Technical Data Sheet

RMOD4000-EW Series ◊ Plug & Play Mobility

4000W ◊ Extra-Wide Input: 180-950VDC

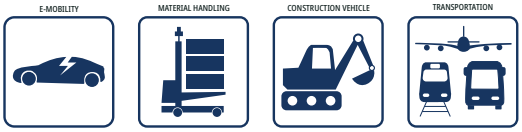
RECOM DC/DC Converter

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
- Integrated Or-ing diode for parallel/redundant operation
- 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

RoHS² compliant 10 from 10 | Reach compliant | CE | E26 10 R - 06 1427

DESCRIPTION

The RMOD high voltage families are On-Board DC/DC converters generating a low voltage network (12/24V) from the vehicle's high voltage traction battery. The units are extremely robust plug & play modules and operate 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 units are extremely compact and easy to implement via CAN-Interface to the vehicle´s 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}= 400-850VDC (28Vout); V_{IN}= 250-950VDC (14Vout)
Note2: Efficiency is tested at nominal input and 50%-100% load and at +25°C ambient

MODEL NUMBERING

RMOD4000-650-__ SEW

- 4000 — nom. Output Power
- 650 — nom. Input Voltage
- __ — nom. Output Voltage
- SEW — **S**ingle

RMOD4000-EW Series ◊ Plug & Play Mobility

4000W ◊ Extra-Wide Input: 180-950VDC

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

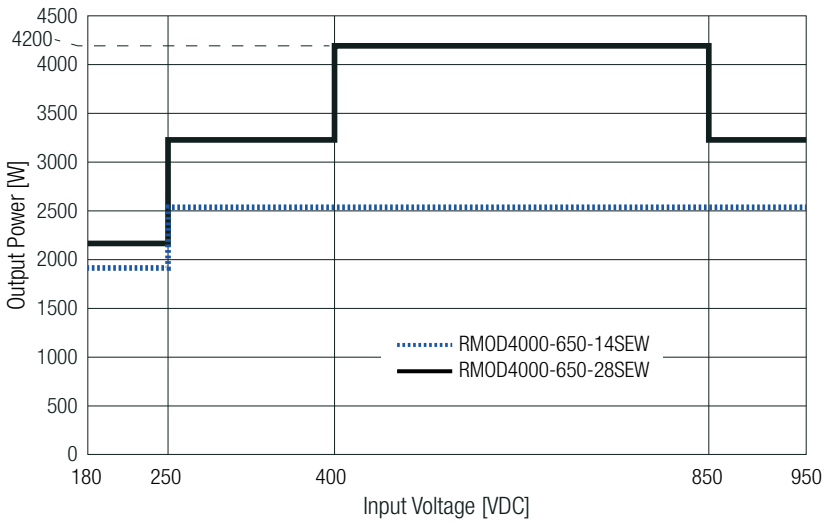
Parameter	Conditions			Min.	Typ.	Max.
Input Voltage Range	nom. V_{IN}= 300/450/650/800VDC			180VDC (3)		950VDC
Input Capacitance	internal				7µF	
Under Voltage Lockout				180VDC		
Input Current	V_{IN}=180VDC				12A	
	V_{IN}= 650VDC				6.5A	
	V_{IN}= 950VDC				3.3A	
Inrush Current	active inrush current limitation					26.5A
No Load Power Consumption	V_{IN}= 250VDC				28.5W	
	V_{IN}= 900VDC				23.4W	
Standby Power (shutdown by remote)						25W
Auxiliary Input (Signal CON2) (4)	KL15, KL30 (plus) KL31 (minus), reverse polarity protected			9VDC	12/24VDC	32VDC
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}= 180-250VDC			75A
			V_{IN}= 251-300VDC			110A
			V_{IN}= 301-850VDC			150A
			V_{IN}= >850VDC			110A
		RMOD4000-650-14SEW	V_{IN}= 180-250VDC			140A
			V_{IN}= 251-950VDC			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}= 200VDC			4.6s
			V_{IN}= 950VDC			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

Note4: Current consumption: 100mA. Aux-Current consumption only applies when no HV is connected. In case HV input is connected, Aux is generated internally. Please refer to **„AUX Current Consumption“**

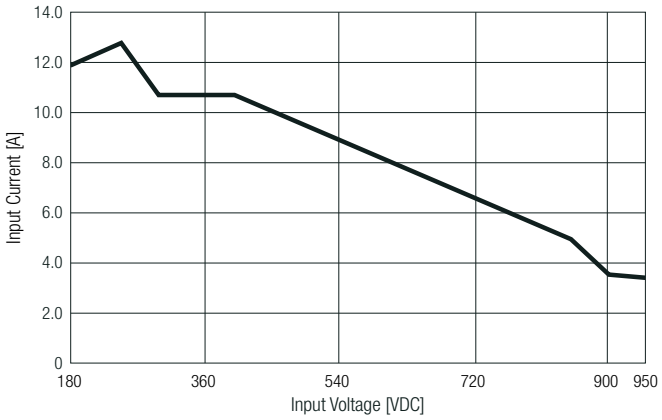
Input Voltage Range

(Line Derating)

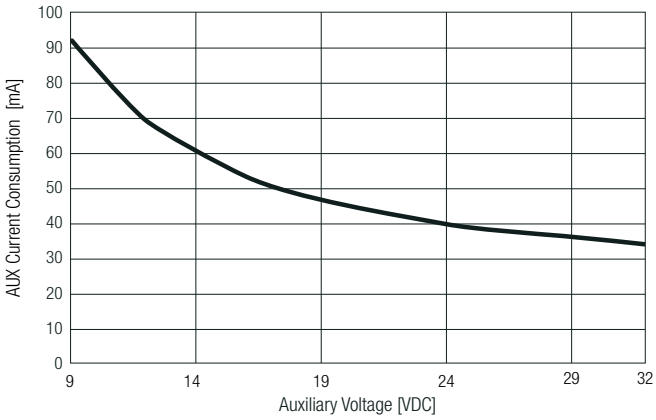


BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Input Current Consumption
(RMOD4000-650-28SEW)

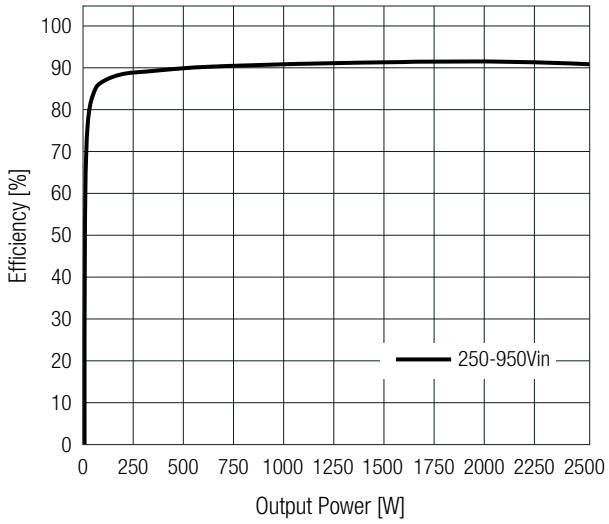


AUX Current Consumption
(without input voltage presence)

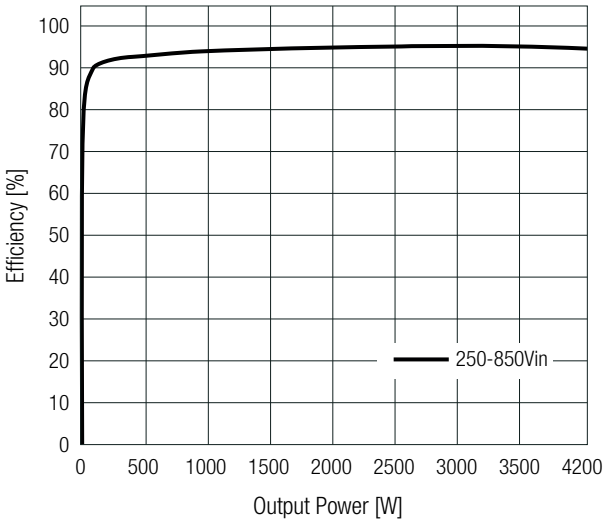


Efficiency vs Load

RMOD4000-650-14SEW



RMOD4000-650-28SEW



REGULATIONS (measured @ T_{AMB}= 25°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.

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

Parameter	Type		Value
Internal Input Fuse			none [5]
Input Discharge Duration	≤60VDC		5s max.
Short Circuit Protection (SCP)	constant current mode, auto recovery		35% of nom. Vout
	hiccup mode, auto recovery		≤35% of nom Vout
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. Vout
	hiccup mode, auto recovery		<35% of nom Vout
Over Temperature Protection (OTP)	internal threshold by NTC, auto restart after cool down		T_J= >80°C
Isolation Coordination	according to EN 60664-1		V_{NOM}= 800VDC
Isolation Voltage [6]	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		1GΩ
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 [7]		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		

Note5: No integrated fuse. A fuse with V_{IN} ≥1000Vdc, I_{IN}≥15A, Fast, min. I^2t= 40A²s must be provided externally by the customer application

Note6: For repeat Hi-Pot testing, reduce the time and/or the test voltage

Note7: 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°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Conditions		Value
Operating Ambient Temperature Range	inlet temperature: 50°C, full load		-40°C to +85°C
Maximum Inlet Coolant Temperature	P_{OUT}= ≤2kW		+60°C max.
	P_{OUT}= ≥2kW		+50°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 max.
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 [8]	according to ISO 20653		IP67
MTBF	according to MIL-HDBK-217, G.M.	T_{AMB}= 25°C	75 x 10³ hours
	according to MIL-HDBK-217, G.F.		160 x 10² hours

Note8: Follow the manufacturer's instructions regarding the mating connectors to ensure the IP67 protection of the entire system

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/s2 (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	T223-0039/24	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 dBµV/m 75-400 MHz; 52-63 dBµV/ m 0.4-1 GHz; 63 dBµV/m	ECE-R10, Rev.4, Part 6.5
	ESA narrow-band limits 30-75 MHz; 52-42 dBµV/ m 75-400 MHz; 42-53 dBµV/ m 0.4-1 GHz; 53 dBµV/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

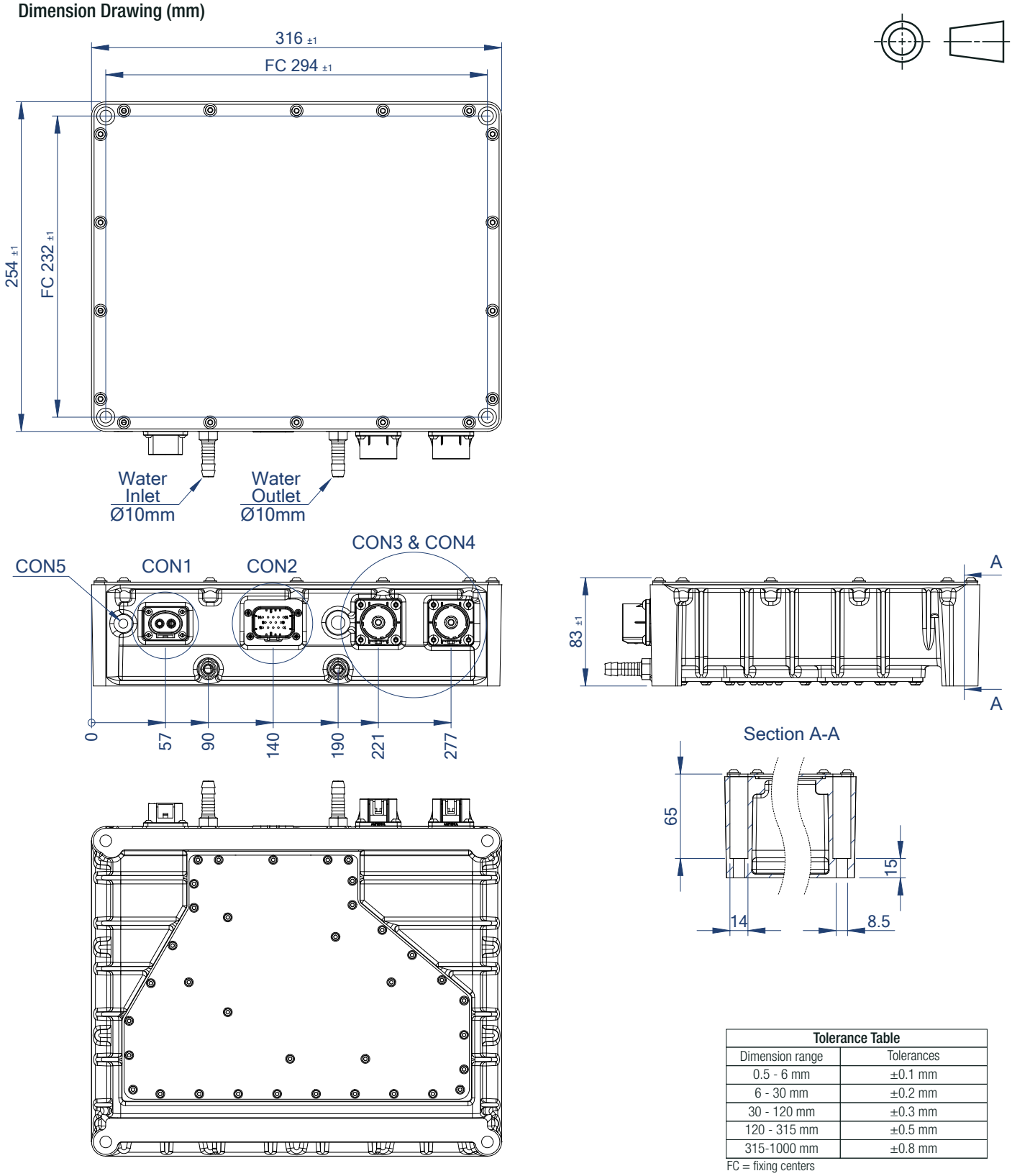
4000W ◊ Extra-Wide Input: 180-950VDC

RECOM DC/DC Converter

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)



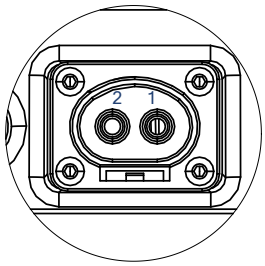
Tolerance Table	
Dimension range	Tolerances
0.5 - 6 mm	±0.1 mm
6 - 30 mm	±0.2 mm
30 - 120 mm	±0.3 mm
120 - 315 mm	±0.5 mm
315-1000 mm	±0.8 mm

FC = fixing centers

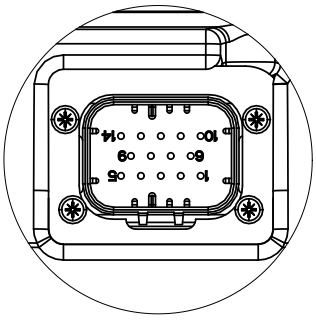
DIMENSION & PHYSICAL CHARACTERISTICS

Connector Information

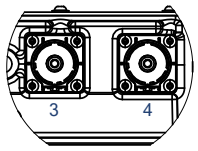
DETAIL CON1



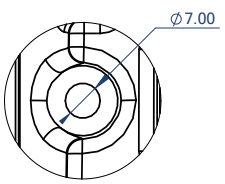
DETAIL CON2



DETAIL CON3 & CON4



DETAIL CON5



Input connector CON1
(Amphenol PL082X-61-4)

#	Function	Wire diameter
1	-Vin	12-11 AWG / 3-4mm²
2	+Vin	12-11 AWG / 3-4mm²

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

Cable requirements: 1000V/16A min.

Output connector CON3 & CON4
(2x Amphenol PL00Y-300-20M8)

#	Function	Wire diameter
3	-Vout	2-1 AWG / 30-50mm²
4	+Vout	2-1 AWG / 30-50mm²

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

Cable requirements: 60VDC/150A min.

Signal CON2
(TE connectivity 1-776267-1)

#	Function
1	Interlock (HVIL)
2	Interlock (HVIL)
3	KL15 (Ignition switch position)
4	KL30 (Vaux positive)
5	KL31 (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.

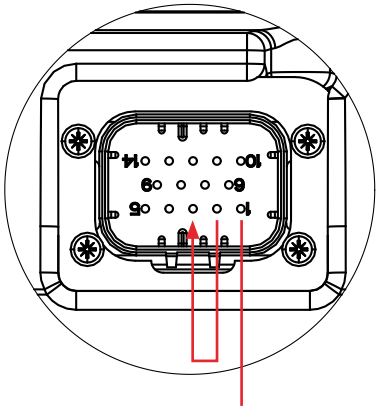
MC connector CON5
(M8 thread)

#	Function
5	chassis ground

Signal CON2
Compatible Connector

TE Connectivity 776273-1 Housing
14 contacts 770854-3

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:

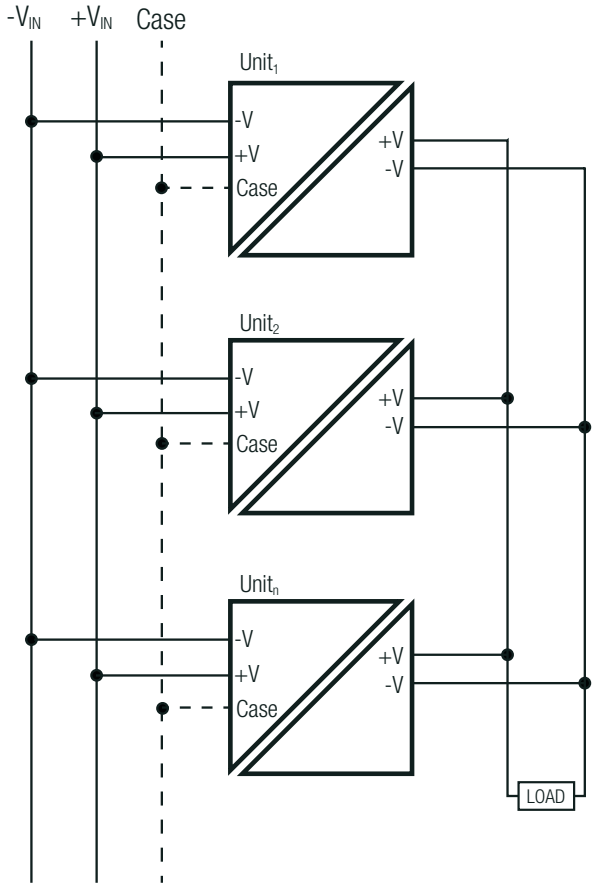


User KL15 cable

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 (ZO). 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.