Technical Data Sheet

RMD500-EW Series / Plug & Play Railway

500W / Extra-Wide Input 50.4V-137.5VDC

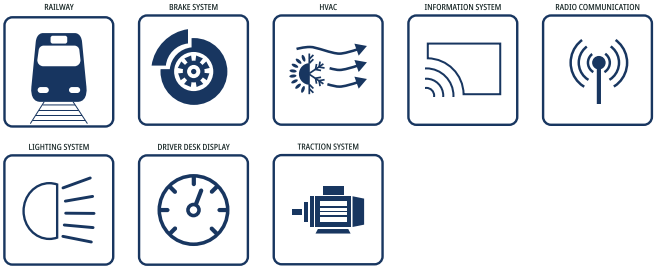
RECOM DC/DC Converter

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)

APPLICATIONS



SAFETY & EMC

CE RoHS² compliant 10 from 10 Reach compliant

DESCRIPTION

The chassis mountable RMD500 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 43.2VDC up to 170VDC 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. (2) [%]	Output Power max. (1) [W]
RMD500-110-24SEW	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

RMD500-110-24 SEW

- RMD500 — nom. Output Power
- 110 — nom. Input Voltage for $110V_{IN}$
- 24 — nom. Output Voltage
- SEW — **S**ingle

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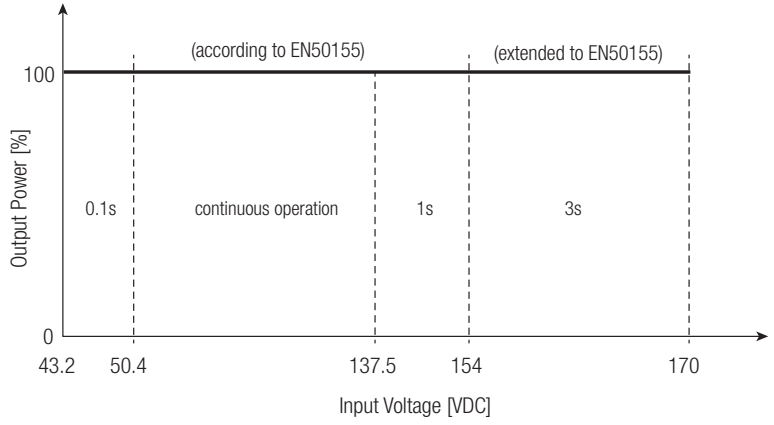
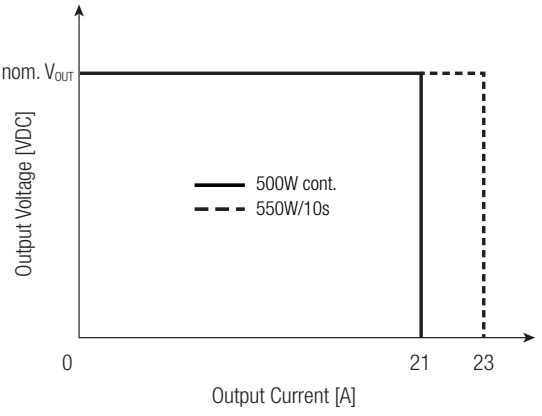
BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Conditions			Min.	Typ.	Max.
Input Voltage Range	refer to **„Input Voltage Range“**	nom. V_{IN}= 72, 110VDC		50.4VDC		137.5VDC
		according to EN 50155	100ms max	43.2VDC		50.4VDC
			1s max.	137.5VDC		154VDC
Input Surge Voltage	3s max. (extended to EN 50155)					170VDC
Input Capacitance	internal				11µF	
Under Voltage Lockout	rising edge			45.3VDC		50.4VDC
	falling edge			35VDC		43.2VDC
Input Current	V_{IN}=43.2VDC				12A	
	V_{IN}= 72VDC				7.5A	
	V_{IN}= 110VDC				5A	
Inrush Current	active inrush current limitation					20A
No Load Power Consumption	V_{IN}= 72VDC				8.5W	
	V_{IN}= 110VDC				8.7W	
Standby Current (shutdown by remote)	V_{IN}=50.4VDC				8.4mA	
	V_{IN}= 72VDC				7.2mA	
	V_{IN}= 110VDC				7.7mA	
	V_{IN}= 137.5VDC				8.4mA	
Output Current Range	continuous operation			0A		21A
	10s max., refer to **„Peak Load Capability“**					23A
Output Voltage					24VDC	
Output Voltage Trimming	refer to **„Output Voltage Trimming“**			19.2VDC		25.2VDC
Minimum Load				0%		
Start-up time	V_{IN}= 72VDC					1s
	V_{IN}= 110VDC					0.6s
	by using CTRL ON/OFF function					0.3s
Rise time					100ms	
Hold-up time	V_{IN}=72VDC				16ms	
	V_{IN}= 110VDC				20ms	
	V_{IN}= 137.5VDC				23ms	
ON/OFF CTRL	DC-DC ON			high/open or 12VDC < V_{CTRL} <154VDC		
	DC-DC OFF (pin15 INH connected pin16 INH0)			low or -2VDC < V_{CTRL} < 2VDC		
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	

Input Voltage Range



Constant Current / Constant Voltage



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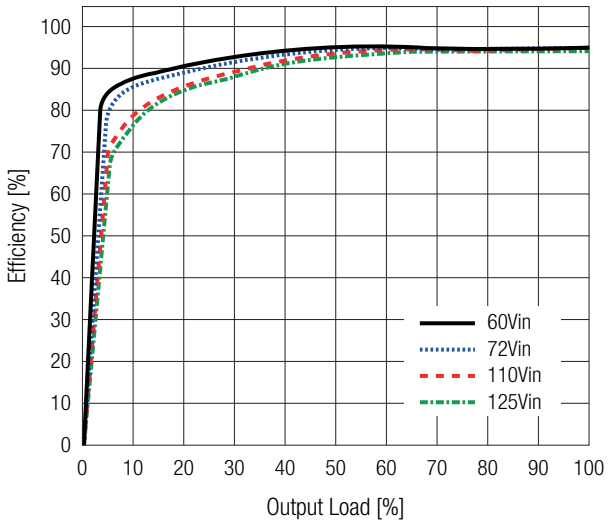
500W / Extra-Wide Input 50.4V-137.5VDC

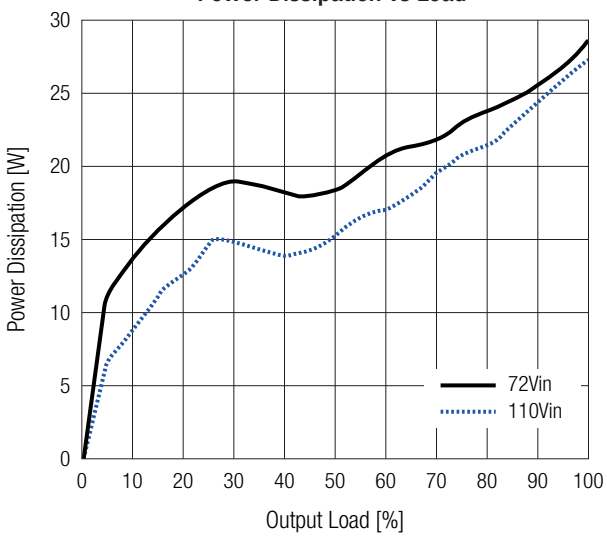
RECOM DC/DC Converter

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

Efficiency vs Load



Power Dissipation vs Load



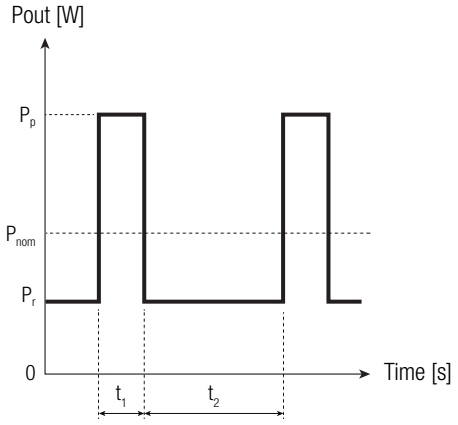
PEAK LOAD CAPABILITY

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:

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



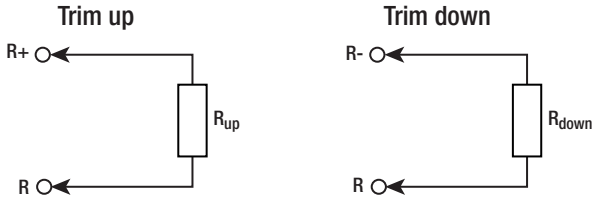
Practical Example:

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

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

OUTPUT VOLTAGE TRIMMING

The output voltage of the RMD500-EW can be trimmed between 19.2DC and 25.2VDC 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:

$Vout_{nom}$	= nominal output voltage	[VDC]
$Vout_{set}$	= 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 RMD500-110-24SEW

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

R_{up} according to E96 ≈ **14kΩ**

Practical Example trim down -10% for RMD500-110-24SEW

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

R_{down} according to E96 ≈ **20kΩ**

OUTPUT VOLTAGE TRIMMING

RMD500-110-24SEW

Trim up	1	2	3	4	5	[%]
$Vout_{set}$ =	24.24	24.48	24.72	24.96	25.2	[VDC]
R_{up} (E96) ≈	1M3	499k	226k	93k1	14k	[Ω]

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

Trim down	-11	-12	-13	-14	-15	-16	-17	-18	-19	-20	[%]
$Vout_{set}$ =	21.36	21.12	20.88	20.64	20.4	20.16	19.92	19.68	19.44	19.2	[VDC]
R_{down} (E96) ≈	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}= 50.4-137VDC	0.5VDC
	recovery time	40ms typ.

PROTECTIONS (measured @ T_{AMB}= 25°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}= 72VDC			0.6A
	V_{IN}= 110VDC			0.4A
Input Reverse Polarity Protection	active protected			-137.5VDC
Over Voltage Protection (OVP)	latch off			27.5VDC - 32.5VDC
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°C
Class of Equipment				Class I
Isolation Coordination	according to EN 50124-1:2018			V_{NOM}= 300VDC
Isolation Voltage [3]	DC tested / AC rated	I/P to O/P		5kVDC / 3.5kVAC
		I/P to PE and O/P to PE		3kVDC / 2kVAC
	routine test	I/P to O/P, 10 seconds		2.8kVDC
		for 10 seconds on safety components	I/P to O/P	3kVAC
			I/P to PE and O/P to PE	2.8kVDC
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

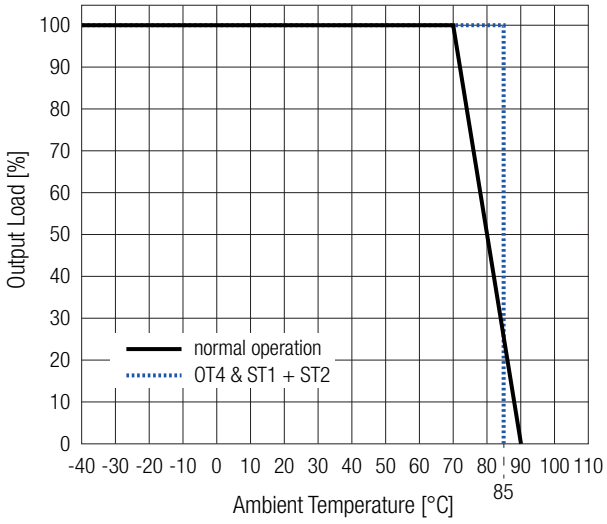
Parameter	Type	Value
Power OK LED	V_{OUT}= >17VDC	green
	V_{OUT}= <17VDC	light off
Relay Status	V_{OUT}= >17VDC	OK: OK2 connected OK or OK1 not connected OK
	V_{OUT}= <17VDC	NOK: OK1 connected to OK or OK2 not connected OK
Relay Capability		0.5A/150VDC

ENVIRONMENTAL (measured @ T_{AMB}= 25°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 IEC61709/ UTE C80-810	T_{AMB}= +25°C	1800 x 10^3 hours
		T_{AMB}= +55°C	1100 x 10^3 hours
Useful Life Class	according to EN50155:2018 (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/s² for 5h [ASD 0.964(m/s²)²/Hz] Transverse axis 2.55m/s² for 5h [ASD 0.192(m/s²)²/Hz] Longitudinal axis 3.96m/s² for 5h [ASD 0.461(m/s²)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/s² for 30ms Transverse axis 30m/s² for 30ms Longitudinal axis 50m/s² 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/s² for 10min [ASD 0.0301(m/s²)²/Hz] Transverse axis 0.45m/s² 10min [ASD 0.006(m/s²)²/Hz] Longitudinal axis 0.7m/s² 10min [ASD 0.0144(m/s²)²/Hz]	EN 61373 clause 8, class B Body mounted
Fire Protection on Railway Vehicles		EN45545-2 Hazard Level HL1 - HL3

SAFETY & CERTIFICATIONS

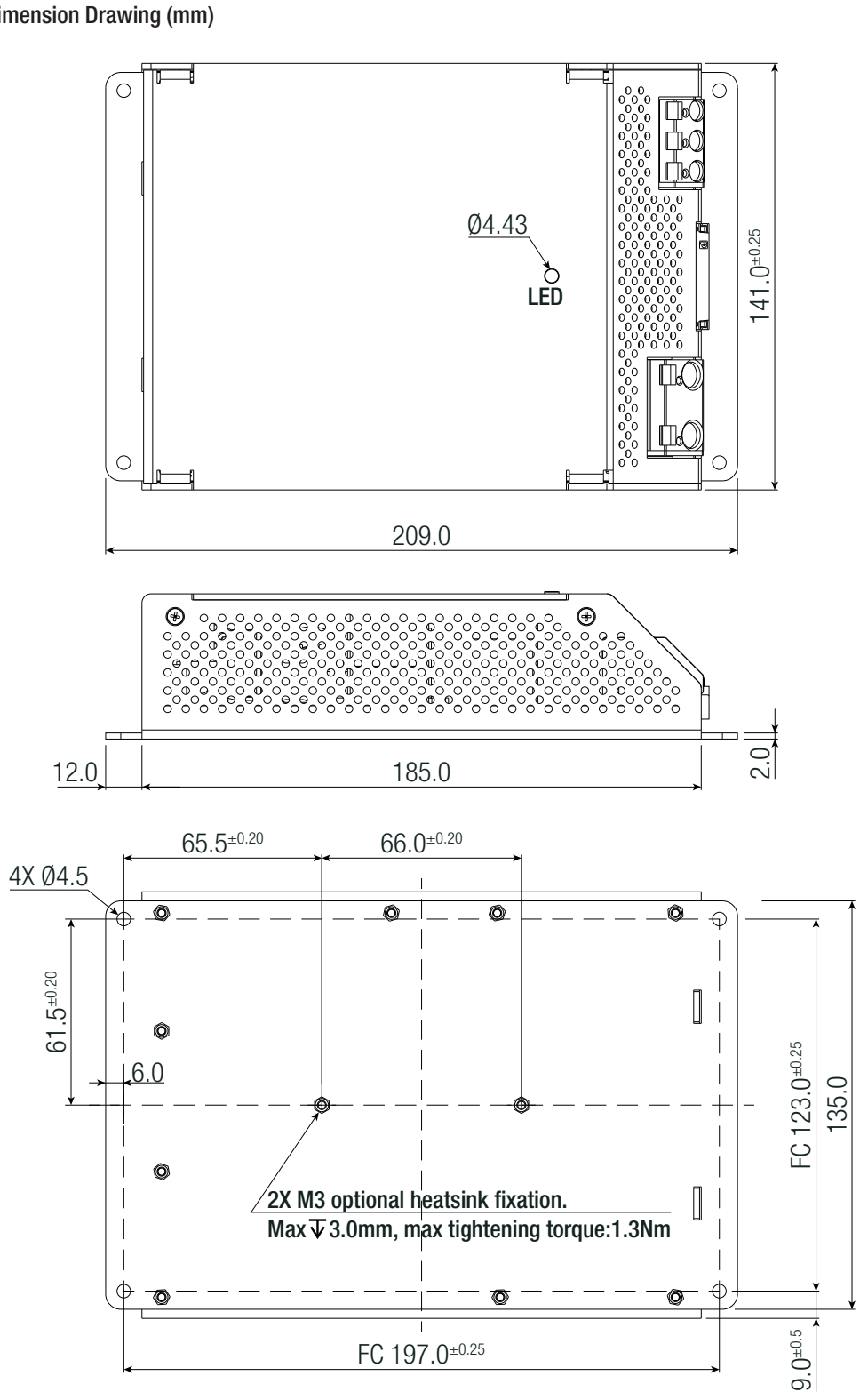
Certificate Type (Safety)	Standard
Audio/video, information and communication technology equipment. Safety requirements	IEC/EN62368-1:2020+A11:2020
Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment	EN50124-1
Railway Applications - Electrical Equipment used on rolling stock	EN50155
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: ±2, 4, 8kV Contact: ±2, 4, 8kV	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: ±2kV	IEC/EN61000-4-4:2012, Criteria A
Surge Immunity	DC Power Port: ±0.5, 1kV line sym. DC Power Port: ±0.5, 1, 2kV 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
Technische Regeln zur Elektromagnetischen Verträglichkeit: Nachweis der Funkverträglichkeit von Schienenfahrzeugen mit Bahnfunkdiensten		Regelung Nr. 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

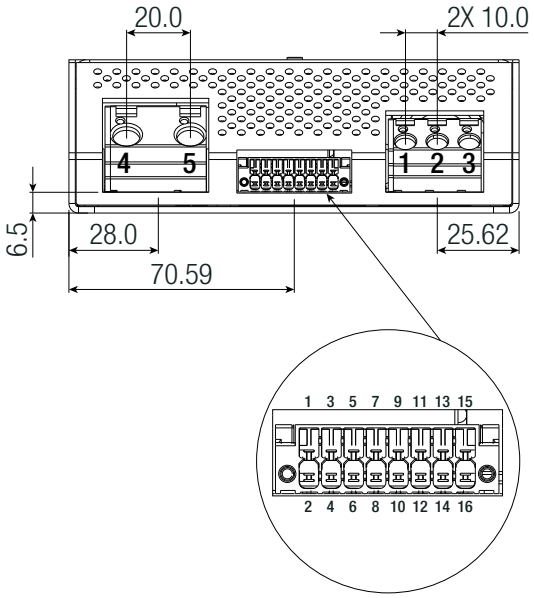
Dimension Drawing (mm)

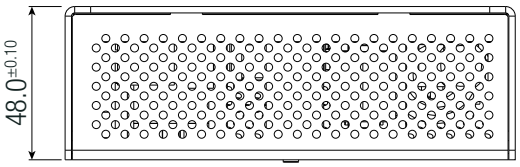


Tolerance Table	
Dimension range	Tolerances
0.5 - 6 mm	±0.1 mm
6 - 30 mm	±0.2 mm
30 - 120 mm	±0.3 mm
120 - 315 mm	±0.5 mm

FC = fixing centers

DIMENSION & PHYSICAL CHARACTERISTICS





Signal CON3

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

#	Function	#	Function
16	INHO	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+

Input connector CAGE CLAMP® CON1

(WAGO 745-353)

#	Function	AWG	Wire diameter
1	-Vin	24-10	0.25-4mm²
2	+Vin	24-10	0.25-4mm²
3	PE	24-10	0.25-4mm²

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	0.25-10mm²
5	-Vout	24-6	0.25-10mm²

wire stripping length: 12-13mm
Conductor connection direction to PCB: 45°

Signal CON3

Compatible Connector (not included)

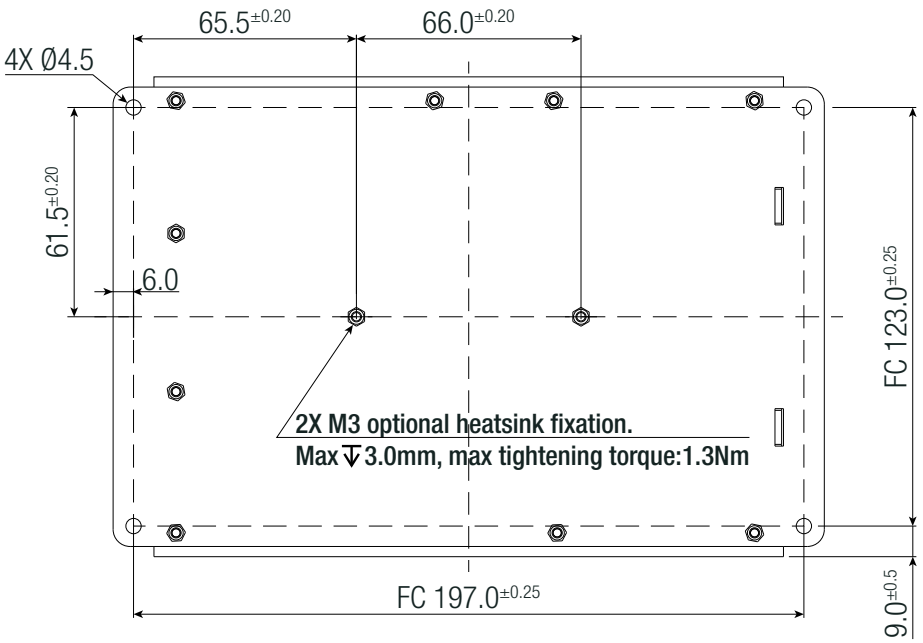
Phoenix DFMC 1,5/ 8-STF-3,5 – 1790357

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.

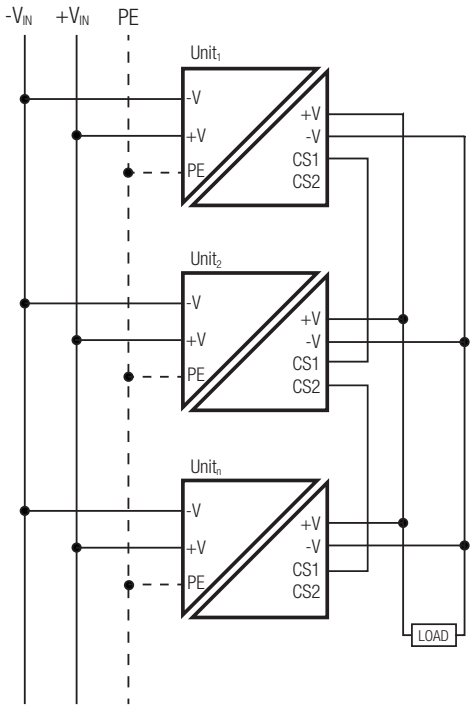
The RMD converter has to be installed with 4 x M4 screws and can be mounted in any mounting direction.

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.

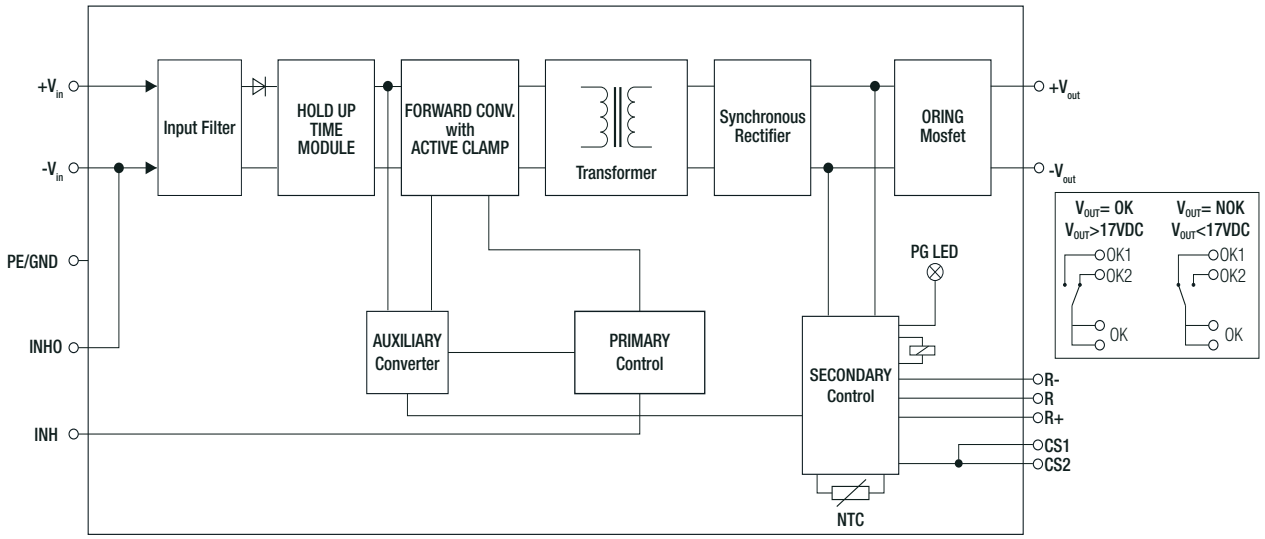
INSTALLATION & APPLICATION

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