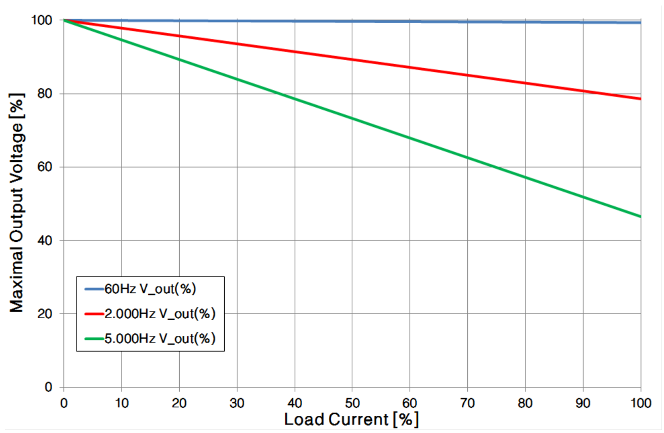


Figure 5. Maximum AC output voltage VS inductive load current.

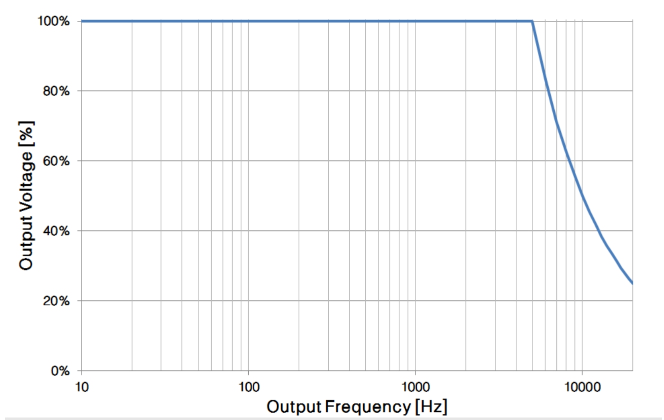


Figure 6. Maximum output voltage versus output frequency.

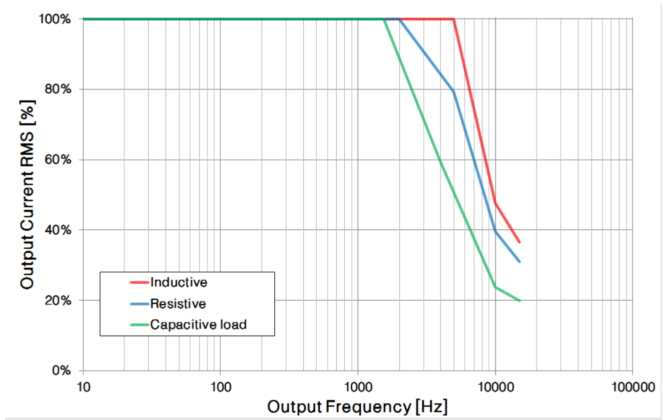


Figure 7. Maximum output current versus frequency for different load types.

When the system operates in single-phase operation mode, the output power needs to be derated depending on the output frequency according to Figure 8. Derating is introduced to limit the variation of the DC-link voltage under safe operating voltage limit (875 V). The Red line in Figure 8 represents the output power of the standard system, and the blue line represents the power of the system with the additional 30 mF (±5%) capacitors of the DC link. At full capacity P_{MAX} corresponds to 200 kW. For each AC operation mode, the values in Figures 4-8 represent the percentages of the maximum voltage and current values from Table 1 for each particular mode.

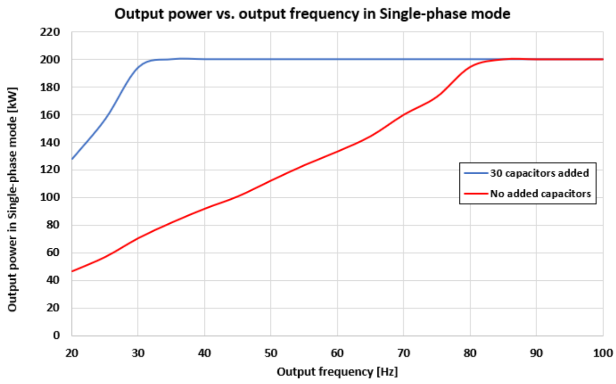


Figure 8. Power derating in single-phase operation mode.

GENERAL SYSTEM PROPERTIES

The electrical properties presented in Table 2. General system properties are valid for an ambient temperature of 25°C.

Table 2. General system properties

System properties		
Number of independent amplifiers		6
Rated system power	P_{OUT}	200 kW
System overload for 60 s	I_{OUT_60s}	1,2×I_{OUT} (only for DC operation modes)
System overload for 2 s	I_{OUT_2s}	1,35×I_{OUT} (only for DC operation modes)
Peak system efficiency	η	95% (at rated output power)
Output harmonics range		Up to the 100th harmonic at 50 Hz fundamental
Interharmonics and subharmonics		0,1 Hz to 5 kHz (full voltage) 5–15 kHz (reduced voltage)
Adjustable limits		Current, voltage
Adjustable trips		Current, voltage, power
System protections		Overvoltage, overcurrent, short circuit, overtemperature, humidity
Rated insulation voltage		1600 V_{DC} (output-to-output and output-to-ground)
Connection to main supply		Permanent
Overvoltage category		II
Protection class		I
Degree of pollution		2
Relative humidity (Non-condensing)		Average: 75% Maximum: 85% for up to 30 days, distributed evenly over the year
Operating ambient temperature		5-30°C
Maximum altitude		2000 m
Ingress protection		IP44 (per IEC 60529)
Noise level (sound pressure level)		< 82 dB (at operator's normal position and bystanders' positions)
Certification		
CE Certified		
The product conforms with the following harmonized standards:		
Safety requirements		EN 61010-1:2020 EN 62477-1:2012 IEC 61000-6-2:2016
Radio-frequency disturbance		EN 55011:2016 + A1:2017
Electromagnetic interference		EN IEC 61000-6-2:2019
The product is compliant with the following European regulations:		
Low Voltage Directive		2014/35/EU
EMC Directive		2014/30/EU
RoHS Directive		2011/65/EU

Table 2. (continued)

Grid converter block		
Grid Connection Type		Three phase four wire
Rated input power	S_{IN}	230 kVA
Rated input voltage	V_{AC}	400 V_{RMS} ±10% (or 480 V_{RMS} ±10%)
Input frequency range	f	47,5–63 Hz
Rated input current	I_{IN}	332 A_{RMS} (for 400 V_{RMS} input), 277 A_{RMS} (for 480 V_{RMS} input)
Inrush current	I_{INRUSH}	1760 A_{PEAK}
Power factor	PF	≈1 (also with partial load and at energy regeneration)
Input current THD	THDi	< 5%
DC-link voltage	$V_{DC\text{-}link}$	850 V
CDA electrical characteristics		
Maximum DC power	P_{DC}	117,6 kW (continuous)
Maximum AC power [3]	P_{AC}	34,00 kVA (continuous)
Output freq. large signal[3]	f_{OUT_LS}	0,1 Hz to 5 kHz
Output freq. small signal[3]	f_{OUT_SS}	0,1 Hz to 15 kHz
Output frequency resolution[3]		±1 mHz
Output phase resolution[3]		±0,01°
Output voltage THD[3]	THDu	< 0,04% (at 50/60 Hz, no load condition) < 0,09% (at 400 Hz, no load condition)
Switching frequency	f_{SW}	125 kHz
Delay time (typical)	t_d	28 µs (setpoint-to-output)
Voltage slew rate	SR	12 V/µs (maximum slew rate of output voltage with a resistive load)
Output voltage accuracy		±1 V
Output current accuracy		±1,4 A (current offset compensation available)
Output voltage ripple	ΔV_{OUT}	3 Vpp maximum
Output contactors		
Rated operational voltage	U_e	1800 V_{DC} or V_{AC} RMS
Rated insulation voltage	U_i	1800 V_{DC} or V_{AC} RMS
Rated operational current	I_e	250 A
Max making current DC τ = 15 ms (per pole)		5000 A
Max making current AC cos φ = 0.8 (per pole)		5000 A
Max breaking current DC τ = 15 ms (per pole)		500
Max breaking current AC cos φ = 8.8 (per pole)		800 A
Voltage and current measurement		
Voltage measurement range		±1000 V (DC or AC peak)
Common-mode voltage range		±500 V (DC or AC peak)
Voltage measurement accuracy		±1 V (0.1% of measurement range)
Current measurement range		±250 A (DC or AC peak)
Current measurement accuracy		±1,4 A (0,56% of measurement range)
Measurement resolution		16 bit
Measurement sample rate		1 MS/s (per channel)
Measurement bandwidth		0,1 Hz–100 kHz (-3 dB)

[3] Only the AC component of the output voltage is considered, as the CDA output voltage has a DC offset of 420 V. The values characterizing AC operation are valid for all AC modes.

COMMUNICATION ARCHITECTURE & INTERFACES

The basic properties of the communication protocols and interfaces supported by the CSU200-1GAMP6-HV are presented in Table 3, and the communication architecture is illustrated in Figure 9. Supported HIL platforms are listed in Table 3.

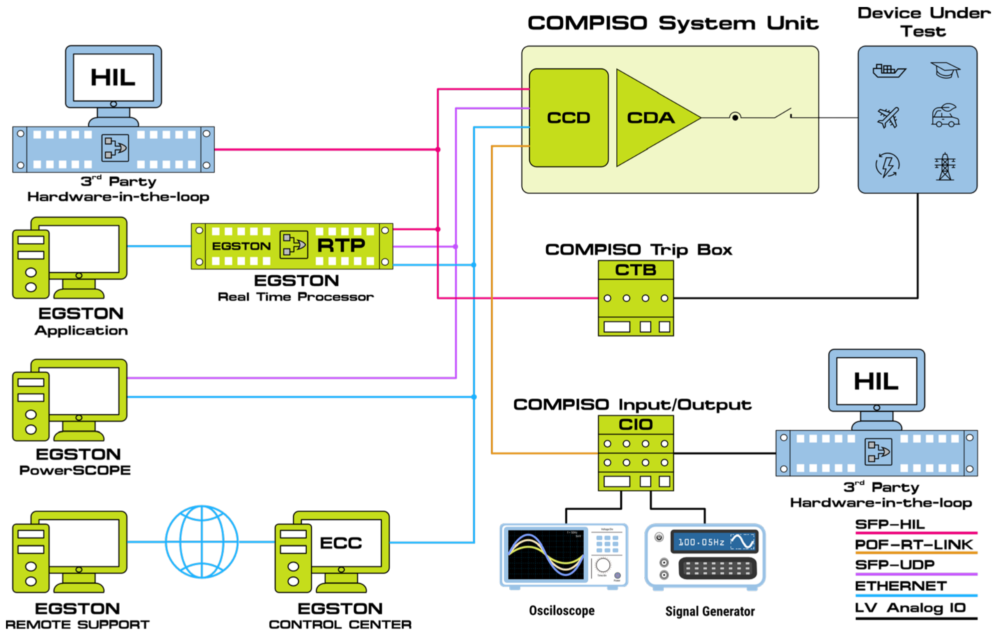


Figure 9. COMPISO communication architecture.

Table 3. Communication protocols and interfaces supported by the CSU200–1GAMP6-HV

Supported commercial HIL platforms	
SFP interface	OPAL-RT National Instruments RTDS Speedgoat Typhoon HIL dSPACE
Analog interface	Any HIL system with low-voltage analog input/output signals
Programming interfaces	
Modbus, Matlab, Python, Java, C/C++	
SFP–HIL ultra-high-speed interface	
Digital RT communication between each GAMP within the CSU and an external HIL RT processor (or an EGSTON Power RT Processor) over optic-fibre cable. Receives voltage or current setpoints and transmits measured voltages and currents.	
Data rate	5 Gbps
Latency	≤ 1 µs
Setpoint time step	4 µs
Setpoint update frequency	250 kHz

Table 3. (continued)

SFP–UDP			
Digital RT data transfer from the GAMPs within the CSU to the EGSTON PowerSCOPE, transmitting measured voltages, currents and setpoints set via the SFP–HIL to the CCD.			
Data rate	1 Gbps (1000BASE-T)		
Ethernet interface (non-RT communication between CSU, ECC and EGSTON Power applications PC)			
Transmission protocol	TCP		
Data rate	100 Mbps		
Recommended cable category	CAT 6a or better		
POF–RT-link–high–speed RT interface (RT communication between the CSU and external COMPISO Input/Outputs Boxes (CIOs))			
RT-link interface to connect CIOs is optional and not part of the product delivery.			
Number of CIOs connected to CSU	3. Each CIO provides 4 analog input and 4 analog output channels.		
Cable	2,2 mm jacketed plastic optic-fibre cable		
Upload (CIO to CSU)	Sample rate	1 MS/s per channel (there are 4 channels in one CIO)	
	Latency	≤ 45,5 µs (from the analog input of CIO to the CSU output)	
Download (CSU to CIO)	Sample rate	256 kS/s per channel (there are 4 channels in one CIO)	
	Latency	≤ 5 µs (from the CSU output to the analog output of the CIO)	
Low-voltage analog interface between CIOs and external HIL platforms			
Analog input signals	Drives amplifier output voltages or currents.		
Analog output signals	Analog low-voltage outputs that transmit high-power voltage and current measurements from the CDAs.		
Input/output voltage range	-10 V to 10 V		
Input impedance	50 kΩ		
Sampling rate	250 kHz		
ADC resolution	16 bit		
Low-voltage digital interface (digital interface between the CIOs and external HIL platforms)			
Digital input signals	Can be transmitted from CIO over POF–RT-link to the CCD. CCD sends the digital values over POF– or SFP–RT-link to external HIL or EGSTON RT Processor for further processing.		
Digital output signals	External HIL or EGSTON RT Processor can send digital values via SFP to the CSU control to drive the digital output signal of the CIOs.		
Logic levels (3,3 V LVCMOS)	Input voltage levels:	2 V ≤ V_{IN_HIGH} ≤ 3,6 V	-0,3 V≤ V_{IN_LOW} ≤ 0,8 V
	Output voltage levels:	3,1 V ≤ V_{OUT_HIGH}	V_{OUT_LOW} ≤ 0,2 V
Maximum currents (3,3 V LVCMOS)	Input current:	IIN_MIN = -5 µA	IIN_MAX = 5 µA
	Output current:	I_{OUT_MIN} = -100 µA	I_{OUT_MAX} = 100 µA

COOLING REQUIREMENTS

Table 4. Cooling requirements

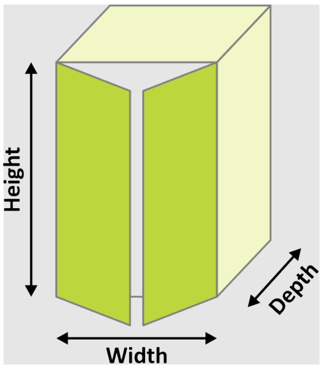
Liquid cooling (CDAs)	
Cooling media	Water, ethylene glycol, propylene glycol, glycol–water solutions
Minimum required cooling power	6,0 kW (for all 6 CDAs operating at full power)
Coolant pressure range	2,5–3 bar
Coolant flow rate for 6 CDAs	21l/min using water with an inlet temperature of 20°C
To avoid condensation, temperature of the cooling liquid must be kept higher than the ambient temperature.	
Forced-air cooling (cabinets)	
Maximum heat dissipation per CSU200-1GAMP6-HV at full power	10,5 kW_{th}

TECHNICAL DATA: MECHANICAL PROPERTIES

The CSU200-1GAMP6-HV system consists of four fixed free-standing cabinets. The dimensions and weight of each cabinet are listed in Table 5.

Table 5. Dimensions and weight of CSU200-1GAMP6-HV cabinets

Mechanical data (cabinet dimensions)								
	Width		Depth		Height		Weight	
	mm	ft	mm	ft	mm	ft	kg	lb
Cabinet 1 transformer	1200	3,94	800	2,63	2450	8,03	1200	2645,5
Cabinet 2 AFE	1200	3,94	800	2,63	2390	7,84	700	1543,2
Cabinet 3 GAMP6	1200	3,94	800	2,63	2110	6,92	600	1322,7
Cabinet 4 output	600	1,97	800	2,63	2110	6,92	300	661,3
Total	**4200**	**13,78**	**800**	**2,63**	**2450**	**8,03**	**2800**	**6172,7**



TESTING CAPABILITIES ACCORDING TO STANDARDS

Power grid:

- IEEE Std. 1547.1; usable as simulated area electric power systems source
- IEC 61000-3-12; meets requirements for power sources

MULTIPLE CSU200-1GAMP6-HV UNITS

Two to six CSU200-1GAMP6-HV units can be combined to form a COMPISO system with a total output power of up to 1.2 MW, without compromizing the flexibility of 6 galvanically isolated, centrally controlled 200 kW output channels.

The CSU200 units can be connected in series, in parallel, or in a combination of both, forming a COMPISO system with higher voltage, current, or both on the output. Such a system is controlled by a single Multi-GAMP Controller (MGC). MGC controls the voltage and current output of each CSU, making sure that all CSUs output the correct values for each operation mode. MGC also makes sure that voltage is shared equally between CSUs connected in series, and current is shared equally between CSUs connected in parallel.

The available voltage, current, and power range in each operation mode for multiple CSU200-1GAMP6-HV units connected in parallel are listed in Table 6, in series in Table 7, and in series & parallel in Table 8. All electrical values in Table 6, Table 7, and Table 8 are valid for an ambient temperature of 25°C.

CSU 200 UNITS CONNECTED IN PARALLEL

Table 6. Available voltage, current and power range in each operation mode for CSU200-1GAMP6-HV Units connected in parallel

Operation mode: Three-phase (without N)						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum LL voltage	$V_{LL\ min}$	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}
Maximum LL voltage	$V_{LL\ max}$	485V_{RMS}	485 V_{RMS}	485 V_{RMS}	485 V_{RMS}	485 V_{RMS}
Minimum current	$I_{L\ min}$	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}
Maximum current	$I_{L\ max}$	480A_{RMS}	720 A_{RMS}	960 A_{RMS}	1200 A_{RMS}	1440 A_{RMS}
Maximum active power	P_{max}	400 kW	600 kW	800 kW	1000 kW	1200 kW
Maximum apparent power	S_{max}	400 kVA	600 kVA	800 kVA	1000 kVA	1200 kVA
Operation mode: Three-phase (without N and with 3rd harmonic injected)						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum LL voltage	$V_{LL\ min}$	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}
Maximum LL voltage	$V_{LL\ max}$	555 V_{RMS}	555 V_{RMS}	555 V_{RMS}	555 V_{RMS}	555 V_{RMS}
Minimum current	$I_{L\ min}$	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}
Maximum current	$I_{L\ max}$	480 A_{RMS}	720 A_{RMS}	960 A_{RMS}	1200 A_{RMS}	1440 A_{RMS}
Maximum active power	P_{max}	400 kW	600 kW	800 kW	1000 kW	1200 kW
Maximum apparent power	S_{max}	461 kVA	692 kVA	923 kVA	1153 kVA	1384 kVA
Operation mode: Three-phase + N						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum LL voltage	$V_{LL\ min}$	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}
Maximum LL voltage	$V_{LL\ max}$	485 V_{RMS}	485 V_{RMS}	485 V_{RMS}	485 V_{RMS}	485 V_{RMS}
Maximum LN voltage	$V_{LN\ max}$	280 V_{RMS}	280 V_{RMS}	280 V_{RMS}	280 V_{RMS}	280 V_{RMS}
Maximum current	$I_{L\ max}$	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}
Maximum current	$I_{L\ max}$	240 A_{RMS}	360 A_{RMS}	480 A_{RMS}	600 A_{RMS}	720 A_{RMS}
Maximum active power	P_{max}	200 kW	300 kW	400 kW	500 kW	600 kW
Maximum apparent power	S_{max}	200 kVA	300 kVA	400 kVA	500 kVA	600 kVA
Operation mode: Three-phase + N (with 3rd harmonic injected)						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum voltage	$V_{LL\ min}$	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}
Maximum voltage	$V_{LL\ max}$	555 V_{RMS}	555 V_{RMS}	555 V_{RMS}	555 V_{RMS}	555 V_{RMS}
Maximum voltage	$V_{LN\ max}$	320 V_{RMS}	320 V_{RMS}	320 V_{RMS}	320 V_{RMS}	320 V_{RMS}
Maximum current	$I_{L\ max}$	240 A_{RMS}	360 A_{RMS}	480 A_{RMS}	600 A_{RMS}	720 A_{RMS}
Maximum active power	P_{max}	230 kW	345 kW	460 kW	575 kW	690 kW
Maximum apparent power	S_{max}	230 kVA	345 kVA	460 kVA	575 kVA	690 kVA

Table 6. (continued)

Operation mode: Single phase						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum voltage	V_{min}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}
Maximum voltage	V_{max}	565 V_{RMS}	565 V_{RMS}	565 V_{RMS}	565 V_{RMS}	565 V_{RMS}
Minimum current	I_{min}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}	0 A_{RMS}
Maximum current	I_{max}	720 A_{RMS}	1080 A_{RMS}	1440 A_{RMS}	1800 A_{RMS}	2160 A_{RMS}
Maximum active power	P_{max}	400 kW	600 kW	800 kW	1000 kW	1200 kW
Maximum apparent power	S_{max}	400 kVA	600 kVA	800 kVA	1000 kVA	1200 kVA
Operation mode: DC bipolar						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum voltage	V_{min}	-800 V	-800 V	-800 V	-800 V	-800 V
Maximum voltage	V_{max}	800 V_{DC}	800 V_{DC}	800 V_{DC}	800 V_{DC}	800 V_{DC}
Minimum current	I_{min}	-840 A	-1260 A	-1680 A	-2100 A	-2520 A
Maximum current	I_{max}	840 A	1260 A	1680 A	2100 A	2520 A
Maximum power	P_{max}	400 kW	600 kW	800 kW	1000 kW	1200 kW
Operation mode: DC unipolar						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum voltage	V_{min}	20 V	20 V	20 V	20 V	20 V
Maximum voltage	V_{max}	820 V_{DC}	820 V_{DC}	820 V_{DC}	820 V_{DC}	820 V_{DC}
Minimum current	I_{min}	-1680 A	-2520 A	-3360 A	-4200 A	-5040 A
Maximum current	I_{max}	1680 A	2520 A	3360 A	4200 A	5040 A
Maximum power	P_{max}	400 kW	600 kW	800 kW	1000 kW	1200 kW
Operation mode: Three-phase + transformer						
Number of parallel CSUs		**2**	**3**	**4**	**5**	**6**
Minimum voltage	$V_{Lx\text{-}Lx\,min}$	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}	0 V_{RMS}
Maximum voltage	$V_{Lx\text{-}Lx\,max}$ [1]	n · 565 V	n · 565 V	n · 565 V	n · 565 V	n · 565 V
Minimum current	$I_{Lx\,min}$	0 A	0 A	0 A	0 A	0 A
Maximum current	$I_{Lx\,max}$	(2/n) ·120 A	(3/n) ·120 A	(4/n) ·120 A	(5/n) ·120 A	(6/n) ·120 A
Maximum active power	P_{max}	400 kW	600 kW	800 kW	1000 kW	1200 kW
Maximum power	S_{max}	400 kVA	600 kVA	800 kVA	1000 kVA	1200 kVA

Note:

n = Primary to secondary ratio

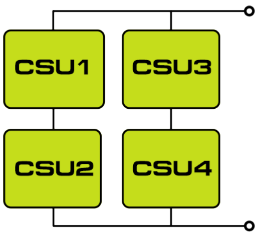
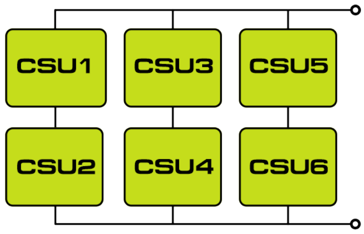
CSU 200 UNITS CONNECTED IN SERIES

Table 7. Available voltage, current and power range in each operation mode for CSU200-1GAMP6-HV Units connected in series

Operation mode: DC unipolar		
Number of CSUs in series		**2 in series**
Minimum voltage	V_{min}	40 V
Maximum voltage	V_{max}	1500 V
Maximum current	I_{max}	840 A
Maximum power	P_{max}	400 kW
Operation mode: DC bipolar		
Number of CSUs in series		**2 in series**
Minimum voltage	V_{min}	-1500 V_{DC}
Maximum voltage	V_{max}	1500 V_{DC}
Maximum current	I_{max}	420 A_{DC}
Maximum active power	P_{max}	400 kW
Operation mode: DC bipolar 4 in series midpoint grounded Note: With two output channels (Bipolar Output) with midpoint grounded		
Number of CSUs in series		**4 in series**
Minimum voltage	V_{min}	0 V
Maximum voltage	V_{max}	±1500 V (per output channel)
Maximum current	I_{max}	420 A
Maximum power	P_{max}	400 kW (per output channel)
Operation mode: Single phase		
Number of CSUs in series		**2 in series**
Minimum voltage	V_{min}	0 V_{RMS}
Maximum voltage (per channel)	V_{max}	1000 V_{RMS}
Maximum current	I_{max}	360 A_{RMS}
Maximum power	P_{max}	360 kW
Maximum apparent power	S_{max}	360 kVA

CSU 200 UNITS CONNECTED IN SERIES & PARALLEL

Table 8. Available voltage, current and power range in each operation mode for CSU200-1GAMP6-HV Units connected in series and parallel

CSU Connection overiew			
Number of CSUs in series & parallel		4 system in series & parallel	6 system in series & parallel
			
Operation mode: DC unipolar			
Minimum voltage	V_{min}	40 V	40 V
Maximum voltage	V_{max}	1500 V	1500 V
Maximum current	I_{max}	1680 A	2520 A
Maximum power	P_{max}	800 kW	1.2 MW
Operation mode: DC bipolar			
Minimum voltage	V_{min}	-1500 V_{DC}	-1500 VDC
Maximum voltage	V_{max}	1500 V_{DC}	1500 VDC
Maximum current	I_{max}	840 A_{DC}	1260 ADC
Maximum power	P_{max}	800 kW	1.2 MW
Operation mode: Single phase			
Minimum voltage	V_{min}	0 VRMS	0 VRMS
Maximum voltage	V_{max}	1000 VRMS	1000 VRMS
Maximum current	I_{max}	720 ARMS	1080 ARMS
Maximum active power	P_{max}	720 kW	1.08 MW
Maximum apparent power	S_{max}	720 kVA	1.08 MVA

The information presented in this document is subject to change without notice and should not be construed as a commitment by EGSTON Power Electronics GmbH.

All pictures shown are for illustration purposes only. Actual product may vary due to product enhancement.