Features

Regulated Converter

- Fully railway approved for EN50155 (S2) applications
- EN50121-3-2, EN50124-1, EN62368-1, EN61373, EN45545-2
- Plug&Play unit for natural convection cooling
- Wide range input for nominal 72V and 110V
- Excellent efficiency and functionality
- Parallel and redundant operation
- Extremely reliable and robust

RECOM
DC/DC Converter

RMD500-EW

500 Watt
8.23"x5.56"
Single Output

2 YEAR warranty

IEC/EN62368-1 pending
EN50124-1 pending
EN45545-2 pending
EN50155 pending
EN50121-3-2 compliant
EN55011 compliant
IEC/EN61000-4-2,3,4,5 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]	nom. Output Voltage [VDC]	max. Output Current [A]	Efficiency typ.(1) [%]	Output Power [W]
RMD500-110-24SEW	50.4 - 137.5	24	21	95	500

Notes:

Note1: Efficiency is tested at nominal input and 50%-100% +25°C ambient

Model Numbering

RMD500-110-__ SEW

- max. Output Power
- nom. Input Voltage
- Single
- nom. Output Voltage

Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

BASIC CHARACTERISTICS						
Parameter	**Condition**			**Min.**	**Typ.**	**Max.**
Input Voltage Range	refer to ***"Input Voltage Range"***	according to EN50155	nom. V_{IN}	50.4VDC	72VDC	137.5VDC
			for 100ms max.	43.2VDC		
Input Surge Voltage			for 1s			154VDC
		for 3s max. (extended to EN50155)				170VDC
Input Capacitance	internal				11µF	
Under Voltage Lockout	rising edge			45.3VDC		50.4VDC
	falling edge			35VDC		43.2VDC
Input Current Range	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	

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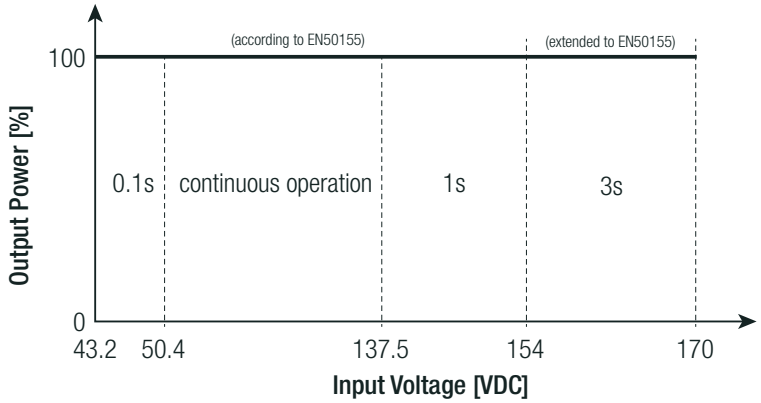
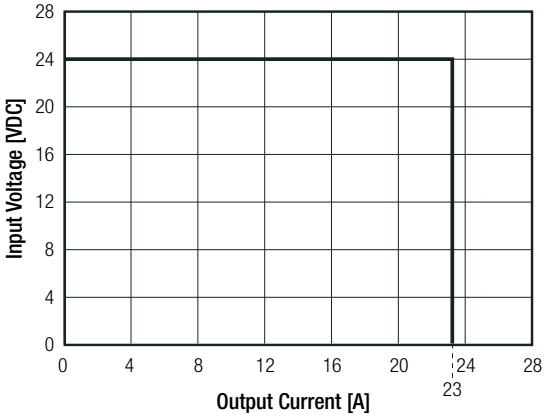
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

BASIC CHARACTERISTICS (continuous)				
Parameter	**Condition**	**Min.**	**Typ.**	**Max.**
Standby Current (shutdown by remote)	V_{IN}= 50.4VDC		7.2mA	
	V_{IN}= 72VDC		6.6mA	
	V_{IN}= 110VDC		6.8mA	
	V_{IN}= 137.5VDC		7.5mA	
Output Current Range	parallel operation refer to ***"PARALLEL OPERATION"***	0A		21A
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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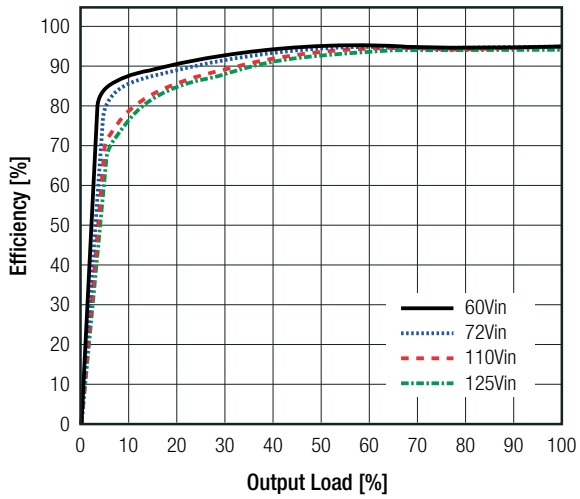
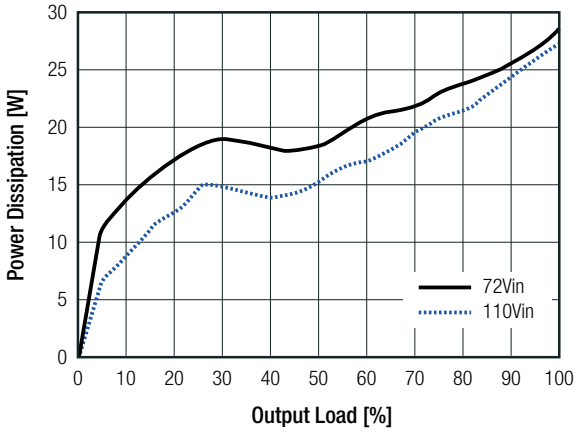
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

Efficiency vs Load



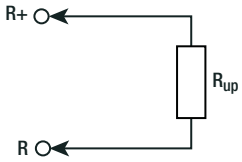
Power Dissipation vs Load



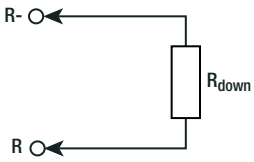
OUTPUT VOLTAGE TRIMMING

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

Trim up



Trim down



Calculation:

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

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

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

Practical Example trim up +5%

$$R_{up} \cong \left[\frac{322k\Omega \text{ x } 25.2V - 306k\Omega \text{ x } 24}{25.2 - 24}\right] = 642k\Omega$$

R_{up} according to E96 ≅ **649kΩ**

Practical Example trim down -10%

$$R_{down} \cong \left[\frac{20k\Omega \text{ x } 21.6V - 16k\Omega \text{ x } 24}{24 - 21.6}\right] = 1978\Omega$$

R_{down} according to E96 ≅ **1k96Ω**

Trim up	1	2	3	4	5	[%]
$Vout_{set}$ =	24.24	24.48	24.72	24.96	25.2	[VDC]
R_{up} (E96) ≈	1M91	1M13	845k	715k	649k	[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]

Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

REGULATIONS		
Parameter	**Condition**	**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			
Parameter	**Type**		**Value**
Input Fuse	internal		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 EN50124-1:2018		OVCIII
Over Current Protection (OCP)	auto recovery		23A - 25.2A
Over Temperature Protection (OTP)	shut down, auto recovery		T_{AMB}= >90°C
Class of Equipment			Class I
Isolation Coordination	according to EN50124-1:2018		V_{NOM}= 300VDC
Isolation Voltage (2)	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, for 10 seconds	3kVAC
		I/P to PE and O/P to PE, 10 seconds	2.8kVDC
Isolation Resistance			100MΩ max.
Isolation Capacitance			650pF max.
Leakage Current			10µA
Insulation Grade			reinforced
Internal Clearance	I/P to O/P I/P to PE O/P to PE		6mm 4mm 3mm

Notes:

Note2: For repeat Hi-Pot testing, reduce the time and/or the test voltage

POWER GOOD		
Parameter	**Condition**	**Value**
Power OK LED	V_{OUT}= >17VDC V_{OUT}= <17VDC	green light off
Relay Status	V_{OUT}= >17VDC V_{OUT}= <17VDC	OK pin1 open NOK pin1 closed
Relay Capability		0.5A/150VDC

Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

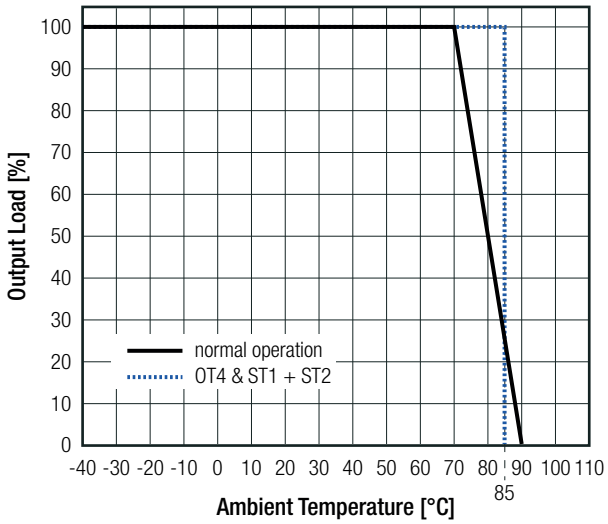
ENVIRONMENTAL

Parameter	Condition		Value
Operating Temperature Range		with derating	-40°C to +90°C
	according to EN50155 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	refer to ***"tc point"***		+95°C
Temperature Coefficient			0.2%/K
Operating Altitude	according to EN50124-1:2018		2000m (OVP III) 5000m (OVP II)
Operating Humidity			95% RH
Conformal Coating [3]	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 10³ hours
		T_{AMB}= +55°C	1100 x 10³ hours
Useful Life Class	according to EN50155:2018 (S1)		L4

Notes:

Note3: 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	Condition	Value
Low Temperature start-up test	Temperature: -40°C Stabilization time 2h	EN 60068-2-1 (Ad)
Dry heat test	Temperature: +70°C Continuos 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)

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Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

ENVIRONMENTAL (RAILWAY STANDARDS)		
Parameter	**Condition**	**Value**
Simulated long-life testing	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	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	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

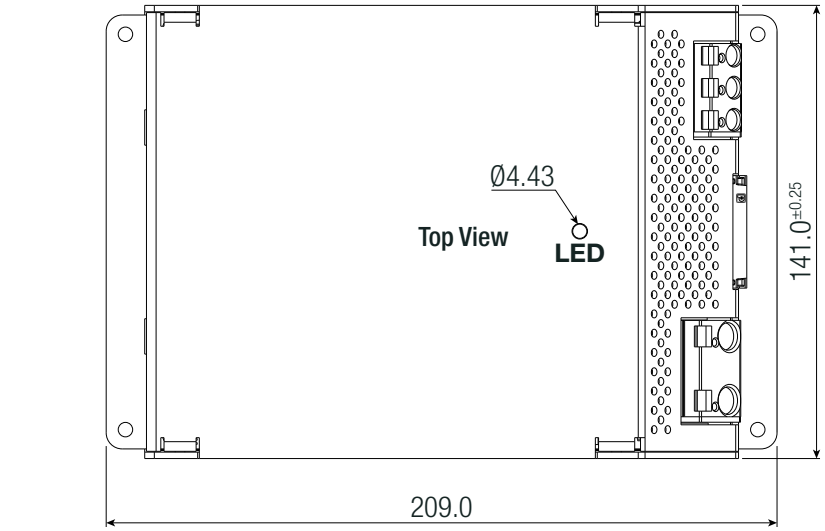
SAFETY AND CERTIFICATIONS (DESIGNED TO MEET)		
Certificate Type (Safety)	**Report Number**	**Standard**
Audio/video, information and communication technology equipment. Safety requirements	pending	IEC/EN62368-1
Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment	pending	EN50124-1
Railway Applications - Electrical Equipment used on rolling stock	pending	EN50155
RoHS2		RoHS 2011/65/EU

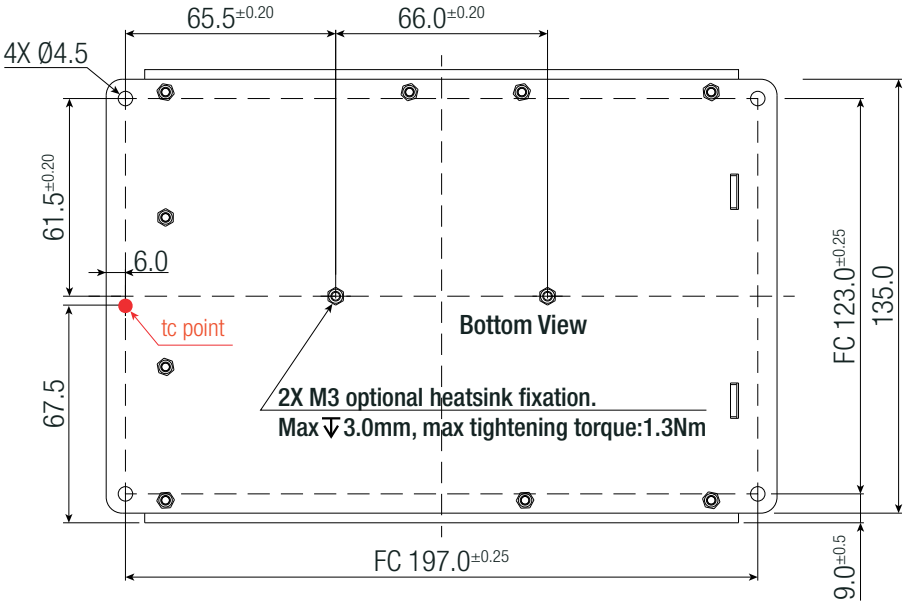
EMC Compliance	Condition	Standard / Criterion
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement		EN50121-3-2
Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement		EN55011
ESD 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 lin unsym.	IEC/EN61000-4-5:2014, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	10Vr.m.s. (0.15-80MHz)	IEC61000-4-6: 2016, Criteria A EN61000-4-6:2016, Criteria A
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

Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

DIMENSION AND PHYSICAL CHARACTERISTICS		
Parameter	**Type**	**Value**
Material	case	aluminum
Dimension (LxWxH)		209.0 x 141.0 x 48.0mm
Weight		1.1kg typ.

Dimension Drawing (mm)





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°

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

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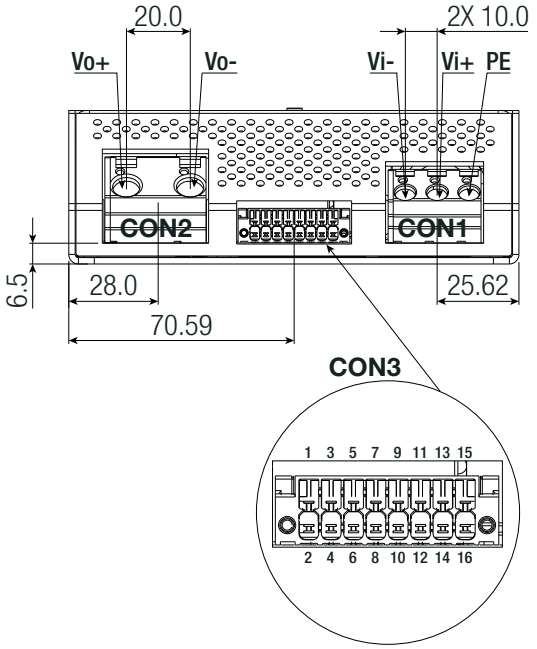
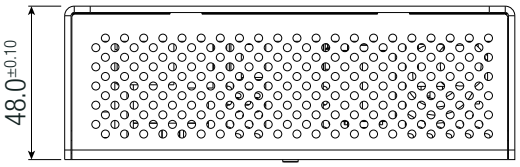
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

Dimension Drawing (mm)



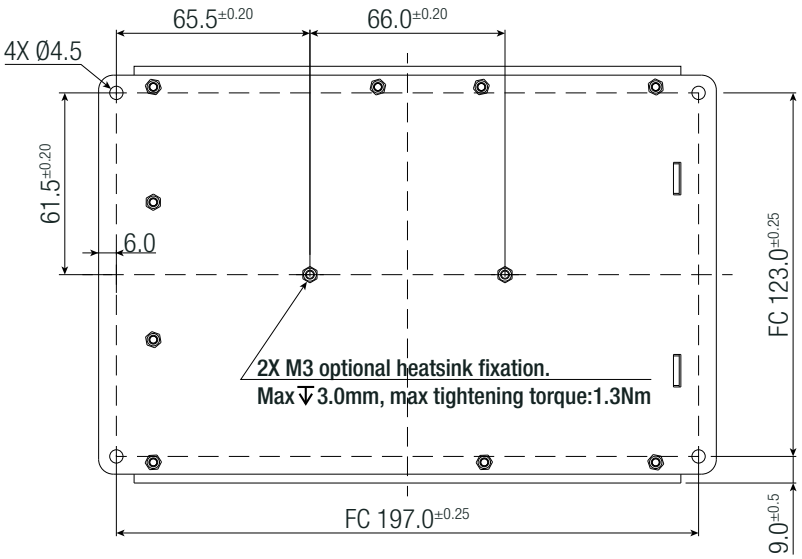


Signal CON3 (Phoenix DMC 1,5/ 8-G1F-3,5-LR)			
#	Function	#	Function
16	INHO	15	INH
14	NC	13	NC
12	OK	11	OK2
10	OK	9	OK1
8	NC	7	NC
6	CS1	5	CS2
4	R	3	R-
2	R	1	R+

Signal CON3 Compatible Connector
Phoenix DFMC 1,5/ 8-STF-3,5 – 1790357

MOUNTING INSTRUCTION

Mounting Dimensions



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

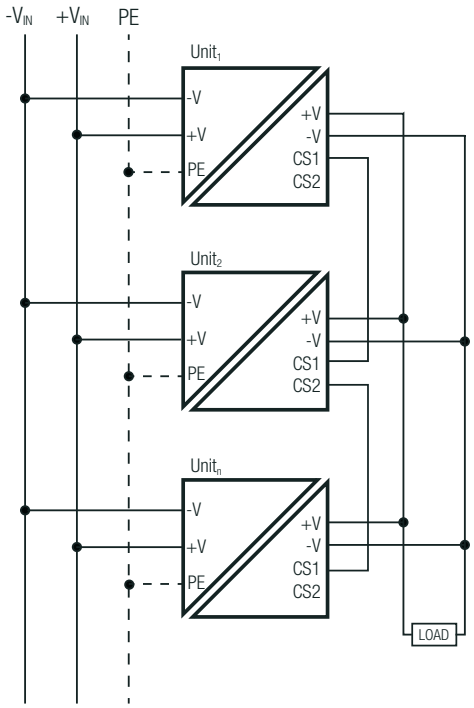
Natural air convection around the unit must be possible at any time and the temperature at the indicated reference point shall not be exceeded.

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.

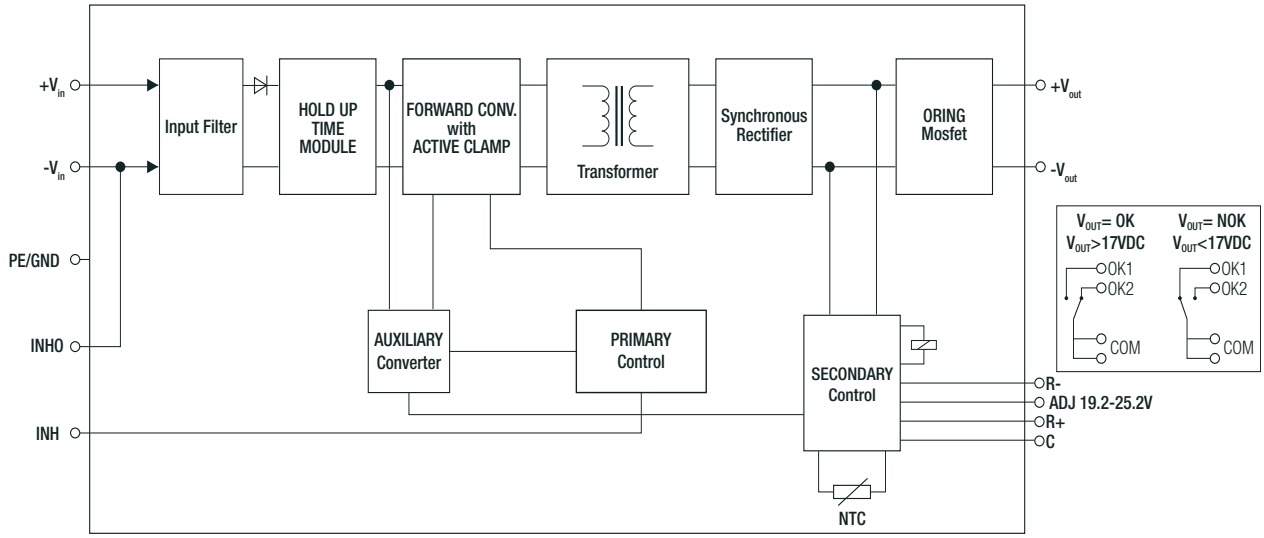
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

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 240.0mm
Packaging Quantity		1pc
Storage Temperature Range		-40°C to +95°C