



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



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 CLS-500 series consists of 500 W DC-DC converters with galvanic isolation between input and output. The converters operate at a fixed switching frequency and use a high-efficiency topology. The input voltage range extends from 43.2 V to 170 V_{dc}, covering railway batteries with nominal voltages of 72 V and 110 V in one model. The output provides a regulated 24 V_{dc} with low ripple and high stability. The converters achieve a typical efficiency of 95 %. The baseplate mounting allows operation without derating from -40 °C to +85 °C, meeting OT4 and ST1/ST2 classes according to EN50155. The reinforced isolation system ensures compliance with EN50124-1 and EN62368-1. The unit includes input reverse polarity protection, inrush current limitation, and protection against over-voltage, over-current and over-temperature. A 10 ms hold-up time ensures continuous operation during short battery interruptions. Remote ON/OFF control and an integrated OR-ing diode enable redundant or parallel configurations. The CLS-500 series complies with EN50155, EN50121-3-2, EN50124-1, EN50125-1, EN61373 Cat. 1B, EN62368-1 and EN45545-2 standards.

| Part Number | Input Voltage Range [V _{dc}] | Output Voltage nom. [V _{dc}] | Output Current max. ⁽¹⁾ [A] | Efficiency typ. [%] | Output Power max. ⁽¹⁾ [W] |
|---------------|--|--|--|---------------------|--------------------------------------|
| CLS-500-36520 | 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



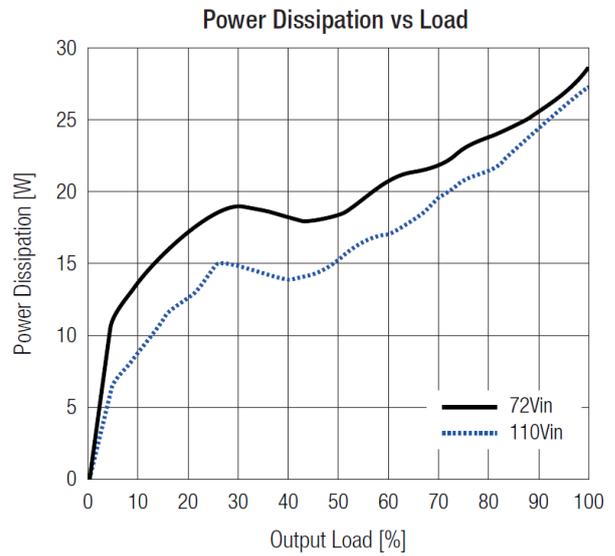
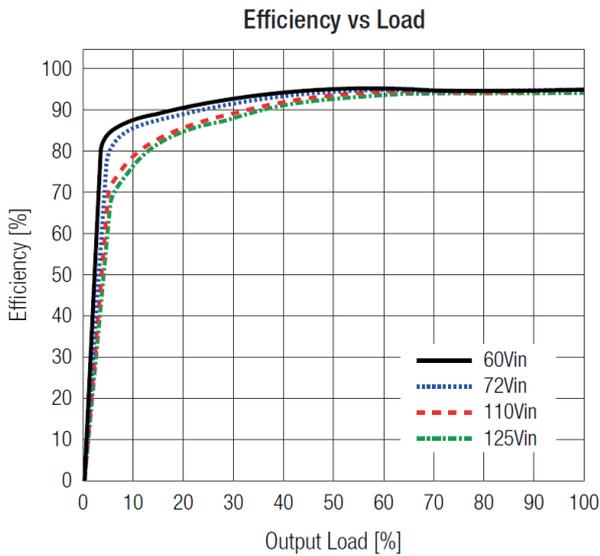
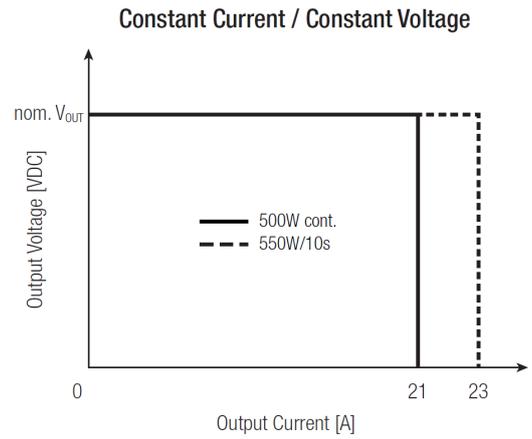
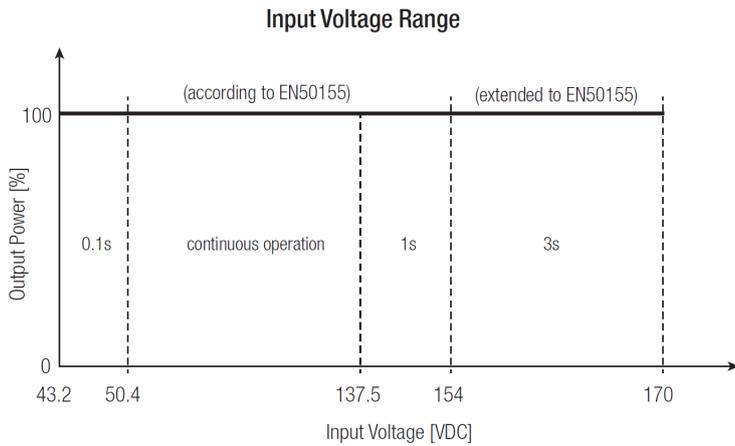
MODEL NUMBERING

CLS-500-36520



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

| Parameter | Conditions | Min. | Typ. | Max. |
|--------------------------------------|---|---|----------------------|----------------------|
| Input Voltage Range | nom. V _{in} = 72, 110V _{dc} | 50.4V _{dc} | | 137.5V _{dc} |
| | refer to "Input Voltage Range" 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 | | 11µF | |
| 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]

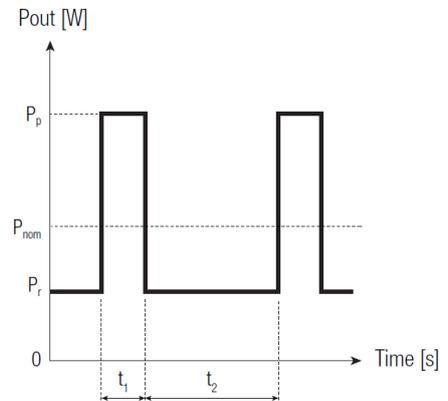
Calculation:

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

Practical Example:

- $P_{nom} = 500W$
- $P_p = 550W$
- $P_r = 450W$
- $t_1 = 10s$

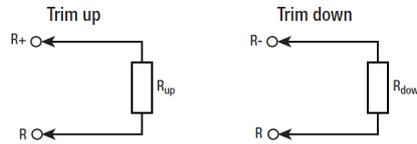
$$t_2 = \frac{(500W - 550W) \times 10s}{450W - 500W} = 10s$$





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 **14kΩ**

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 **20kΩ**

| 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 | I/P to O/P | 3kVAC |
| | | | I/P to PE and O/P to PE | $2.8kV_{dc}$ |
| Isolation Resistance | | 100MΩ min. | | |
| Isolation Capacitance | | 650pF max. | | |
| Leakage Current | | 10μA | | |
| 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 | | $0.5A/150V_{dc}$ |

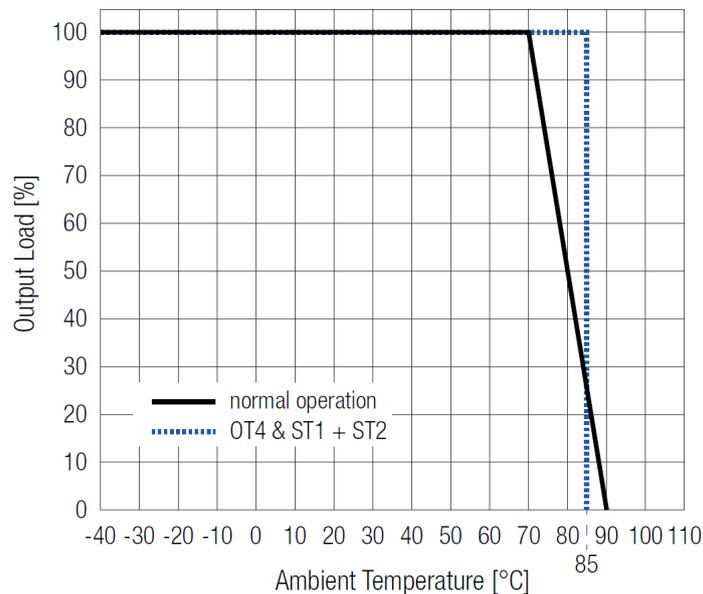


ENVIRONMENTAL (measured @ $T_{amb} = 25^{\circ}\text{C}$, nom. V_{in} , full load and after warm-up unless otherwise stated)

| 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 |



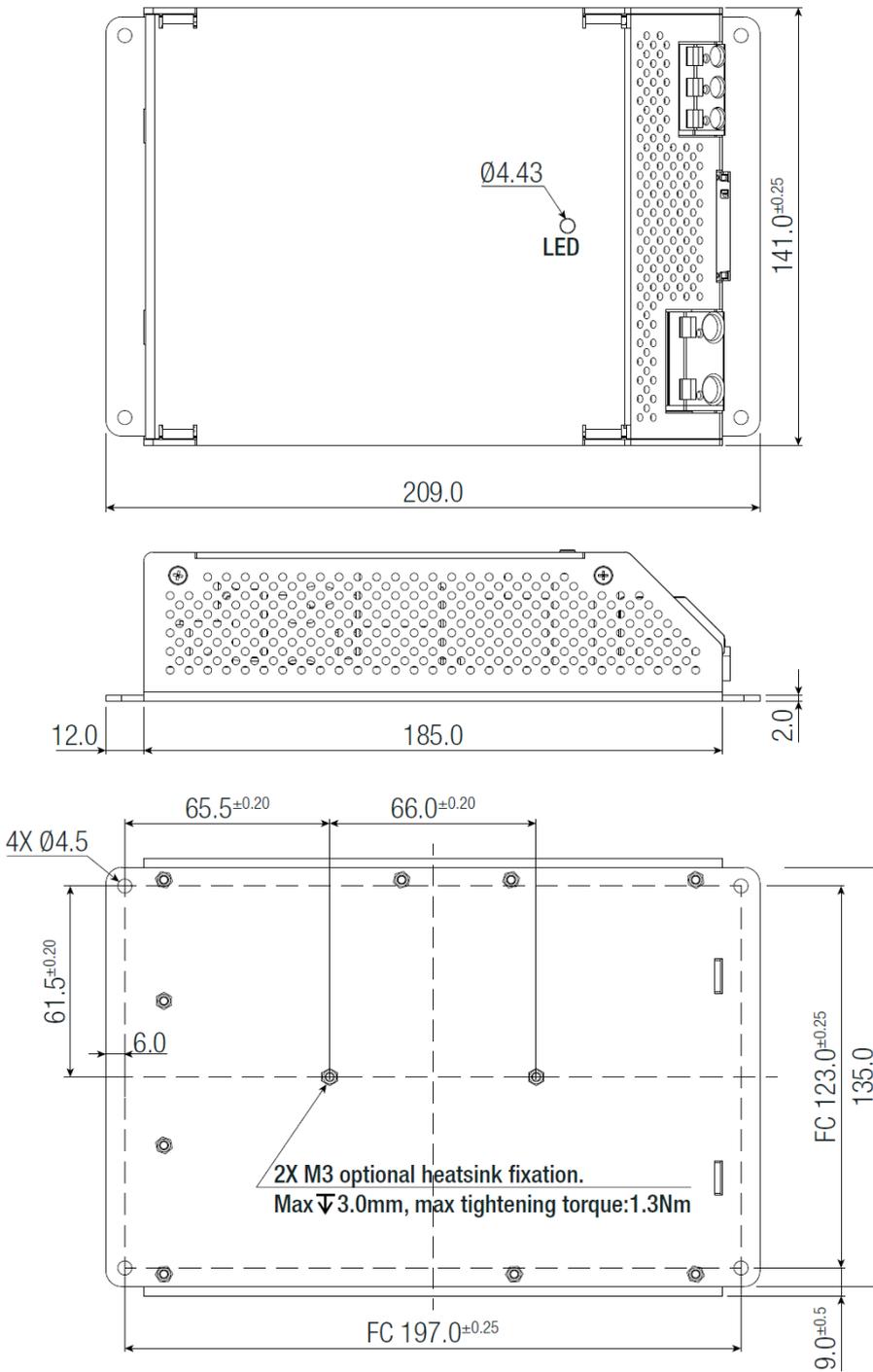
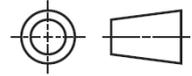
| EMC Compliance | Conditions | Standard / Criterion |
|---|---|---|
| Railway applications - Electromagnetic compatibility | | EN50121-3-2:2016 |
| Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments | | EN61000-6-4:2007+A1:2011 |
| ESD Electrostatic 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 |

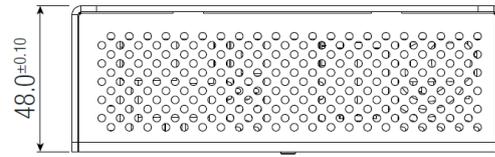
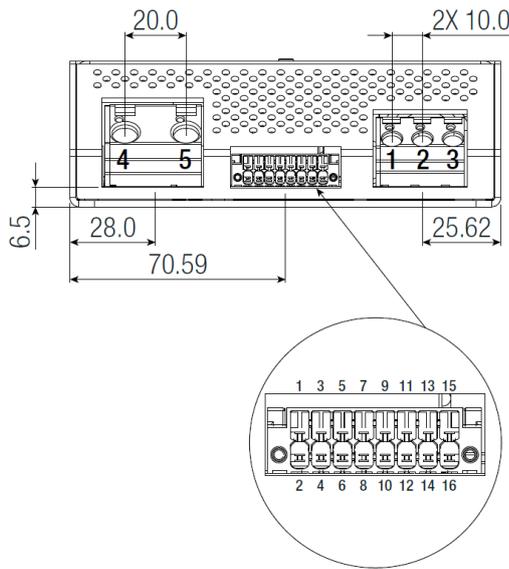


DIMENSION DRAWING (mm)



| 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)

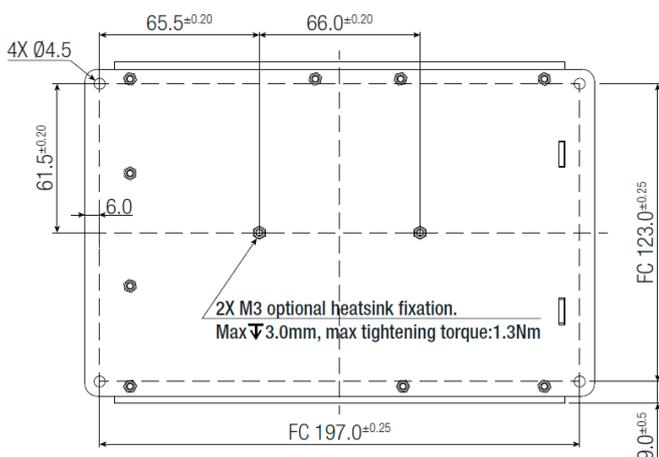
Phoenix DFMC 1,5/ 8-STF-3,5 – 1790357

| 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

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.

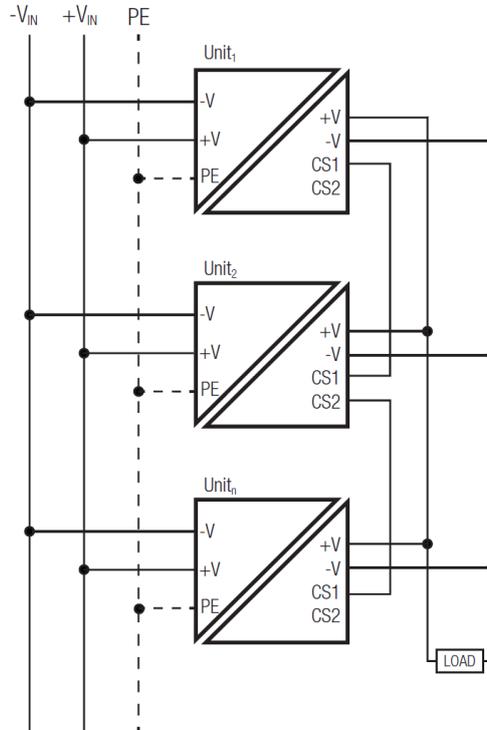
ACCESORIES

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

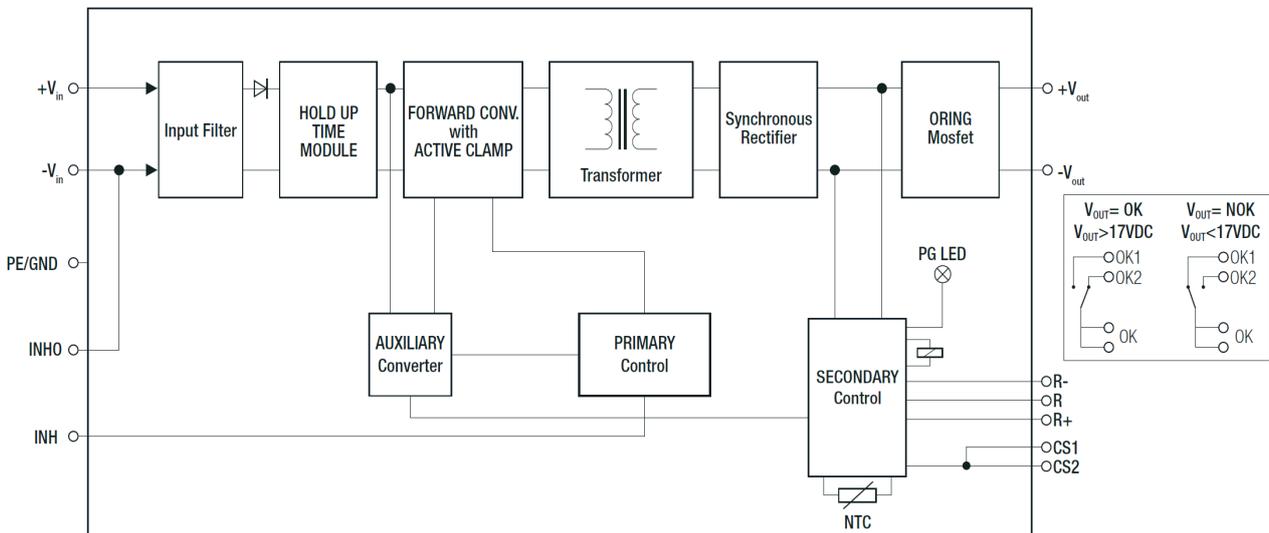
INSTALLATION & APPLICATION

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 |