



CLS-500

500W / EXTRA-WIDE INPUT 50.4V-137.5V

GENERAL FEATURES

- Fully EN50155 compliant, no external circuits
- Extra-wide input range 4:1 reduces product variety
- Excellent efficiency, lowest power loss, full lifetime
- Full power up to +85° without heat sink, no derating
- Active input reverse polarity protection
- Active inrush current limitation - network protection
- 10ms hold-up time over the entire input range
- Reinforced insulation, 6mm air/creepage distances
- Trim-output for long cable runs or battery charging
- Parallel and redundant operation
- 10% Peak load capability for 10s
- Remote (on/off) and DC OK with relay changer
- 2 years warranty



Dimensions (LxWxH): 209.0 x 141.0 x 48.0mm
(8.23 x 5.55 x 1.89 inch) 1100g (2.43 lbs)

SAFETY & EMC



APPLICATIONS



DESCRIPTION

The chassis mountable CLS-500 series DC/DC converter is designed for railway rolling stock and transportation applications. The unit is designed with 4:1 input voltage range to cover the input voltages from 43.2V_{dc} up to 170V_{dc} for nominal 72V and 110V in one range with isolated and regulated 24V output, based on a reinforced isolation system. The converter has a constant and high efficiency of 95%, and the base plate mounting permits a wide operating temperature for OT4+ST1&ST2 class from -40°C to +85°C without derating. Input reverse polarity protection, inrush current limitation, 10ms hold-up time, remote control, and output OR-ing diode round up the functionality of this fully railway compliant Plug&Play unit.

SELECTION GUIDE

Part Number	Input Voltage Range [VDC]	Output Voltage nom. [VDC]	Output Current max. ⁽¹⁾ [A]	Efficiency typ. [%]	Output Power max. ⁽¹⁾ [W]
CLS-500-6520	50.4-137.5	24	23	95	550

Note1: Refer to "Peak load Capability"

Note2: Efficiency is tested at nominal input and 50%-100% +25°C ambient



MODEL NUMBERING

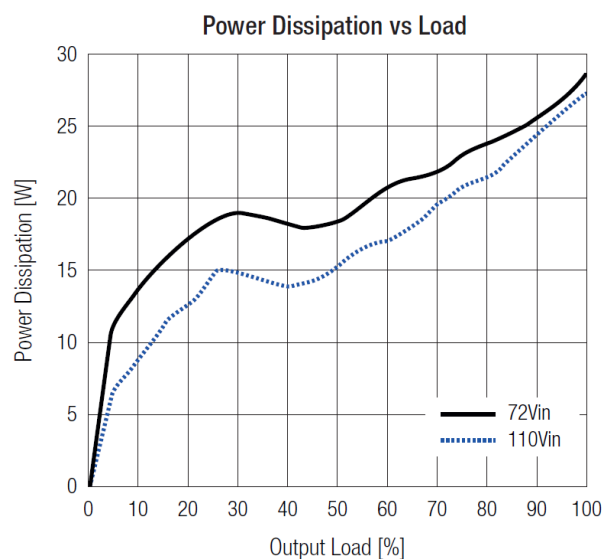
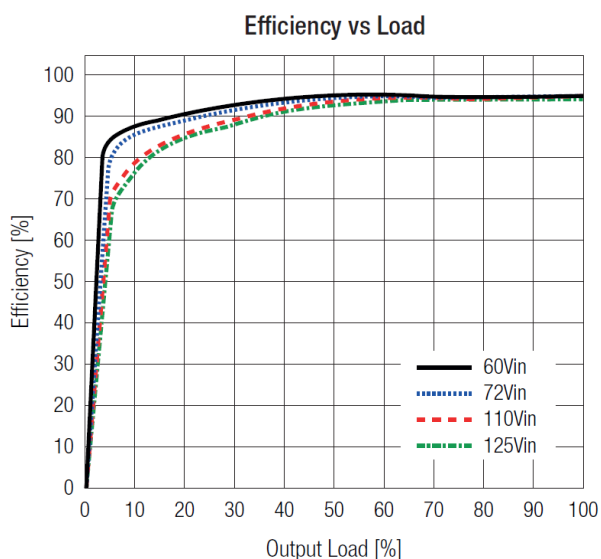
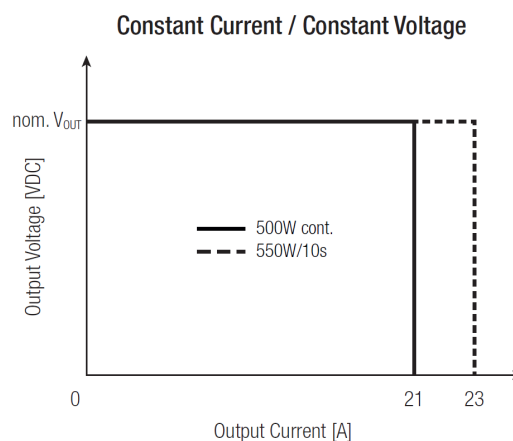
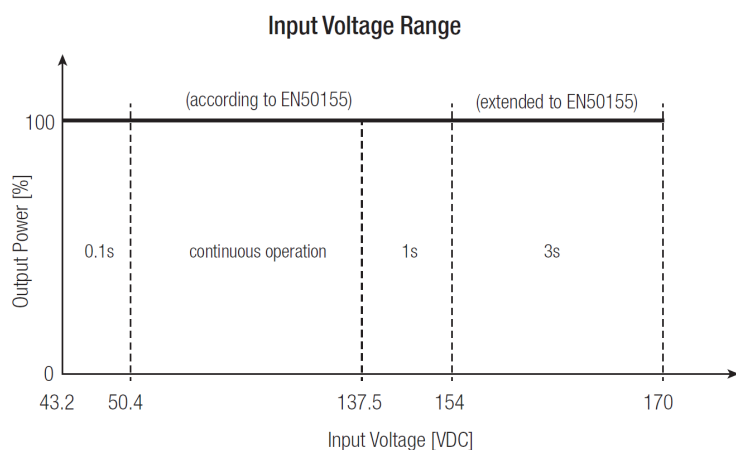
CLS-500-6520

nom. Input Voltage

nom. Output Voltage

BASIC CHARACTERISTICS (measured @ $T_{amb} = 25^{\circ}\text{C}$, nom. V_{in} , full load and after warm-up unless otherwise stated)

Parameter	Conditions		Min.	Typ.	Max.
Input Voltage Range	refer to "Input Voltage Range"	nom. $V_{in} = 72, 110V_{dc}$	$50.4V_{dc}$		$137.5V_{dc}$
		according to EN 50155	100ms max	$43.2V_{dc}$	$50.4V_{dc}$
			1s max.	$137.5V_{dc}$	$154V_{dc}$
Input Surge Voltage	3s max. (extended to EN 50155)				$170V_{dc}$
Input Capacitance	internal			$11\mu\text{F}$	
Under Voltage Lockout	rising edge		$45.3V_{dc}$		$50.4V_{dc}$
	falling edge		$35V_{dc}$		$43.2V_{dc}$
Input Current	$V_{in} = 43.2V_{dc}$			12A	
	$V_{in} = 72V_{dc}$			7.5A	
	$V_{in} = 110V_{dc}$			5A	
Inrush Current	active inrush current limitation				20A
No Load Power Consumption	$V_{in} = 72V_{dc}$			8.5W	
	$V_{in} = 110V_{dc}$			8.7W	
Standby Current (shutdown by remote)	$V_{in} = 50.4V_{dc}$			8.4mA	
	$V_{in} = 72V_{dc}$			7.2mA	
	$V_{in} = 110V_{dc}$			7.7mA	
	$V_{in} = 137.5V_{dc}$			8.4mA	
Output Current Range	continuous operation		0A		21A
	10s max., refer to "Peak Load Capability"				23A
Output Voltage				$24V_{dc}$	
Output Voltage Trimming	refer to "Output Voltage Trimming"		$19.2V_{dc}$		$25.2V_{dc}$
Minimum Load			0%		
Start-up time	$V_{in} = 72V_{dc}$				1s
	$V_{in} = 110V_{dc}$				0.6s
	by using CTRL ON/OFF function				0.3s
Rise time				100ms	
Hold-up time	$V_{in} = 72V_{dc}$			16ms	
	$V_{in} = 110V_{dc}$			20ms	
	$V_{in} = 137.5V_{dc}$			23ms	
ON/OFF CTRL	DC-DC ON		high/open or $12V_{dc} < V_{ctrl} < 154V_{dc}$		
	DC-DC OFF (pin15 INH connected pin16 INH0)		low or $-2V_{dc} < V_{ctrl} < 2V_{dc}$		
Input Current of CTRL pin	DC-DC ON			10mA	
Internal Operating Frequency				70kHz	
Output Ripple and Noise	over full input and load range, 20MHz BW				50mVp-p
Maximum Capacitive Load				50mF	



PEAK LOAD CAPABILITY

Peak power capability supports short power peaks of dynamic loads like motors, relays, storage devices or computer booting sequences. In addition allowing faster charge of load sided capacitors and reliable circuit breaker operation.

P_{nom} = nominal output power [W]

P_p = peak output power (550W max) [W]

P_r = recovery power [W]

t_1 = peak time (10s max) [s]

t_2 = recovery time (calculated) [s]

Calculation:

$$t_2 = \frac{(P_{nom} - P_p) \times t_1}{P_r - P_{nom}}$$

Practical Example:

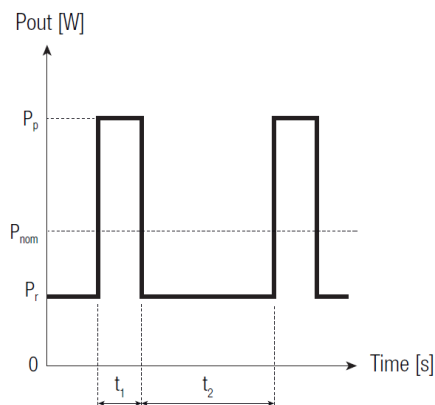
$P_{nom} = 500W$

$P_p = 550W$

$P_r = 450W$

$t_1 = 10s$

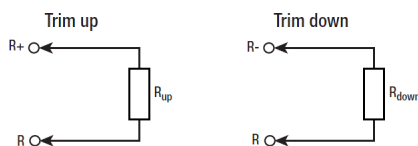
$$t_2 = \frac{(500W - 550W) \times 10s}{450W - 500W} = 10s$$





OUTPUT VOLTAGE TRIMMING

The output voltage of the CLS-500 can be trimmed between 19.2V_{dc} and 25.2V_{dc} by using an external trim resistor. The values for the trim resistor are according to standard E96 values; therefore, the specified voltage may slightly vary. Resistor values may be calculated with the following equation:



Calculations:

$V_{out_{nom}}$ = nominal output voltage [VDC]
 $V_{out_{set}}$ = trimmed output voltage [VDC]
 R_{up} = trim up resistor [Ω]
 R_{down} = trim down resistor [Ω]

$$R_{up} \cong \frac{322k\Omega \times V_{OUTnom} - 306k\Omega \times V_{OUTset}}{V_{OUTset} - V_{OUTnom}}$$

$$R_{down} \cong \frac{20k\Omega \times V_{OUTset} - 16k\Omega \times V_{OUTnom}}{V_{OUTnom} - V_{OUTset}}$$

Practical Example trim up +5% for CLS-500-6520

$$R_{up} = \left[\frac{322k\Omega \times 24V - 306k\Omega \times 25.2V}{25.2V - 24V} \right] = 14000\Omega$$

R_{up} according to E96 $\approx$ 14k Ω

Practical Example trim down -10% for CLS-500-6520

$$R_{down} = \left[\frac{20k\Omega \times 21.6V - 16k\Omega \times 24V}{24V - 21.6V} \right] = 20000\Omega$$

R_{down} according to E96 $\approx$ 20k Ω

Trim up	1	2	3	4	5	[%]
$V_{out_{set}} =$	24.24	24.48	24.72	24.96	25.2	[V _{dc}]
R_{up} (E96) $\approx$	1M3	499k	226k	93k1	14k	[Ω]

Trim down	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	[%]
$V_{out_{set}} =$	23.76	23.52	23.28	23.04	22.8	22.56	22.32	22.08	21.84	21.6	[V _{dc}]
R_{down} (E96) $\approx$	383k	182k	113k	80k6	60k4	46k4	37k4	30k1	24k3	20k	[Ω]

Trim down	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20	[%]
$V_{out_{set}} =$	21.36	21.12	20.88	20.64	20.4	20.16	19.92	19.68	19.44	19.2	[V _{dc}]
R_{down} (E96) $\approx$	16k2	13k3	10k7	8k45	6k65	4k99	3k48	2k21	1k05	0	[Ω]

REGULATIONS (measured @ T_{amb} = 25°C, nom. V_{in}, full load and after warm-up unless otherwise stated)

Parameter	Conditions	Value
Output Accuracy		±1.0% max.
Line Regulation	low line to high line, full load	0.1%
Load Regulation	10%-100% load	0.1% typ. / 0.2% max.
Transient Response	10-90% load, V _{in} = 50.4-137V _{dc}	0.5V _{dc}
	recovery time	40ms typ.



PROTECTIONS (measured @ $T_{amb} = 25^{\circ}\text{C}$, nom. V_{in} , full load and after warm-up unless otherwise stated)

Parameter	Type		Value
Internal Input Fuse			T15A, slow blow type
Short Circuit Protection (SCP)	constant current mode, auto recovery		>110% of nom. output current
Short Circuit Input Current	$V_{in} = 72V_{dc}$		0.6A
	$V_{in} = 110V_{dc}$		0.4A
Input Reverse Polarity Protection	active protected		$-137.5V_{dc}$
Over Voltage Protection (OVP)	latch off		$27.5V_{dc} - 32.5V_{dc}$
Over Voltage Category (OVC)	according to EN 50124-1:2018		OVC III
Over Current Protection (OCP)	auto recovery		110%-125%
Over Temperature Protection (OTP)	shut down, auto recovery		$T_{amb} = >90^{\circ}\text{C}$
Class of Equipment			Class I
Isolation Coordination	according to EN 50124-1:2018		$V_{nom} = 300V_{dc}$
Isolation Voltage ⁽³⁾	DC tested / AC rated	I/P to O/P	$5kV_{dc} / 3.5kVAC$
		I/P to PE and O/P to PE	$3kV_{dc} / 2kVAC$
	routine test	I/P to O/P, 10 seconds	$2.8kV_{dc}$
		for 10 seconds on safety components	3kVAC
		I/P to PE and O/P to PE	$2.8kV_{dc}$
Isolation Resistance			100M Ω min.
Isolation Capacitance			650pF max.
Leakage Current			10 μ A
Insulation Grade			reinforced
Internal Clearance	I/P to O/P		6mm
	I/P to PE		4mm
	O/P to PE		3mm

Note3: For repeat Hi-Pot testing, reduce the time and/or the test voltage

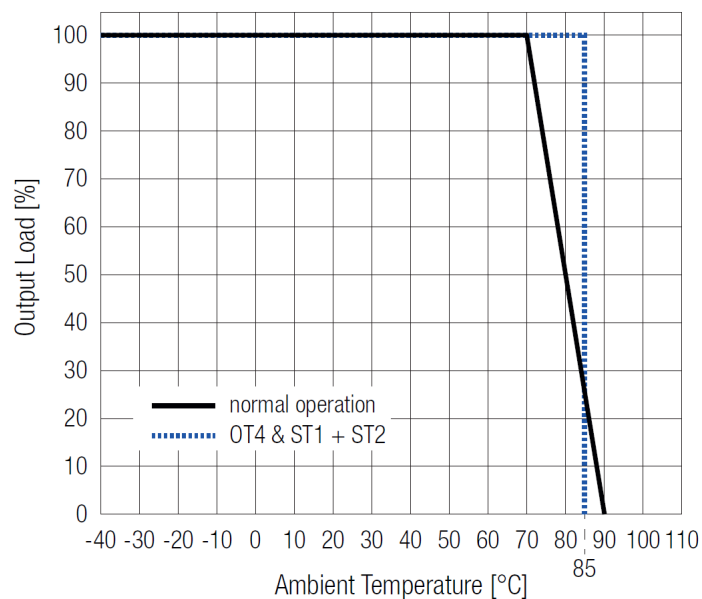
POWER GOOD (measured @ $T_{amb} = 25^{\circ}\text{C}$, nom. V_{in} , full load and after warm-up unless otherwise stated)

Parameter	Type	Value
Power OK LED	$V_{OUT} = >17V_{dc}$	green
	$V_{OUT} = <17V_{dc}$	light off
Relay Status	$V_{OUT} = >17V_{dc}$	OK: OK2 connected OK or OK1 not connected OK
	$V_{OUT} = <17V_{dc}$	NOK: OK1 connected to OK or OK2 not connected OK
Relay Capability		0.5A/150V $_{dc}$

**ENVIRONMENTAL** (measured @ $T_{amb} = 25^{\circ}\text{C}$, nom. V_{in} , full load and after warm-up unless otherwise stated)

Parameter	Conditions		Value
Operating Ambient Temperature Range		with derating	-40°C to +90°C
	according to EN 50155 operating temperature class OT4 and extended operating temperature class ST1 & ST2	without derating	-40°C to +70°C
		without derating for 15 minutes	-40°C to +85°C
Maximum Baseplate Temperature			+95°C
Temperature Coefficient			0.2%/K
Operating Altitude	according to EN 50124-1:2018		2000m (OVC III)
			5000m (OVC II)
Operating Humidity	non-condensing		95% RH max.
Conformal Coating ⁽⁴⁾	according to EN 50155		Class PC2
Pollution Degree			PD2
IP Rating			IP20
Design Lifetime			20 years
MTBF	according to IEC 61709/ UTE C80-810	$T_{amb} = +25^{\circ}\text{C}$	1800×10^3 hours
		$T_{amb} = +55^{\circ}\text{C}$	1100×10^3 hours
Useful Life Class	according to EN50155:2021 (S1)		L4

Note4: The board is protected on both sides with a protective / transparent / fluorescent / coating. The coating is compliant with class 2, according to IPC-A-610G: 2017

DERATING GRAPH



ENVIRONMENTAL (Railway Standards)

Parameter	Conditions	Value
Low Temperature start-up test	Temperature: -40°C Stabilization time: 2h	EN 60068-2-1 (Ad)
Dry heat test	Temperature: +70°C Continuous operational checks time: 6h	EN 60068-2-2 (Be) – Cycle A
Low temperature storage test	Temperature: -40°C Low temperature exposition time: 16h	EN 60068-2-1 (Ab)
Cyclic damp heat test	Temperature: +70°C/+25°C Number of cycles: 2 Time: 2x 24h	EN 60068-2-30 (Db)
Simulated long-life testing (Test performed at maximum level for each axis.)	Random Vibration, unit not powered during test Frequency range 5-150Hz with -6db/oct from 20 to 150Hz Vertical axis 5.72m/s ² for 5h [ASD 0.964(m/s ²) ² /Hz] Transverse axis 2.55m/s ² for 5h [ASD 0.192(m/s ²) ² /Hz] Longitudinal axis 3.96m/s ² for 5h [ASD 0.461(m/s ²) ² /Hz]	EN 61373 clause 9, class B Body mounted
Shock testing (Test performed at maximum level for each axis.)	Half-sine shock, unit powered during test Vertical axis 30m/s ² for 30ms Transverse axis 30m/s ² for 30ms Longitudinal axis 50m/s ² for 50ms Number of shocks: 18 (3x polarity for each axis)	EN 61373 clause 10, class B Body mounted
Functional random vibration test (Test performed at maximum level for each axis.)	Random Vibration, unit powered during test Frequency range 5-150Hz with -6db/oct from 20 to 150Hz Vertical axis 1.01m/s ² for 10min [ASD 0.0301(m/s ²) ² /Hz] Transverse axis 0.45m/s ² 10min [ASD 0.006(m/s ²) ² /Hz] Longitudinal axis 0.7m/s ² 10min [ASD 0.0144(m/s ²) ² /Hz]	EN 61373 clause 8, class B Body mounted
Fire Protection on Railway Vehicles		EN45545-2 Hazard Level HL1 - HL3

SAFETY & CERTIFICATIONS

Certificate Type (Safety)	Standard
Audio/video, information and communication technology equipment. Safety requirements	IEC/EN62368-1:2020+A11:2020
Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment	EN50124-1
Railway Applications - Electrical Equipment used on rolling stock	EN50155:2021
RoHS2	RoHS 2011/65/EU + AM2015/863



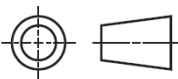
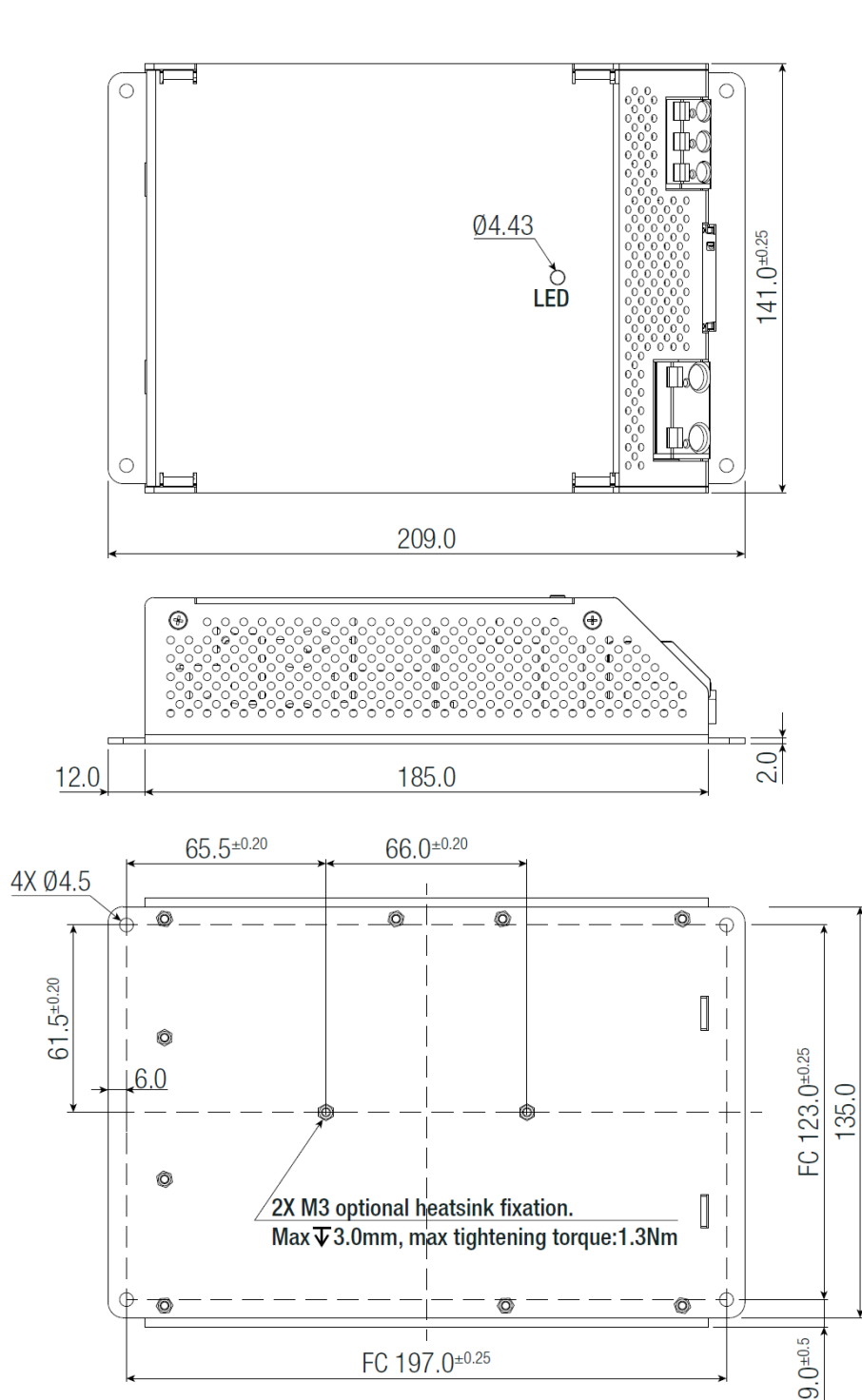
EMC Compliance	Conditions	Standard / Criterion
Railway applications - Electromagnetic compatibility		EN50121-3-2:2016
Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments		EN61000-6-4:2007+A1:2011
ESD Electrostatic discharge immunity test	Air: $\pm 2, 4, 8\text{kV}$ Contact: $\pm 2, 4, 8\text{kV}$	IEC61000-4-2:2009, Criteria A EN61000-4-2:2008, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	20V/m (80-1000MHz) 10V/m (1000-2000MHz) 5V/m (2000-4000MHz) 3V/m (4000-6000MHz)	IEC/EN61000-4-3:2006, Criteria A
Fast Transient and Burst Immunity	DC Power Port: $\pm 2\text{kV}$	IEC/EN61000-4-4:2012, Criteria A
Surge Immunity	DC Power Port: $\pm 0.5, 1\text{kV}$ line sym. DC Power Port: $\pm 0.5, 1, 2\text{kV}$ line unsym.	IEC/EN61000-4-5:2014, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	10Vr.m.s. (0.15-80MHz)	IEC/EN61000-4-6: 2016, Criteria A
Technical rules for electromagnetic compatibility: Proof of radio compatibility of rail vehicles with railway radio services		Regulation No.EMV 06:2019

DIMENSION & PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Material	case	aluminum
Dimension (LxWxH)		209.0 x 141.0 x 48.0mm 8.23 x 5.55 x 1.89 inch
Weight		1100g typ. 2.43 lbs

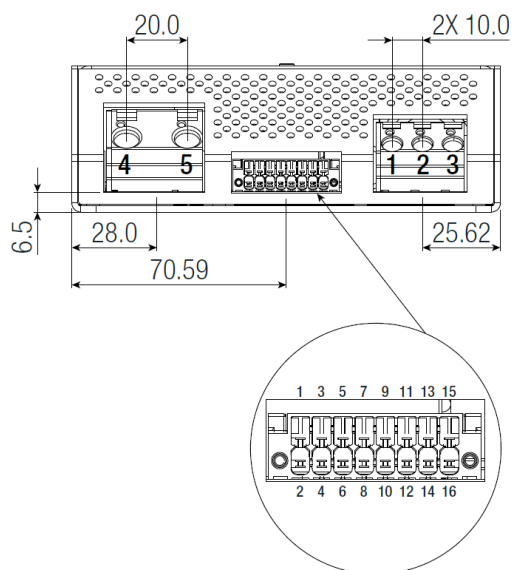


DIMENSION DRAWING (mm)



Tolerance Table	
Dimension range	Tolerances
0.5 - 6 mm	± 0.1 mm
6 - 30 mm	± 0.2 mm
30 - 120 mm	± 0.3 mm
120 - 315 mm	± 0.5 mm

FC = fixing centers



Input connector CAGE CLAMP® CON1
(WAGO 745-353)

#	Function	AWG	Wire diameter
1	-Vin	24-10	0.25-4mm ²
2	+Vin	24-10	0.25-4mm ²
3	PE	24-10	0.25-4mm ²

wire stripping length: 11-12mm

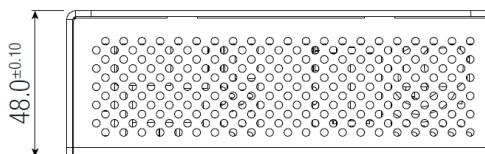
Conductor connection direction to PCB 45°

Output connector CAGE CLAMP® CON2
(WAGO 745-602/006-000)

#	Function	AWG	Wire diameter
4	+Vout	24-6	0.25-10mm ²
5	-Vout	24-6	0.25-10mm ²

wire stripping length: 12-13mm

Conductor connection direction to PCB: 45°



Signal CON3

(Phoenix DMC 1,5/ 8-G1F-3,5-LR)

#	Function	#	Function
16	INH0	15	INH
14	NC	13	NC
12	OK	11	OK2
10	OK	9	OK1
8	NC	7	NC
6	CS1	5	CS2
4	R	3	R-
2	R	1	R+

Signal CON3

Compatible Connector
(not included)

Phoenix DFMC 1,5/ 8-STF-3,5 – 1790357

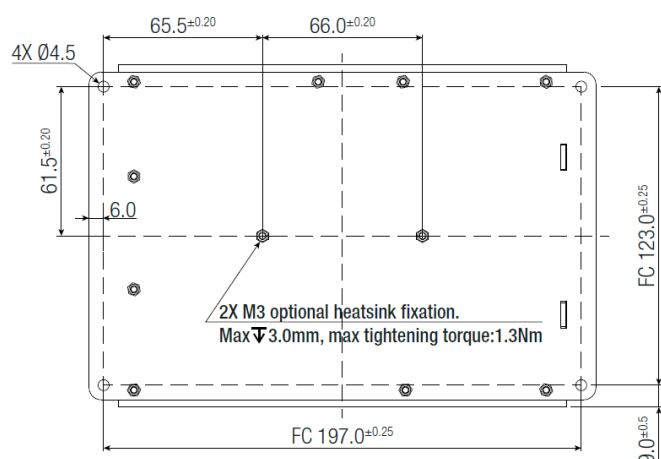
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0.5 - 6 mm	±0.1 mm
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30 - 120 mm	±0.3 mm
120 - 315 mm	±0.5 mm

FC = fixing centers

INSTALLATION & APPLICATION

MOUNTING INSTRUCTIONS



For operation of the DC/DC converter the PE connection at the intended connection point as part of the overall EMC concept is mandatory.

Natural air convection around the unit must be possible at any time and the temperature shall not be exceeded.

The converter has to be installed with 4 x M4 screws and can be mounted in any mounting direction.

All control and signal terminals have been tested and have passed the requirements according to the EN50121-3-2 regulations, nevertheless for installation conditions with cable lengths above 30m, maybe additional protection against disturbances will be necessary.

ACCESORIES

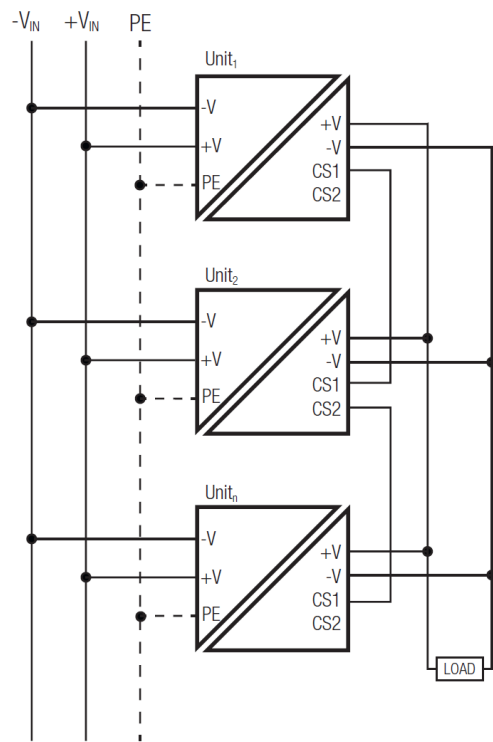
Accesories	Notes	Order qty. / device	CODE
Signals mating connector	DEGSON 15EDGKNG-3.5-XXP-1Y-1000A(H)	1	2601-1120



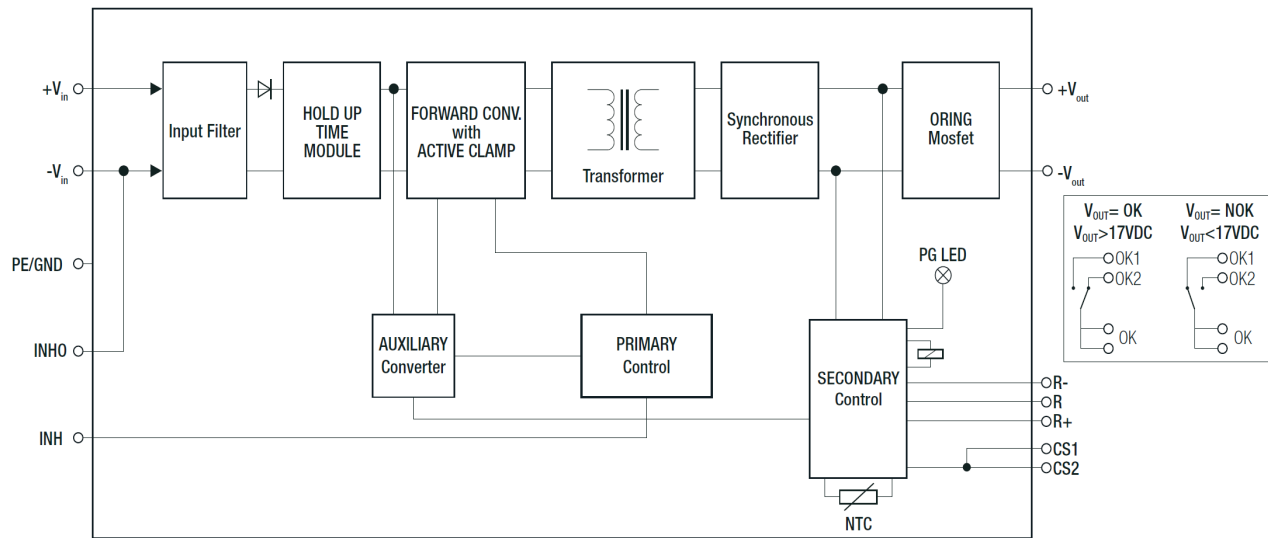
INSTALLATION & APPLICATION

PARALLEL OPERATION

Here the example of three parallel connected units. CS1/CS2 is a double connection of the same pin to be able to connect more than two units.



BLOCK DIAGRAM



PACKAGING INFORMATION

Parameter	Type	Value
Packaging Dimension (LxWxH)	cardboard box	145.0 x 53.0 x 218.0mm
Packaging Quantity		1pc
Storage Temperature Range		-40°C to +85°C