Technical Data Sheet

RMOD400-W Series / Plug & Play E-Mobility

400W / Wide Input 16.8-43.5VDC / 33.6-96VDC

RECOM DC/DC Converter

FEATURES

- On-Board DC/DC Converter
- E-Mobility and industry vehicles
- Wide input voltage range for 24V/36V or 48V/80V
- Plug & Play, ready to use
- Chassis mount and base plate cooled
- Full power at ambient temperature up to 85°C (13V)
- Water and dust proof (IP69K), robust and reliable
- High and extremely constant efficiency
- Parallel operation without active current sharing
- High power density
- 2 years warranty

Dimensions (LxWxH): 203.0 x 115.0 x 61.0mm (8.0 x 4.53 x 2.4 inch)
1700g (3.75 lbs)

APPLICATIONS

SAFETY & EMC

CE UKCA cULus E196683 RoHS2 compliant 10 from 10 Reach compliant

DESCRIPTION

The RMOD families are extremely robust plug & play modules which are used to generate the low voltage network from a vehicle's traction battery. The wide input voltage range up to 43.5VDC (56V / 5minutes) or 96VDC (120V / 5 minutes) covers all common battery voltages in the off-highway vehicle (OHV) segment. Thanks to the waterproof and dust proof housing construction, the devices can be connected mechanically and thermally directly to the chassis, i.e., at any point on the vehicle, and will therefore operate reliably even under the most adverse conditions. This solution is ideal for electric vehicles with nominal 24V...36V or 48V...80V battery-powered systems in "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. [A]	Efficiency typ. (1) [%]	Output Power max. [W]
RMOD400-28-13SW	16.8-43.5	13	30.8	85	400
RMOD400-60-24SW	33.6-96	24	16.7	85	400

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

MODEL NUMBERING

RMOD400-__-__SW

- 400 — max. Output Power
- __ — nom. Input Voltage
- __ — nom. Output Voltage
- S — Single
- W

RMOD400-W Series / Plug & Play E-Mobility

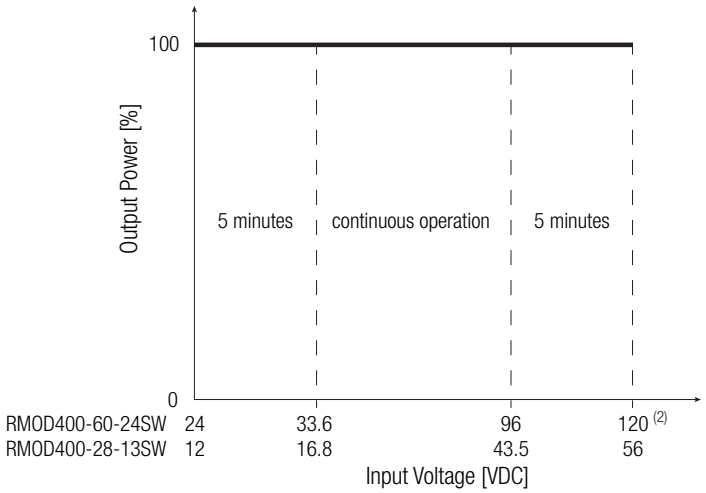
400W / Wide Input 16.8-43.5VDC / 33.6-96VDC

RECOM DC/DC Converter

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}= 24, 36VDC	RMOD400-28-13SW	16.8VDVC		43.5VDC
	nom. V_{IN}= 48, 80VDC	RMOD400-60-24SW	33.6VDVC		96VDC
	Extended range: 5 minutes max. refer to **„Input Voltage Range“**	RMOD400-28-13SW	12VDC		16.8VDC
			43.5VDC		56VDC
		RMOD400-60-24SW	24VDC		33.6VDC
			96VDC		120VDC (2)
Input Current	RMOD400-28-13SW				39A
	RMOD400-60-24SW				22A
Inrush Current					1.5A²s
Quiescent Current	nom. V_{IN}= 80VDC				60mA
Minimum Load			0%		
Start-up Time	RMOD400-28-13SW			300ms	
	RMOD400-60-24SW			150ms	
Rise Time	RMOD400-28-13SW			100ms	
	RMOD400-60-24SW			50ms	
Internal Operating Frequency	MAIN power stage			130kHz	
	auxiliary			300kHz	
Output Ripple and Noise				100mVp-p	500mVp-p

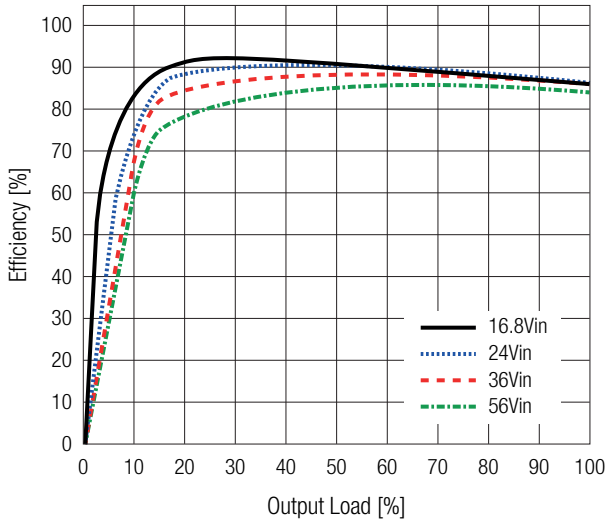
Input Voltage Range (2)



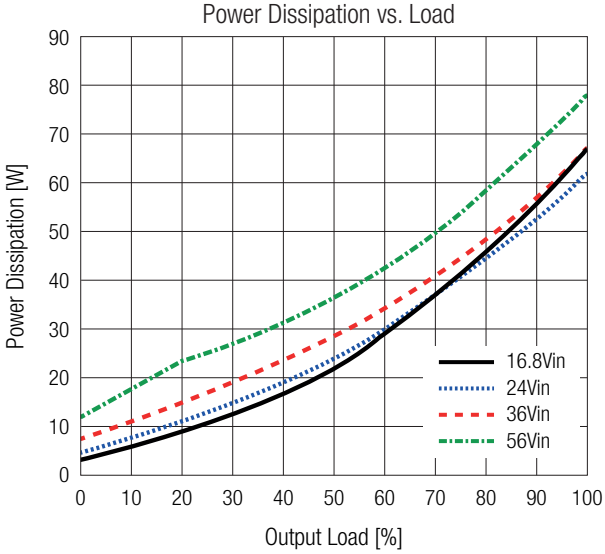
Note2: Recognized by safety agency for safe operation at input voltage up to 108VDC.

RMOD400-28-13SW

Efficiency vs. Load



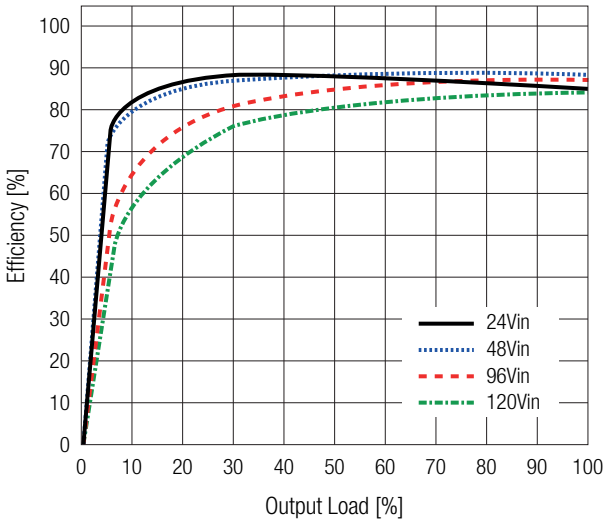
Power Dissipation vs. Load



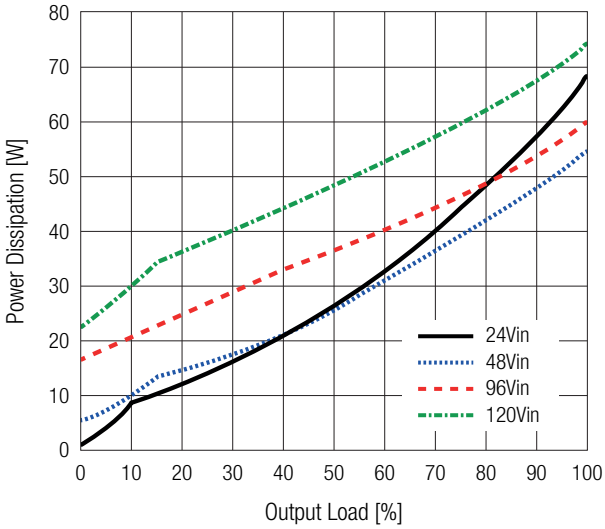
BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

RMOD400-60-24SW

Efficiency vs. Load



Power Dissipation vs. Load

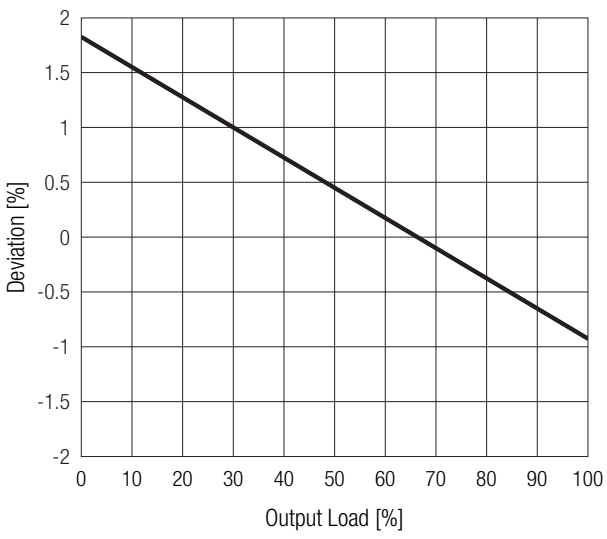


REGULATIONS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Conditions		Value
Output Accuracy			±4.0% max.
Line Regulation	low line to high line, full load	V_{IN}= 16.8-56VDC and 33.6-96VDC	±1.0% max.
		V_{IN}= 12-16.8VDC; 24-33.6VDC; 96-120VDC	±3.0% max.
Load Regulation	10-90% load		4.0% typ.
Transient Response	RMOD400-28-13SW	10-90% load, V_{IN}= 16.8-56VDC	0.65VDC
	RMOD400-60-24SW	10-90% load, V_{IN}= 33.6-96VDC	1.92VDC
	recovery time		100ms typ.

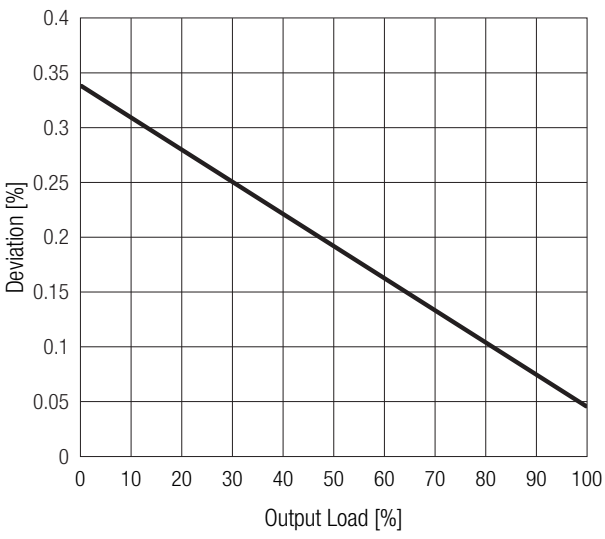
RMOD400-28-13SW

Deviation vs. Load
(nom. V_{IN})



RMOD400-60-24SW

Deviation vs. Load
(nom. V_{IN})



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

Parameter	Type		Value
Short Circuit Protection (SCP)	auto recovery		current limitation
Input Reverse Polaritiy Protection	only for RMOD400-28-13SW		-50VDC max.
Over Current Protection (OCP)	auto recovery	RMOD400-28-13SW	40.5A typ.; current limitation
		RMOD400-60-24SW	21A typ.; current limitation
Over Temperature Protection (OTP)			yes
Isolation Voltage [2]	1 minute	I/P to O/P; I/P to case	2.5kVDC
		O/P to case	1.7kVDC
Isolation Resistance			10MΩ min.
Insulation Grade			basic

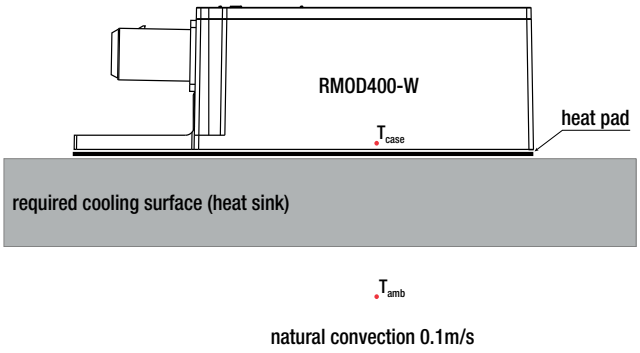
Note2: For repeated Hi-Pot testing, reduce the time and/or the test voltage

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

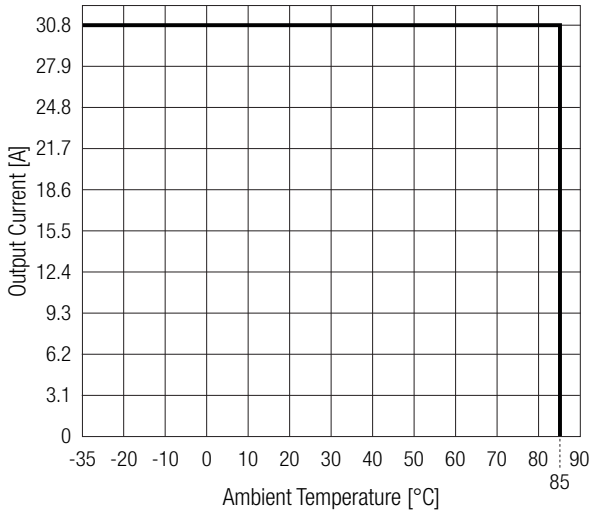
Parameter	Conditions		Value
Operating Ambient Temperature Range	refer to **„Thermal Consideration“**	RMOD400-28-13SW [3]	-35°C to +85°C
		RMOD400-60-24SW	-35°C to +70°C
Operating Altitude			3000m
Pollution Degree			PD3
IP Rating	according to ISO 20653		IP69K
MTBF	according to SR-332; T_{AMB}= +50°C	RMOD400-28-13SW	1000 x 10³ hours
		RMOD400-60-24SW	500 x 10³ hours

Note3: For operation above +70°C ambient, take care about sufficient cooling (never exceed max. allowed base plate temperature = 70°C)

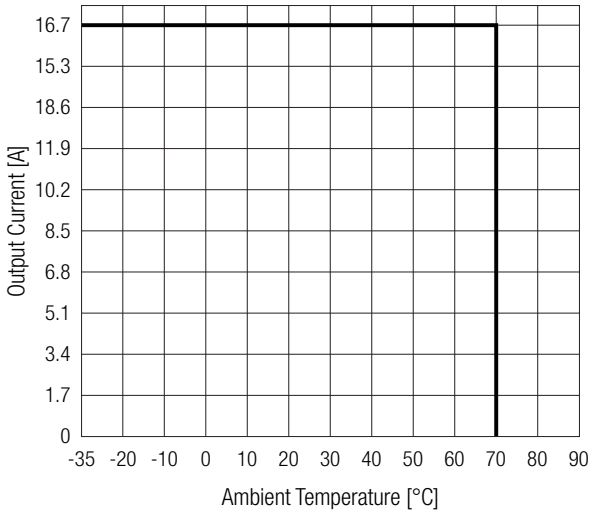
Thermal Consideration



RMOD400-28-13SW



RMOD400-60-24SW



The module can be used in enclosed applications with full load, as long as the cooling is sufficient to keep the baseplate temperature at T_{CASE} below 70°C. The surrounding temperature should not exceed 85°C (70°C).

ENVIRONMENTAL RMOD400-28-13SW

Parameter	Condition	Standard
Temperature Change	duration: 240 hours and 20 cycles minimum; time at -35°C/85°C	EN60068-2-14
Constant Temperature- warm	duration: 96 hours, ambient: 85°C	EN60068-2-2
Temperature Shock	duration: 20 cycles; operation mode: in operation test temperature: 85°C test duration: 1hour fully tempered + 15 minutes transfer duration: < 5 seconds test medium: water 0°C, 5% dissolved salt content time under water: 5 minutes water volumes: at least 5 times the component volume no water ingress	EN60068-2-14
Humidity/Heat Cycle	max. air temperature: 55°C; number of cycles: 6 operation mode: 1 hour in operation, 1 hour without function air humidity: 93%; cycles duration: 24 hours temperature change ≥ 5K/min; minimum air temperature 25°C	EN60068-2-30
Vibrations, Sinusoidal	shock load: 10g; frequency range: 10-500Hz length of time subject to load: 3 axes,, 9 hours (50 cycles) per axis shock form: sinusoidal; operation mode: operational	EN60068-2-6
Continuous Shock	shock load: 10g, duration: 16ms number of impacts: 10.000 shocks	EN60068-2-29
Shock	shock load: 30g, duration: 6ms length of time subject to load: 3 shocks per direction, 6 directions	EN60068-2-27
Salt Spray	at 35°C for 96 hours	EN60068-2-11

ENVIRONMENTAL RMOD400-60-24SW

Parameter	Condition	Standard
Temperature Change	1 cycle: -25°C (30 mins) and 70°C (20 mins); Transition 5°C/min. 100 cycles. Operational	EN60068-2-14
Constant Temperature- warm	duration: 21 days, ambient: 70°C	EN60068-2-2
Temperature Shock	Duration: 20 cycles Operation mode: Non-operating Test temperature: Chamber 1: 75°C; Chamber 2: -30°C Test duration: 1 hour per chamber Transfer duration: <10 s	EN60068-2-14
Humidity/Heat Cycle	Max air temperature: 55°C Number of cycles: 2 Cycles duration: 24 hours	EN60068-2-30
Vibrations, Sinusoidal	Shock load: 5G Frequency range: 10-500Hz Length of time subject to load: 3 axes, 2 hours (10 cycles) per axis Shock form: sinusoidal Operation mode: operational	EN60068-2-6
Continuous Shock	Shock load: 10G Duration: 16 ms Number of impacts: 1000 shocks/axis	EN60068-2-29
Shock	Shock load: 30G Duration: 11 ms 3 shocks per direction, 6 directions	EN60068-2-27
Salt Spray	at 35°C for 96 hours	EN60068-2-11

SAFETY & CERTIFICATIONS

Certificate Type (Safety)	Standard
Audio/Video, information and communication technology equipment - Part1: Safety requirements 2nd Edition	UL62368-1:2014 2nd Edition CAN/CSA-C22.2 No. 62368-1-14 2nd Edition
Audio/Video, information and communication technology equipment - Part1: Safety requirements 2nd Edition	IEC62368-1:2014 2nd Edition EN62368-1:2014+A11:2017
RoHS2	RoHS 2011/65/EU + AM2015/863

SAFETY & CERTIFICATIONS

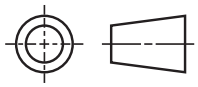
EMC Compliance for RMOD400-28-13SW	Condition	Standard
Industrial trucks - Electromagnetic compatibility		EN12895
Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers		CISPR25 / EN55025
Fast Transient and Burst Immunity		EN61000-4-4
Road vehicles - Test methods for electrical disturbances from electrostatic discharge		ISO 10605
Road vehicles - Component test methods for electrical disturbances from narrow-band radiated electromagnetic energy - Part 2: Absorber-lined shielded enclosure		ISO 11452-2
Road vehicles - Component test methods for electrical disturbances from narrow-band radiated electromagnetic energy - Part 4: Harness excitation methods		ISO 11452-4
Road vehicles - Component test methods for electrical disturbances from narrow-band radiated electromagnetic energy - Part 8: Immunity to magnetic fields		ISO 11452-8

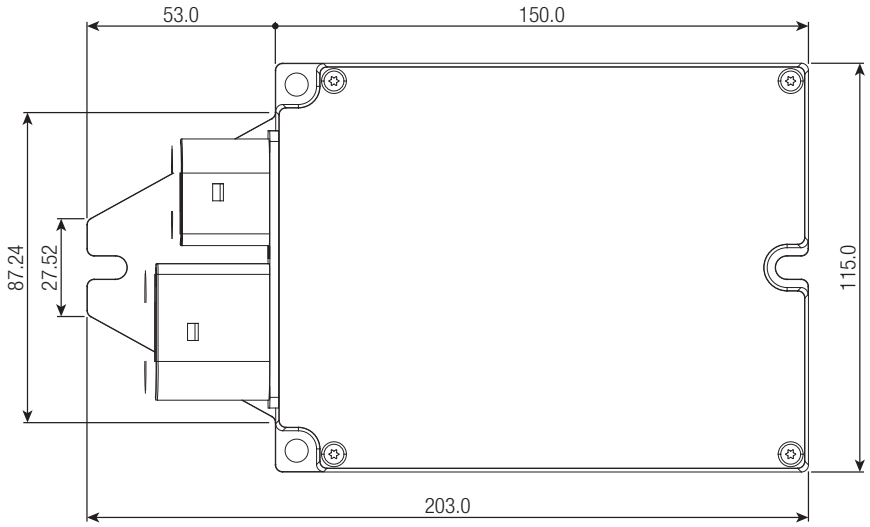
EMC Compliance for RMOD400-60-24SW	Condition	Standard
Industrial trucks - Electromagnetic compatibility		EN12895
Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers		CISPR25 / EN55025
ESD Electrostatic Discharge Immunity Test		EN61000-4-2
Radiated, radio-frequency, electromagnetic field immunity test		EN61000-4-3
Fast Transient and Burst Immunity		EN61000-4-4
Surge Immunity		EN61000-4-5
Immunity to conducted disturbances, induced by radio-frequency fields		EN61000-4-6
Power Magnetic Field Immunity		EN61000-4-8

DIMENSION & PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Material	case	aluminum
Dimension (LxWxH)		203.0 x 115.0 x 61.0mm 8.0 x 4.53 x 2.4 inch
Weight	RMOD400-28-13SW	1700g typ. 3.75 lbs
	RMOD400-60-24SW	1500g typ. 3.3 lbs

Dimension Drawing RMOD400-28-13SW (mm)

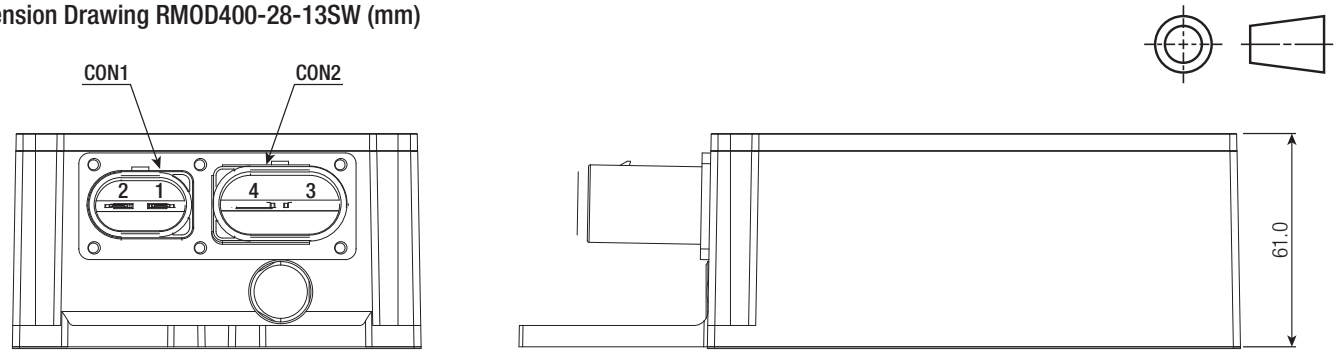


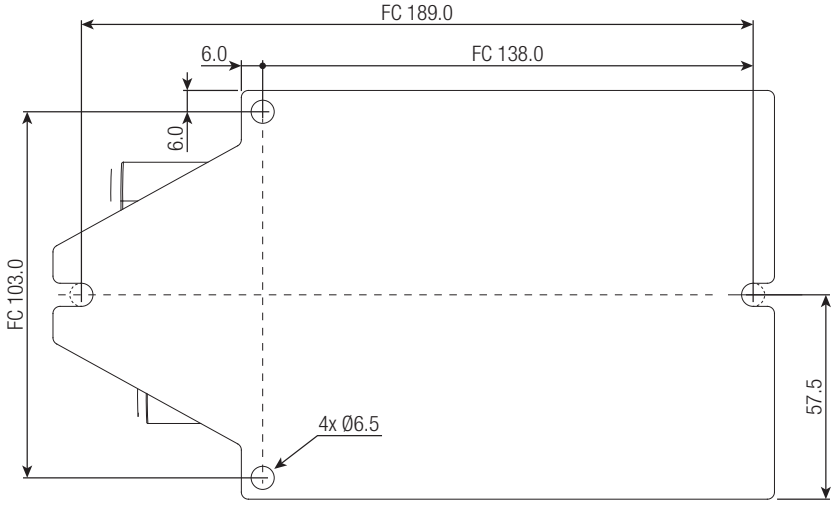


Tolerance: ±0.5mm

DIMENSION & PHYSICAL CHARACTERISTICS

Dimension Drawing RMOD400-28-13SW (mm)





Connector Information

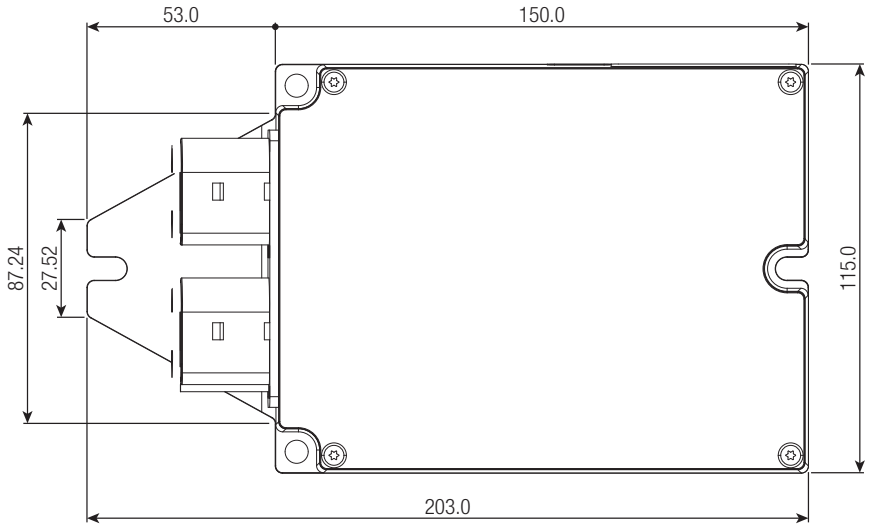
Connector	#	Function
DC Input CON1	1	$+V_{IN}$
	2	$-V_{IN}$
DC Output CON2	3	$-V_{OUT}$
	4	$+V_{OUT}$

FC= fixing centers

Compatible Connector

Connector	Housing
DC Input CON1	FEP 42122900
DC Output CON2	FEP 42161000

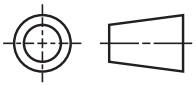
Dimension Drawing RMOD400-60-24SW (mm)

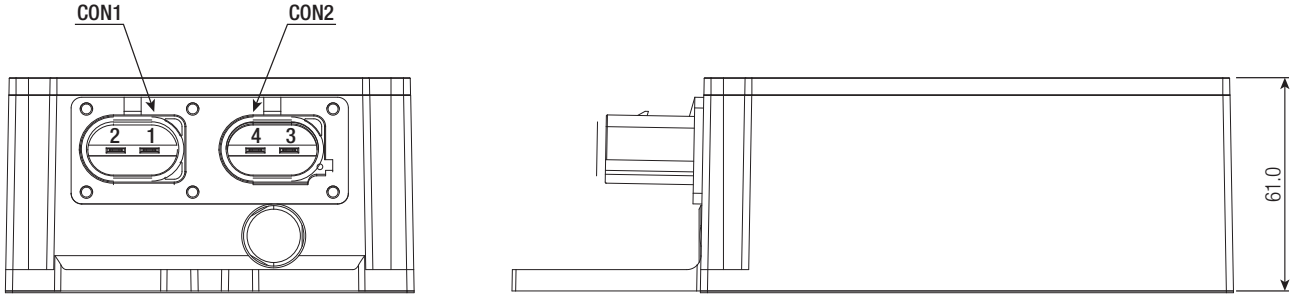


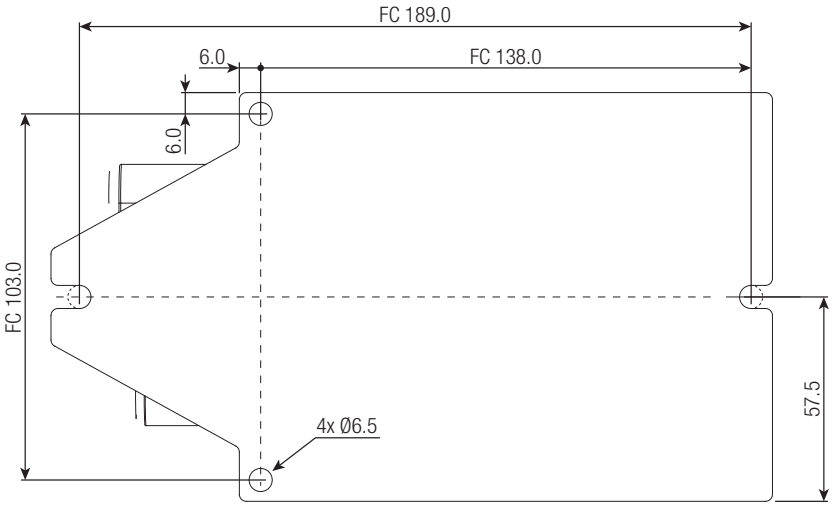
Tolerance: ±0.5mm

DIMENSION & PHYSICAL CHARACTERISTICS

Dimension Drawing RMOD400-60-24SW (mm)







Tolerance: ±0.5mm

Connector Information

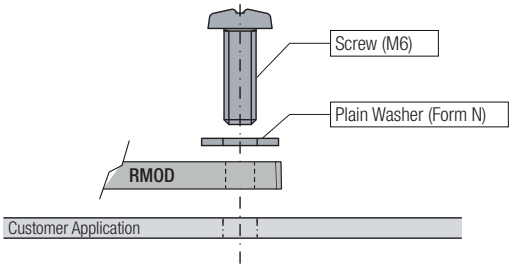
Connector	#	Function
DC Input CON1	1	$+V_{IN}$
	2	$-V_{IN}$
DC Output CON2	3	$-V_{OUT}$
	4	$+V_{OUT}$

FC= fixing centers

Compatible Connector

Connector	Housing
DC Input CON1	FEP 42122900
DC Output CON2	FEP 42123400

Mounting Instructions



Recommended mounting screw/washer:
4x M6 stainless steel screw
Minimum length= 12mm
Head diameter= 10.5mm max.

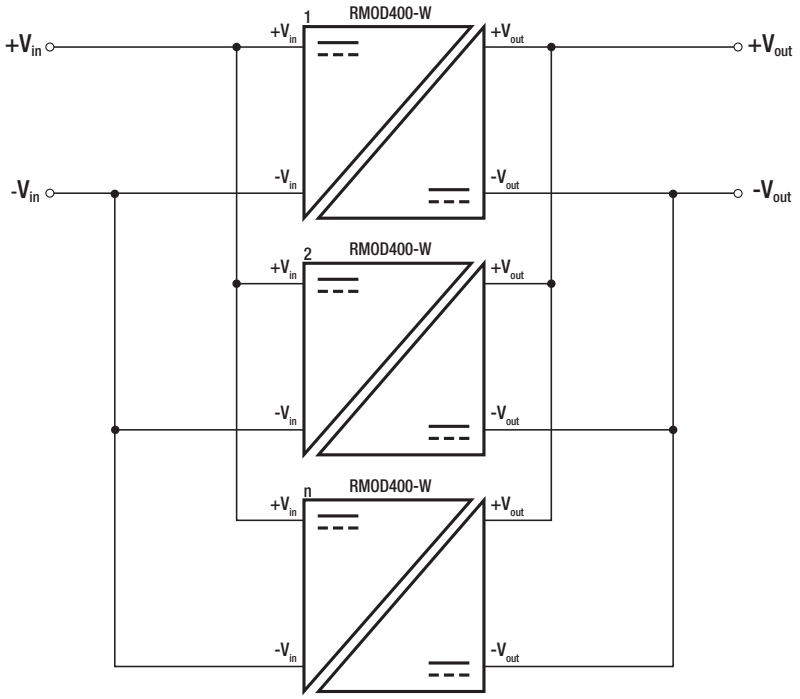
4x plain washer acc. to ISO 10673 form N
(hardness class 200HV)

Recommended tightening torque: 4.6Nm

INSTALLATION & APPLICATION

Parallel Operation

Parallel operation is possible with all combinations of DC/DC converter versions providing they have the same rated output voltage.
There is no active current sharing and therefore the units connected in parallel could be contributing different amounts to the total load current.



PACKAGING INFORMATION

Parameter	Type	Value
Packaging Dimension (LxWxH)	cardboard box	788.0 x 594.0 x 99.0mm
Packaging Quantity		10pcs
Storage Temperature Range		-40°C to +85°C
Storage Humidity		95% max.