

FEATURES

- High voltage DC/DC converter for E-Mobility
- Covering input voltage range 180-950VDC
- IP67 protection acc. to ISO 20653
- EN62477-1, ISO 6469-3, ECE-R10/100
- CAN J1939 interface
- High power density
- Excellent efficiency
- Liquid cooled
- 2 year warranty



Dimensions (LxWxH): 316.0 x 254.0 x 83.0mm (12.44 x 10 x 3.27 inch)
6500g (14.33 lbs)

APPLICATIONS



SAFETY & EMC



DESCRIPTION

The RMOD high voltage families are On-Board DC/DC converter to generate the low voltage network (12/24V) from the vehicle's high voltage traction battery. The units are extremely robust plug & play modules and operates reliably even under the most adverse conditions. The ultra-wide input voltage range from 180V to 950VDC covers all battery voltages from nominal 250V up to 800V, which are commonly used in On- and Off-highway vehicles. Thanks to the excellent efficiency the unit is extremely compact and easy to implement via CAN-Interface to the vehicles Control-Network. The housing construction is waterproof and dust proof and the devices runs with base plate cooling or with water cooling. This solution is ideal for HV-battery powered electric vehicles "On- and Off-Highway E-Mobility Applications" such as Material Handling, Forklift trucks, Golf cars, AGVs, Loaders, Construction vehicles, Airport equipment, People mover, Special vehicles, Transporters, Tractors, etc.

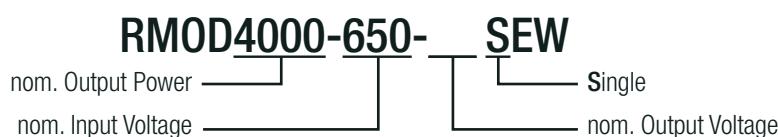
SELECTION GUIDE

Part Number	Input Voltage Range [VDC]	Output Voltage nom. [VDC]	Output Current max. ⁽¹⁾ [A]	Efficiency typ. ⁽²⁾ [%]	Output Power max. ⁽¹⁾ [W]
RMOD4000-650-14SEW *coming soon	180-950	14	180	91	2500
RMOD4000-650-28SEW	180-950	28	150	94	4200

Note1: refer to „Input Voltage Range“ Maximum P_{OUT} at $V_{IN}= 400-850$ VDC (28Vout); $V_{IN}= 250-950$ VDC (14Vout)

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

MODEL NUMBERING



RMOD4000-EW Series ◊ Plug & Play Mobility

4000W ◊ Extra-Wide Input: 180-950VDC

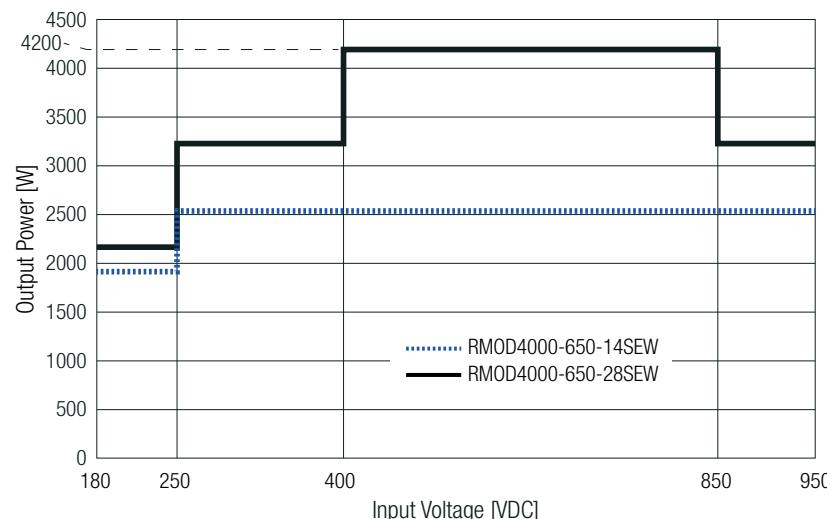
BASIC CHARACTERISTICS (measured @ $T_{AMB} = 25^\circ C$, nom. V_{IN} , full load and after warm-up unless otherwise stated)

Parameter	Conditions			Min.	Typ.	Max.		
Input Voltage Range	nom. $V_{IN} = 300/450/650/800$ VDC			180VDC ⁽³⁾		950VDC		
Input Capacitance	internal				7 μ F			
Under Voltage Lockout				180VDC				
Input Current	$V_{IN} = 180$ VDC				12A			
	$V_{IN} = 650$ VDC				6.5A			
	$V_{IN} = 950$ VDC				3.3A			
Inrush Current	active inrush current limitation					26.5A		
No Load Power Consumption	$V_{IN} = 250$ VDC				28.5W			
	$V_{IN} = 900$ VDC				23.4W			
Standby Power (shutdown by remote)						25W		
Output Current Range refer to below „Input Voltage Range“	unit is equipped with an automatic/active current limitation depending on the input voltage	RMOD4000-650-28SEW	$V_{IN} = 180-250$ VDC			75A		
			$V_{IN} = 251-300$ VDC			110A		
			$V_{IN} = 301-850$ VDC			150A		
		RMOD4000-650-14SEW	$V_{IN} = >850$ VDC			110A		
			$V_{IN} = 180-250$ VDC			140A		
			$V_{IN} = 251-950$ VDC			180A		
Output Voltage Range	RMOD4000-650-14SEW			12VDC		14VDC		
	RMOD4000-650-28SEW			24VDC		28VDC		
Minimum Load				0%				
Start-up time	input voltage is applied, by using the CAN command	$V_{IN} = 200$ VDC				4.6s		
		$V_{IN} = 950$ VDC				3.5s		
ON/OFF CTRL	enable/disable Hardware contact	DC-DC ON (input voltage applied)		KL15 >9VDC, unit can be turned ON by CAN command or if it's running Unit ON				
		DC-DC OFF (input voltage applied)		KL15 <4.5VDC, unit cannot be turned ON by CAN command, or if it's running unit turns OFF				
Internal Operating Frequency	first stage				65kHz			
	second stage				75kHz			
Output Ripple and Noise	over full input and load range, 20MHz BW					5%p-p		

Note3: Start-up voltage= 200VDC; after run-up, operation until 180VDC

Input Voltage Range

(Line Derating)

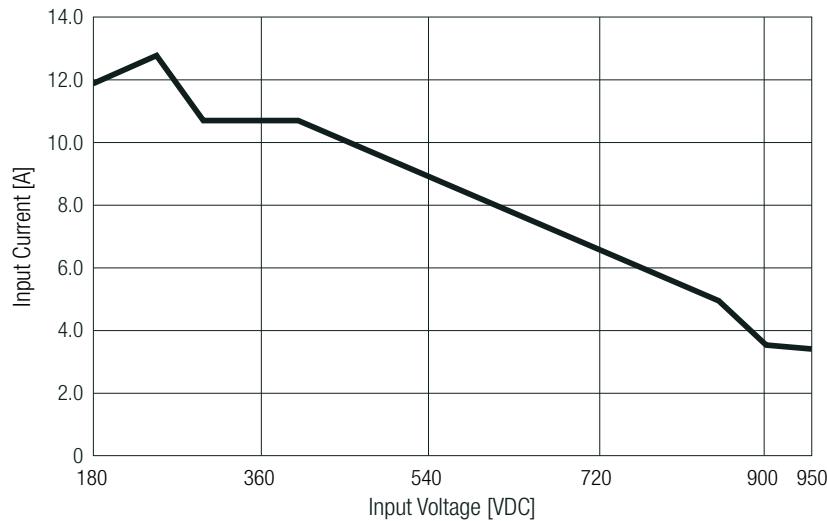


RMOD4000-EW Series ◊ Plug & Play Mobility

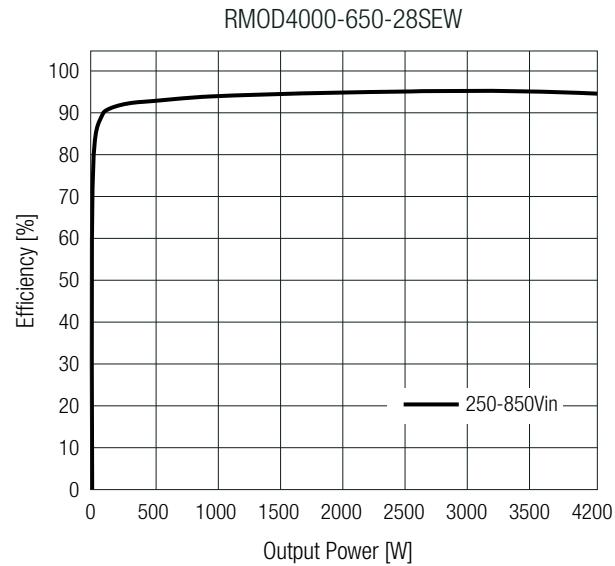
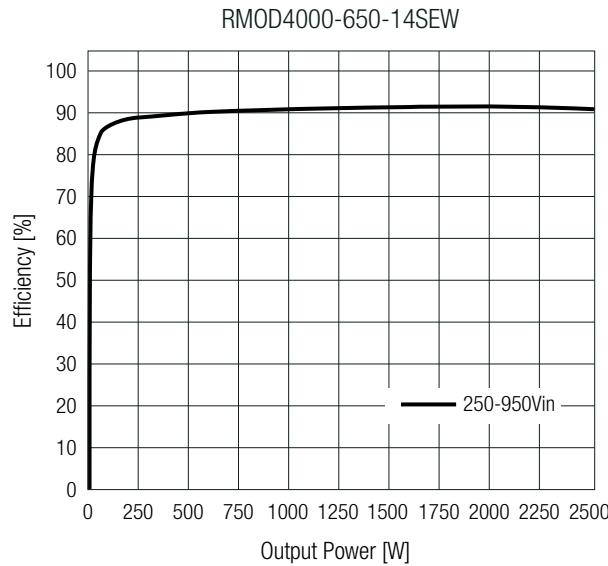
4000W ◊ Extra-Wide Input: 180-950VDC

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

Input Current Consumption (RMOD4000-650-28SEW)



Efficiency vs Load



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

Parameter	Conditions		Value
Output Accuracy	manufacturing set-up tolerance		±2.0% typ.
Line and Load Regulation	low line to high line, 10-100% load		±3.0% max.
Transient Response	10-90% load	RMOD4000-650-28SEW	840mV
		RMOD4000-650-14SEW	420mV
	recovery time		50ms typ.

RMOD4000-EW Series ◊ Plug & Play Mobility

4000W ◊ Extra-Wide Input: 180-950VDC

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

Parameter	Type	Value	
Internal Input Fuse		none ⁽⁴⁾	
Input Discharge Duration	$\leq 60VDC$	5s max.	
Short Circuit Protection (SCP)	constant current mode, auto recovery	35% of nom. V_{OUT}	
	hiccup mode, auto recovery	$\leq 35\%$ of nom V_{OUT}	
Input Reverse Polarity Protection	mechanical protection	by connector	
Over Voltage Protection (OVP)	RMOD4000-650-28SEW	29.4V - 32.2VDC, latch off	
	RMOD4000-650-14SEW	14.7V - 16.1VDC, latch off	
Over Voltage Category (OVC)		OVC I	
Over Current Protection (OCP)	constant current mode, auto recovery	35% of nom. V_{OUT}	
	hiccup mode, auto recovery	$< 35\%$ of nom V_{OUT}	
Over Temperature Protection (OTP)	internal threshold by NTC, auto restart after cool down	$T_J = > 80^{\circ}C$	
Isolation Coordination	according to EN 60664-1	$V_{NOM} = 800VDC$	
Isolation Voltage ⁽⁵⁾	5 seconds	I/P to O/P + CAN	2100VAC / 3050VDC
		I/P to Case	1050VAC / 1520VDC
		O/P + CAN to Case	80VAC / 110VDC
		O/P to CAN	160VAC / 220VDC
Isolation Resistance	I/P to Case; O/P to Case; 24Aux to Case	$1G\Omega$	
Isolation Capacitance		I/P to Case	25nF max.
		O/P to Case	40nF max.
		24Aux to Case	300pF max.
Insulation Grade		I/P to O/P; I/P to 24Aux; O/P to 24Aux	reinforced
		I/P to Case ⁽⁶⁾	basic
		O/P to Case; 24Aux to Case	basic
Internal Clearance		I/P to O/P; I/P to 24Aux	7mm
		I/P to Case	4mm
		O/P to Case; O/P to 24Aux; 24Aux to Case	2mm
HVIL function		High voltage interlock, safety feature for low-voltage loop	

Note4: No integrated fuse. A fuse with $V_{IN} \geq 1000VDC$, $I_{IN} \geq 15A$, Fast, min. $I^2t = 40A^2s$ must be provided externally by the customer application

Note5: For repeat Hi-Pot testing, reduce the time and/or the test voltage

Note6: Use an external ground fault protection circuit to the input of the device (CON5), which will monitor voltage on chassis.

The supplementary protection needs to be operated immediately after fault of basic insulation.

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

Parameter	Conditions	Value
Operating Ambient Temperature Range	inlet temperature: $50^{\circ}C$, full load	$-40^{\circ}C$ to $+85^{\circ}C$
Maximum Inlet Coolant Temperature	$P_{OUT} = \leq 2kW$	$+60^{\circ}C$ max.
	$P_{OUT} = \geq 2kW$	$+50^{\circ}C$ max.
Coolant Medium/Mixture		Min 50% water to max 50% antifreeze
Minimum Coolant Flow		6ltr/min
Maximum Coolant Pressure		1.8bar
Maximum Pressure Drop		0.22bar
Operating Altitude		2000m
Operating Humidity	non-condensing	95% RH max.
Pollution Degree	for inside isolation coordination	PD1
	entire device in IP67 and provided mating connectors ⁽⁷⁾	PD4
IP Rating ⁽⁷⁾	according to ISO 20653	IP67
MTBF	according to MIL-HDBK-217, G.M.	75×10^3 hours
	according to MIL-HDBK-217, G.F.	160×10^2 hours

Note7: Follow the manufacturer's instructions regarding the mating connectors to ensure the IP67 protection of the entire system

RMOD4000-EW Series ◊ Plug & Play Mobility

4000W ◊ Extra-Wide Input: 180-950VDC

ENVIRONMENTAL

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)
Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Mechanical loads ISO 16750-3	sinusoidal (Excitation) 10-150Hz (frequency), 0.075mm 10-58Hz; 58-150Hz (frequency), 1G (acceleration) 10 sweeps X, Y, Z (Axis)	IEC 60068-2-6, Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal)
	Half sinusoidal (Excitation) 100m/s ² (Peak acceleration) 16ms (Duration) 6 shocks to each axis (Quantity) ±X, ±Y, ±Z (Axis)	IEC 60068-2-27, Environmental testing — Part 2: Tests — Test Eb and guidance: Bump
	Random (Excitation) 10 (m/s ²) ² /Hz (ASD), 10-50Hz (frequency) 10 to 0.1 (m/s ²) ² /Hz (ASD), 50-1000Hz (frequency) 33 m/s ² (RMS value acceleration), 8h per axis (Duration), 1 Oct/min X, Y, Z (Axis)	IEC 60068-2-64, Environmental testing — Part 2: Test methods — Test Fh: Vibration, broad-band random

SAFETY & CERTIFICATIONS

Certificate Type (Safety)	Report Number	Standard
Safety requirements for power electronic converter systems and equipment - Part 1: General	T251-0261_24	IEC62477-1:2012+A1:2016 1st Edition
Electrically propelled road vehicles - Safety specifications - Part 3: Electrical safety		ISO 6469-3
RoHS2		RoHS 2011/65/EU + AM2015/863

EMC Compliance	Conditions	Standard / Criterion
Regulation No 10 of the Economic Commission for Europe of the United Nations (UN/ECE) - Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility	Clauses 6.5, 6.6, 6.7, 6.8 and 6.9 (except RMOD4000-650-14SEW)	E/ECE Regulation No.10 Revision 6 with Amendment 1
Approval of vehicles with regard to electromagnetic compatibility	ESA broadband limits applicable parts of the standard 30-75 MHz; 62-52 dB μ V/m 75-400 MHz; 52-63 dB μ V/m 0.4-1 GHz; 63 dB μ V/m	ECE-R10, Rev.4, Part 6.5
	ESA narrow-band limits 30-75 MHz; 52-42 dB μ V/m 75-400 MHz; 42-53 dB μ V/m 0.4-1 GHz; 53 dB μ V/m	ECE-R10, Rev.4, Part 6
	Conducted Emissions Tab. / tab 2	ECE-R10, Rev.4, Part 6.9
	Störfestigkeit / Immunity HF-Stromeinspeisung / Bulk Current Injection applicable parts of the standard 0.02 - 2 GHz ; 60 mA	ECE-R10, Rev.4, Part 6.7
	Immunity of ESA to electromagnetic radiation: 0.04-2 GHz, 30V/m	ECE-R10, Rev.4, Part 6.7
Road vehicles - Electrical disturbances from conduction and coupling	Transients test pulse 1, test pulse 2a, test pulse 2b, test pulse 3a/b	ECE R10 ISO 7637-3
Radiated emission (broad and narrow-band) for ESA		CISPR 25:2002
Voltage transient emission test	Severity Level III	ISO 7637-2:2004
Immunity of ESA to electromagnetic radiation	Criteria A	ISO 11452-2:2004
Immunity of ESA to transient disturbances conducted along supply lines		ISO 7637-2:2004
Immunity to bulk current injection (BCI)	Criteria A	ISO 11452-2:2011

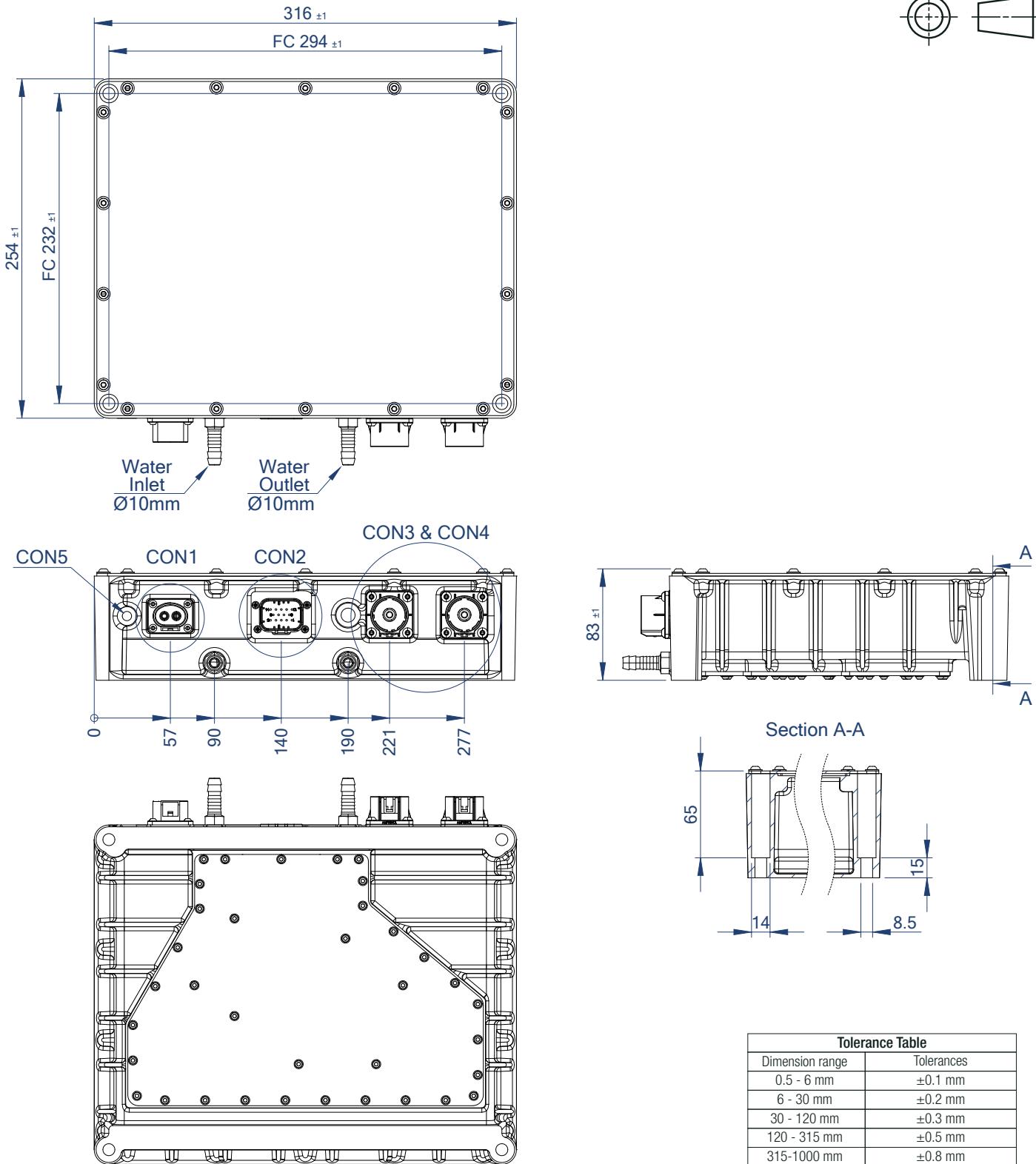
RMOD4000-EW Series ◊ Plug & Play Mobility

4000W ◊ Extra-Wide Input: 180-950VDC

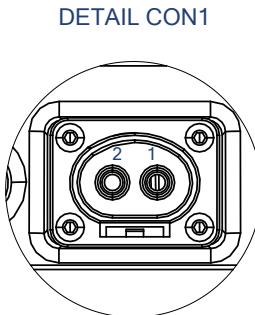
DIMENSION & PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Material	case	aluminum
Dimension (LxWxH)	without connectors	316.0 x 254.0 x 83.0mm 12.44 x 10 x 3.27 inch
Weight		6500g typ. 14.33 lbs

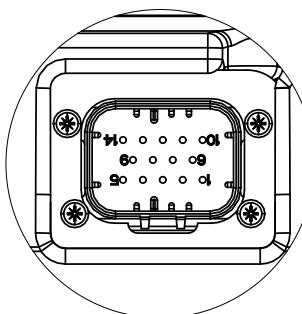
Dimension Drawing (mm)



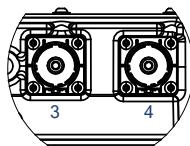
Tolerance Table	
Dimension range	Tolerances
0.5 - 6 mm	±0.1 mm
6 - 30 mm	±0.2 mm
30 - 120 mm	±0.3 mm
120 - 315 mm	±0.5 mm
315-1000 mm	±0.8 mm

DIMENSION & PHYSICAL CHARACTERISTICS
Connector Information


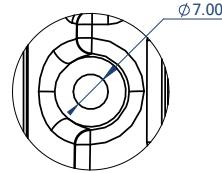
DETAIL CON2



DETAIL CON3 & CON4



DETAIL CON5


Input connector CON1

(Amphenol PL082X-61-4)

#	Function	Wire diameter
1	-Vin	12-11 AWG / 3-4mm ²
2	+Vin	12-11 AWG / 3-4mm ²

 Compatible Connector "(7)":
 Amphenol PL182X-61-4

Cable requirements: 1000V/16A min.

MC connector CON5

(M8 thread)

#	Function
5	chassis ground

Output connector CON3 & CON4

(2x Amphenol PL00Y-300-20M8)

#	Function	Wire diameter
3	-Vout	2-1 AWG / 30-50mm ²
4	+Vout	2-1 AWG / 30-50mm ²

 Compatible Connector "(7)":
 CON3= Amphenol PL18Y-300-50
 CON4= Amphenol PL18W-300-50

Cable requirements: 60VDC/150A min.

Signal CON2
Compatible Connector

 TE Connectivity 776273-1 Housing
 14 contacts 770854-3

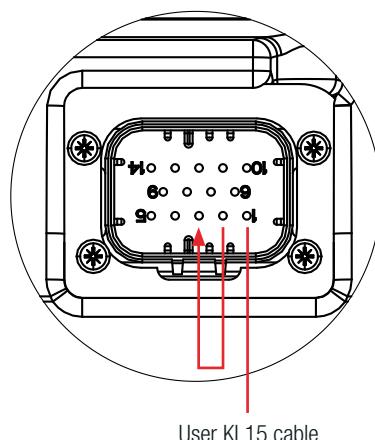
Signal CON2

(TE connectivity 1-776267-1)

#	Function
1	Interlock (HVIL)
2	Interlock (HVIL)
3	K15 (Ignition switch position)
4	K30 (Vaux positive)
5	K31 (Vaux negative)
6	I/O signal (Optionals)
7	I/O signal (Optionals)
8	I/O signal (Optionals)
9	I/O signal (Optionals)
10	Shield
11	CANH
12	CANL
13	CANH
14	120 Ω resistor (with short circuit between pin 13-14)

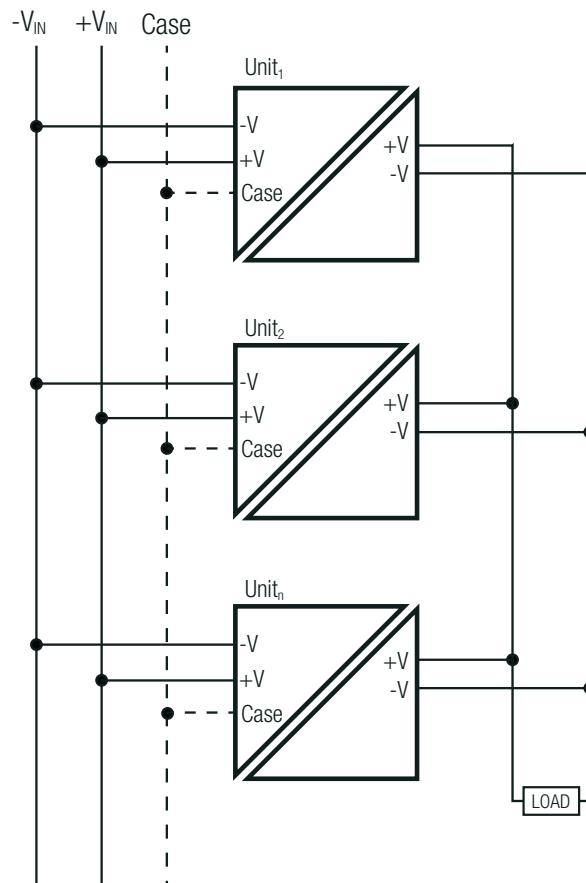
Wire Diameter: 20-16 AWG / 0.75-1mm²
 Cable requirements: shielded, 40VDC min.

In some applications the presence and correct fixing of input connector must be ensured before start up the unit. To realize this function KL15 (Pin 3) can be connected in series with HVIL pins (Pin 1/2). In that way the converter will be in disable status until the input cable connection will be present. The following picture shows the connection described:



INSTALLATION & APPLICATION
Parallel Operation

Here the example of three parallel connected units. The connection of 3 units for power redundant or safety redundant or n+1 redundancy is possible. Parallel operation is possible due to implemented OR-ing Diode. Programmable current sharing via CAN communication.



Refer to **Board address modification procedure**
in the [CAN-Command.pdf](#)

CAN BUS (Interface acc. to ISO 11898-1 J1939)
Termination Resistor Connection

The ISO11898 standard specifies the interconnect to be a single twisted pair cable (shielded or unshielded) with 120Ω characteristic impedance (Z_0). User can realize the termination with a short circuit between pins 13 and 14 of signals/Can Bus connectors.
refer to [CAN-Command.pdf](#)

PACKAGING INFORMATION

Parameter	Type	Value
Packaging Dimension (LxWxH)	cardboard box	400.0 x 380.0 x 150.0mm
Packaging Quantity		1 pc
Storage Temperature Range		-40°C to +85°C
Storage Humidity		85% RH max.

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