# Features

# Regulated Converters

- 10:1 Ultra wide input voltage range
- 3kVAC/1 Minute reinforced insulation
- UL/IEC/EN60950-1certified, CE marked
- EN50155 Compliant
- Efficiency up to 90%
- -40°C To +100°C Baseplate temperature range

RECOM

DC/DC Converter

# RPA100H-RUW

## 100 Watt Half Brick Single Output

3 YEAR Warranty


RoHS 2 compliant 10 from 10

REACH compliant

CE

c UL us
E224736

UL60950-1 certified
IEC/EN60950-1 certified
EN50155 Compliant
CE marked

## Description

The half-brick RPA100H series DC/DC converter is designed for railway rolling stock and high voltage battery applications. It has a 10:1 input voltage range to cover all input voltages from nominal 24VDC up to 110VDC (including EN50155 transients) in a single product and offers isolated and regulated 12V or 24VDC outputs. The converter has a consistently high efficiency over the entire input voltage range and comes with a metal baseplate to permit a wide operating temperature range from -40°C to +97°C (when suitably cooled). The case is fitted with threaded inserts to allow secure mounting to the PCB or bulk-head for use in high shock and vibration environments. The converter is compliant to EN50155 and certified to UL/IEC/EN60950 and comes with a three year warranty.

## Selection Guide

| Part Number | Nom. Input Voltage Range[1] [VDC] | Output Voltage [VDC] | Output Current [A] | Efficiency typ.[2] [%] | Max. Capacitive Load[3] [µF] |
|---|---|---|---|---|---|
| RPA100H-11012SRUW[4] | 16.8-137.5 | 12 | 8.5 | 90 | 2200 |
| RPA100H-11024SRUW[4] | 16.8-137.5 | 24 | 4.2 | 88 | 1000 |

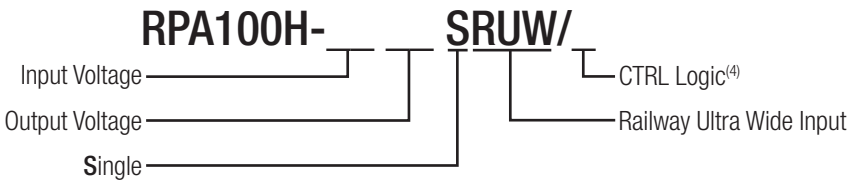
**Notes:**

Note1: Refer to input voltage graph

Note2: Efficiency is tested at nominal input and full load at +25°C ambient

Note3: Max. Cap Load is tested at nominal input and full resistive load

## Model Numbering




**Ordering Examples**

RPA100H-11012SRUW/P = 110V Input, 12V Output, Single, Pos. CTRL function

RPA100H-11012SRUW/N = 110V Input, 12V Output, Single, Neg. CTRL function

**Notes:**

Note4: standard part is with suffix "P" for positive logic (1=ON, 0=OFF) or add suffix "N" instead for negative logic (0=ON, 1=OFF)

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

| BASIC CHARACTERISTICS | | | | |
|---|---|---|---|---|
| **Parameter** | **Condition** | **Min.** | **Typ.** | **Max.** |
| Internal Input Filter | | | | Pi-Type |
| Input Voltage Range | start up Vin = 110VDC | 16.8VDC | 110VDC | 137.5VDC |
| Input Surge Voltage | <100ms | | | 156VDC |
| Under Voltage Lockout (UVLO) | DC-DC ON<br>DC-DC OFF | 15.6VDC<br>13.6VDC | 16.0VDC<br>14.0VDC | 16.4VDC<br>14.4VDC |
| Over Voltage Lockout (OVLO) | DC-DC ON<br>DC-DC OFF | 142VDC<br>154VDC | 146VDC<br>156VDC | 150VDC<br>160VDC |
| Input Current Range | Vin = 16.8V | 7A | 7.2A | 7.5A |

continued on next page

# RPA100H-RUW Series

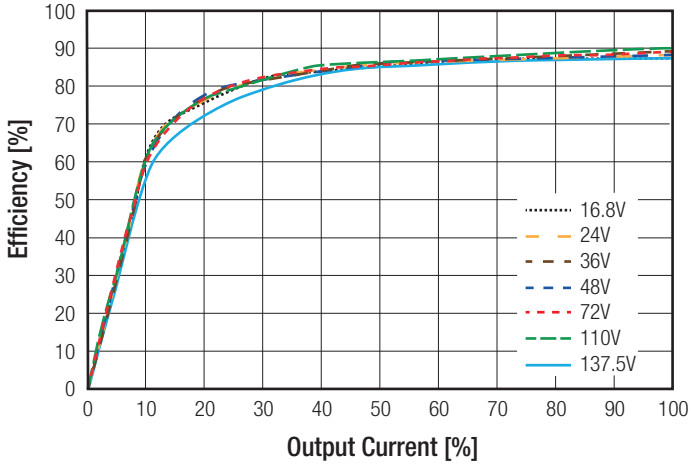
## Specifications (measured @ ta = 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### BASIC CHARACTERISTICS

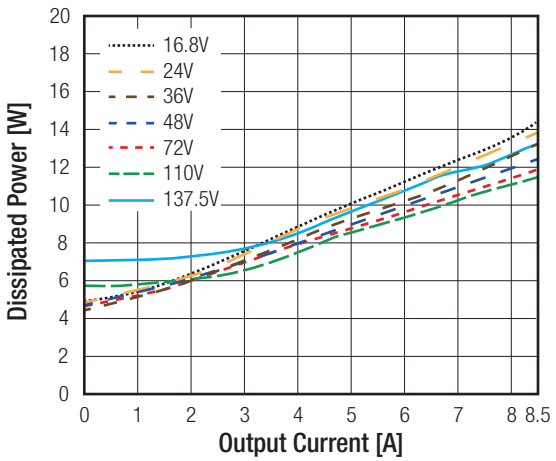
| Parameter | Condition | | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| Quiescent Current | 12 & 24Vout | | 30mA | 60mA | 90mA |
| Output Voltage Trimming | | | -20% | | +10% |
| Minimum Load | | | 0% | | |
| Start-up Time | Power up<br>Remote ON/OFF | | 200ms<br>200ms | | 460ms<br>460ms |
| Rise Time | Vout from 10% to 90% | | | | 100ms |
| ON/OFF Control | Positive Logic | DC-DC ON<br>DC-DC OFF | Open or 3 < Vr < 5VDC<br>Short or 0 < Vr < 0.4VDC | | |
| | Negative Logic | DC-DC ON<br>DC-DC OFF | Short or 0 < Vr < 0.4VDC<br>Open or 3 < Vr < 5VDC | | |
| Input current of CTRL pin | DC-DC ON<br>DC-DC OFF | | | 0.1mA<br>0.1mA | 0.2mA<br>0.2mA |
| Standby Current | | | | | 30mA |
| Internal Operating Frequency | | | | 140kHz | |
| Output Ripple & Noise | 5Hz to 20MHz BW | 12Vout<br>24Vout | | | 420mVp-p<br>100mVp-p |
| Remote Sense | | | | | 10% |

RPA100H-11012SRUW

Efficiency vs. Output Current

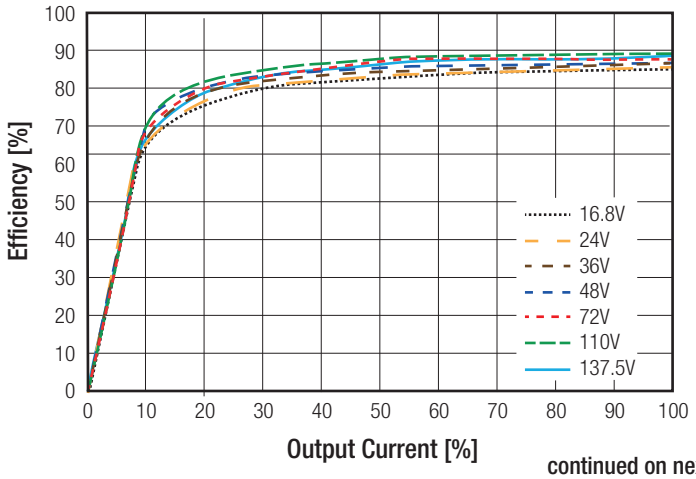



Power Dissipation vs Load Current

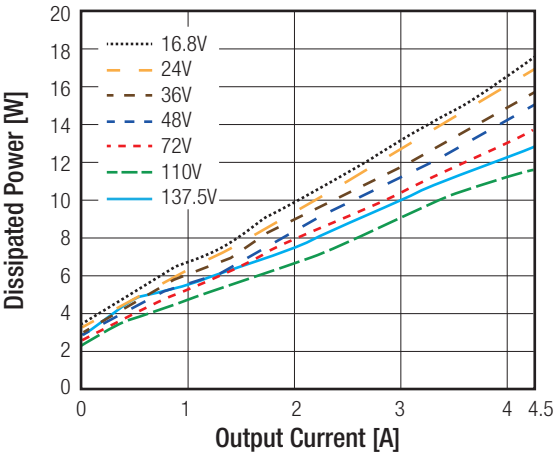



RPA100H-11024SRUW

Efficiency vs. Output Current



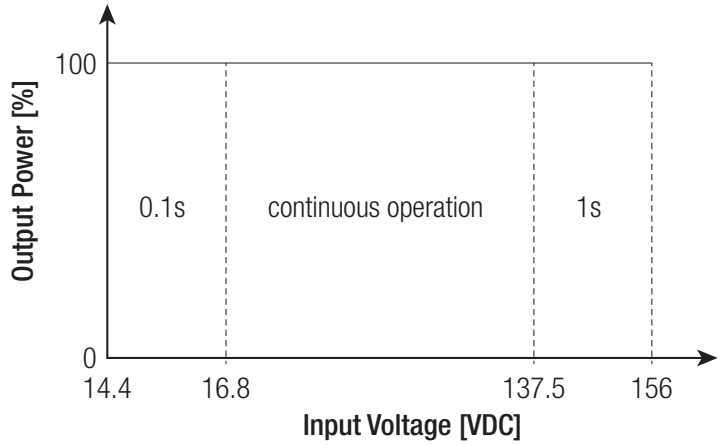

Power Dissipation vs Output Current




continued on next page

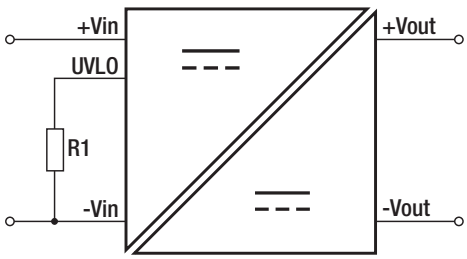
## Specifications (measured @ ta = 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### Input Voltage Range




Continuous full power operation is certified between 16.8V and 137.5V, including full load start-up.
Once running, the converter will operate for short periods of time over an extended input voltage range down to 14.4V and up to 156V, thus covering all EN50155 under-voltage and over-voltage transient conditions.

## UNDER VOLTAGE LOCKOUT



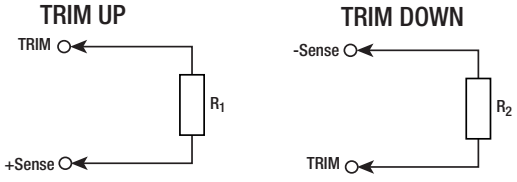

The RPA100H series has an adjustable under voltage lockout which will shut down the converter according to following settings.

| Input Voltage [VDC] | 24 | 36 | 48 | 72 | 110 |
|---|---|---|---|---|---|
| Turn Off Threshold [VDC] | 14 | 20.6 | 27.5 | 40 | 64 |
| Turn On Threshold [VDC] | 16 | 24 | 32 | 46.5 | 74 |
| Resistor R1 [kΩ] | open | 27.4 | 13 | 6.81 | 3.57 |

## OUTPUT VOLTAGE TRIMMING

### Output Voltage Trimming

RPA100H-RUW converters offer the feature of trimming the output voltage over a certain range around the nominal value by using external trim resistors. The values for trim resistors shown in trim tables below are according to standard E96 values; therefore, the specified voltage may slightly vary.




Vout = Output Voltage
ΔVout = Output Voltage Change in %
R1 = trim up resistor
R2 = trim down resistor

### Trim Calculation

**Trim Up:**

**12Vout**

$R_1 = (\frac{45}{\Delta Vout} + 40)k\Omega$

**24Vout**

$R_1 = (\frac{95}{\Delta Vout} + 90)k\Omega$

**Trim Down:**

$R_2 = (\frac{5.11}{\Delta Vout} - 10.22)k\Omega$

**Practical Example:**

**Trim Up:**

Vout = 12V, ΔVout = +10% (13.2V)

$R_1 = (\frac{45}{0.1} + 40)k\Omega = 490k\Omega$

**Trim down:**

Vout = 24V, ΔVout = -8% (22V)

$R_2 = (\frac{5.11}{0.08} - 10.22)k\Omega = 53.65k\Omega$

continued on next page

# RPA100H-RUW Series

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

### Trim up:

**RPA100H-11012SRUW**

| Trim up | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vout = | 12.12 | 12.24 | 12.36 | 12.48 | 12.60 | 12.72 | 12.84 | 12.96 | 13.08 | 13.20 | Volts |
| $R_1$ = | 4530 | 2320 | 1540 | 1150 | 931 | 787 | 681 | 604 | 536 | 487 | kOhms |

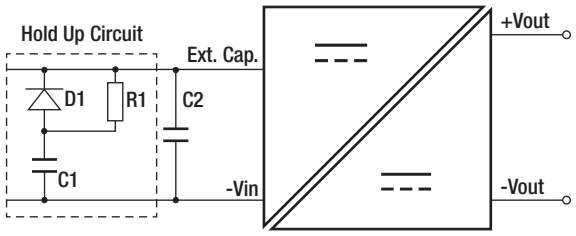
**RPA100H-11024SRUW**

| Trim up | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vout = | 24.24 | 24.48 | 24.72 | 24.96 | 25.20 | 25.44 | 25.68 | 25.92 | 26.16 | 26.40 | Volts |
| $R_1$ = | 9530 | 4870 | 3240 | 2490 | 2000 | 1690 | 1430 | 1270 | 1150 | 1050 | kOhms |

**Trim down RPA100H series**

| Trim down | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_2$ = | 499 | 243 | 162 | 118 | 90.9 | 75 | 63.4 | 53.6 | 46.4 | 41.2 | kOhms |
| Trim down | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | % |
| $R_2$ = | 36.5 | 32.4 | 28.7 | 26.1 | 23.7 | 22.1 | 20 | 18.2 | 16.5 | 15.4 | kOhms |

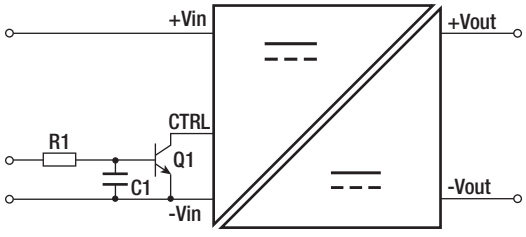
## EXTERNAL CAPACITOR




A 240µF/200V capacitor (C2) is required for normal operation.
To meet power supply interruptions, an external circuit comprised of a capacitor (C1), a 100R 10W resistor (R1) and a FX2000D diode (D1) is required.

| C1 | 24Vin | 36Vin | 48Vin | 72Vin | 96Vin | 110Vin |
|---|---|---|---|---|---|---|
| For 10ms | 2300µF | 2300µF | 2300µF | 2300µF | 1200µF | 800µF |
| For 30ms | 6900µF | 6900µF | 6900µF | 6900µF | 3600µF | 2400µF |

## REMOTE ON/OFF

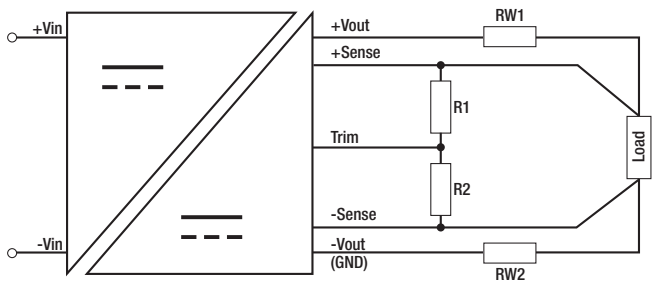



Remote on/off can be controlled by an external voltage or transistor between the CTRL terminal and the Vin(-) terminal.

For negative logic if the remote on/off feature is not used, short the on/off pin to Vin(-).

For positive logic if the remote on/off feature is not used, leave the on/off pin floating.

## REMOTE SENSE




The output voltage can be adjusted by both trim and remote sense. The maximum combined adjustment range is ±10%. Derate the maximum output power if using the trim or sense function to increase the output voltage.

$R_{W1}$ ... wire losses +
$R_{W2}$ ... wire losses -
$R_1$ ... trim up resistor
$R_2$ ... trim down resistor

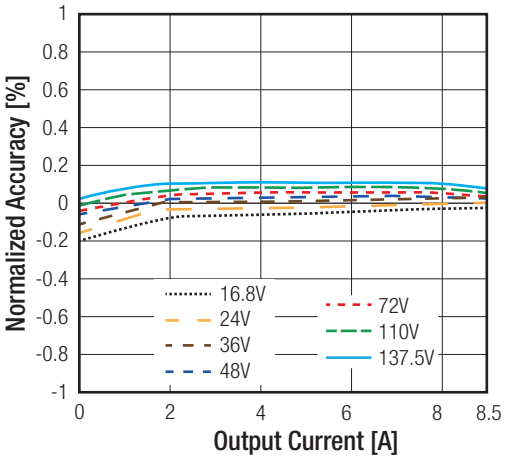
## Specifications (measured @ ta = 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### REGULATION

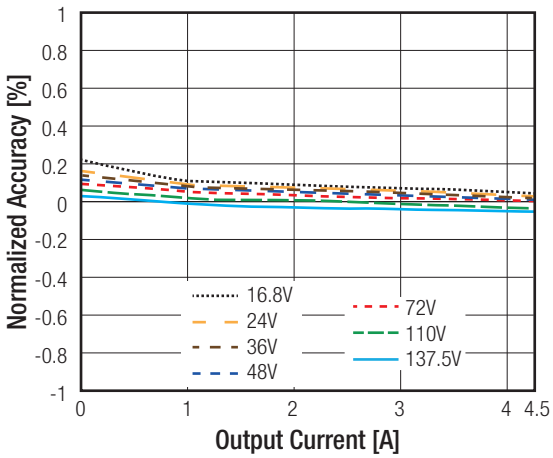
| Parameter | Condition | | | Value |
|---|---|---|---|---|
| Output Accuracy | | | | ±1.0% max. |
| Line Regulation | Vin = 16.8 to 137.5V, Iout = full load | | | ±0.01% typ. to ±0.2% max. |
| Load Regulation | Iout = Iout min to Iout max. | | | ±0.05% typ. to ±0.2% max. |
| Transient Response | 0.1A/µs | 12Vout | 50% Iout max to 75%<br>75% Iout max to 50% | 400mV max.<br>400mV max. |
| | | 24Vout | 50% Iout max to 75%<br>75% Iout max to 50% | 500mV max.<br>500mV max. |

**Accuracy vs Load**

RPA100H-11012SRUW




RPA100H-11024SRUW




### PROTECTION

| Parameter | Condition | | Value |
|---|---|---|---|
| Over Voltage Protection (OVP) | | | 110-130%, auto recovery |
| Over Current Protection (OCP) | | | hiccup Mode |
| Over Temperature Protection (OTP) | @ tc point | | +105°C, automatic recovery after cooling down |
| Isolation Voltage[5] | I/P to O/P<br>I/P to Base<br>O/P to Base | rated for 1 minute | 3kVAC, 4.2kVDC<br>3kVAC, 4.2kVDC<br>3kVAC, 4.2kVDC |
| Isolation Resistance | | | 10MΩ typ. |
| Isolation Capacitance | | | 500pF |
| Leakage Current | | | 0.42mA |
| Insulation Grade | | | Reinforced |

**Notes:**

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

Note6: An input fuse is required if the mains supply is not over-current protected. Recommended fuse T20A slow blow type

# RPA100H-RUW Series

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

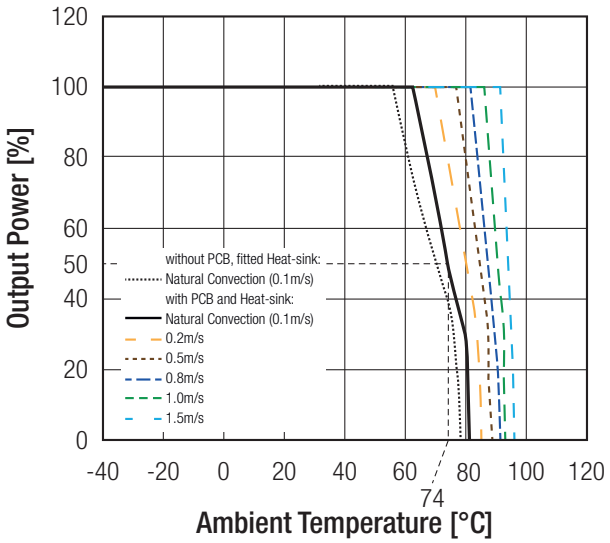
| ENVIRONMENTAL | | |
|---|---|---|
| **Parameter** | **Condition** | **Value** |
| Operating Temperature Range | refer to derating graphs | -40°C to +97°C |
| Maximum Baseplate Temperature | | +100°C |
| Temperature Coefficient | | 0.007%/°C |
| Thermal Impedance | | refer to Rth tables |
| Operating Altitude | | 5000m |
| Operating Humidity | | 5%-95% RH |
| Pollution Degree (PD) | | PD2 |
| Fire protection on railway vehicles | refer to page 8 | according to EN45545-2 standard |
| MTBF | according to Telcordia SR332 Issue 2 Method I standard, 25°C | 1480 x $10^3$ hours |

**Notes:**

Note7: Following calculations are made with RPA200H-11012SRUW/P.
Used Test PCB: 160x100mm 105µm (Eurocard), double layer

### Thermal Derating with Fan Cooling, Double Layer PCB and Heat-sink

| Thermal Impedance | |
|---|---|
| **airflow** [m/s] | **Rth** [°C/W] |
| 0.1 | 3.3 |
| 0.2 | 2.62 |
| 0.5 | 2.0 |
| 0.8 | 1.57 |
| 1.0 | 1.22 |
| 1.5 | 0.75 |



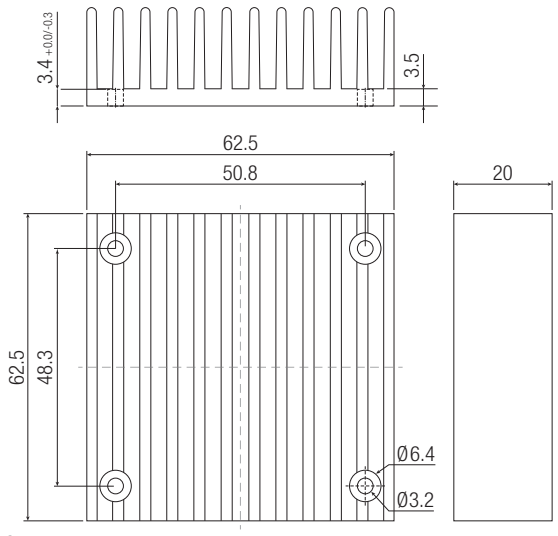

### Thermal Calculation

Iout = 50%
$R_{th}$ = 3.3°C/W
$P_{DISS}$ = 7.87W
$T_{ICmax}$ = 100°C

$T_{OVER}$ = $R_{th}$ x $P_{Diss}$ = 3.3°C/W x 7.87W = +**26°C**

$T_{AMBmax}$ = $T_{ICmax}$ - $T_{OVER}$ = 100°C - 26°C = +**74°C**

### Dimension Drawing Heat-sink (mm)




**Notes:**

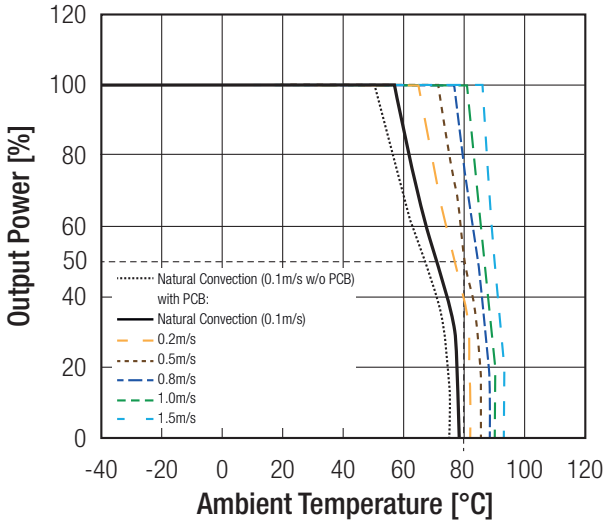
Note8: For further Heat-sink details please contact our Tech Support Team
techsupportAT@recom-power.com

continued on next page

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

### Thermal Derating with Fan Cooling and Double Layer PCB

| Thermal Impedance | |
|---|---|
| **airflow** [m/s] | **Rth** [°C/W] |
| 0.1 | 3.8 |
| 0.2 | 3.12 |
| 0.5 | 2.5 |
| 0.8 | 2.07 |
| 1.0 | 1.72 |
| 1.5 | 1.25 |




**Thermal Calculation**

Iout = 50%
$R_{th}$ = 2.5°C/W
$P_{DISS}$ = 7.87W
$T_{ICmax}$ = 100°C

$T_{OVER}$ = $R_{th}$ x $P_{Diss}$ = 2.5°C/W x 7.87W = **+20°C**

$T_{AMBmax}$ = $T_{ICmax}$ - $T_{OVER}$ = 100°C -20°C = **+80°C**

### Thermal Derating with Water Cooling

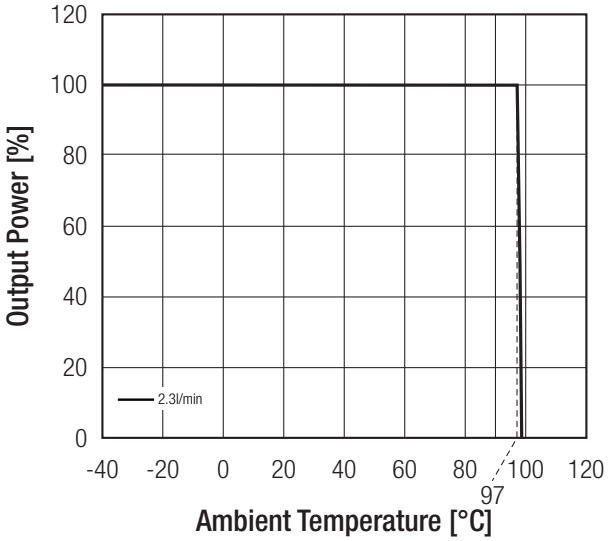
| Thermal Impedance | |
|---|---|
| **flow** [l/min] | **Rth** [°C/W] |
| 2.3 | 0.31 |

**Thermal Calculation**

Iout = 100%
$R_{th}$ = 0.31°C/W
$P_{DISS}$ = 10.94W
$T_{ICmax}$ = 100°C

$T_{OVER}$ = $R_{th}$ x $P_{Diss}$ = 0.31°C/W x 10.94W = **+3.4°C**

$T_{AMBmax}$ = $T_{ICmax}$ - $T_{OVER}$ = 100°C - 3.4°C = **+97°C**




**Notes:**

Note9: For further details about the water cooling please contact our Tech Support Team techsupportAT@recom-power.com

| SAFETY AND CERTIFICATIONS | | |
|---|---|---|
| **Certificate Type (Safety)** | **Report / File Number** | **Standard** |
| Information Technology Equipment, General Requirements for Safety | E224736-A54 | UL60950-1, 2nd Edition, 2014<br>CSA C22.2 No. 60950, 2nd Edition, 2014 |
| IEC/EN Information Technology Equipment - General Requirments for Safety (CB Scheme) | E224736-A54-CB-1 | IEC60950-1, 2nd Edition, 2005+ AM2, 2013<br>EN60950-1, 1st Edition, 2006 + AM2, 2013 |
| Railway Applications - Electrical Equipment used on rolling stock | designed to meet | EN50155, 1st Edition, 2007 |
| RoHS | | RoHS 2011/65/EU + AM2015/863 |

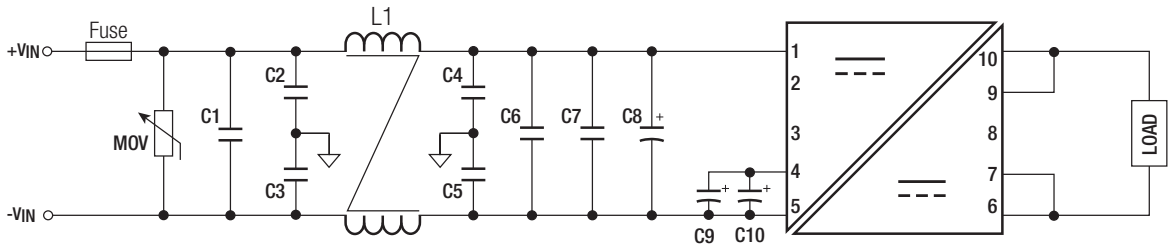
continued on next page

# RPA100H-RUW Series

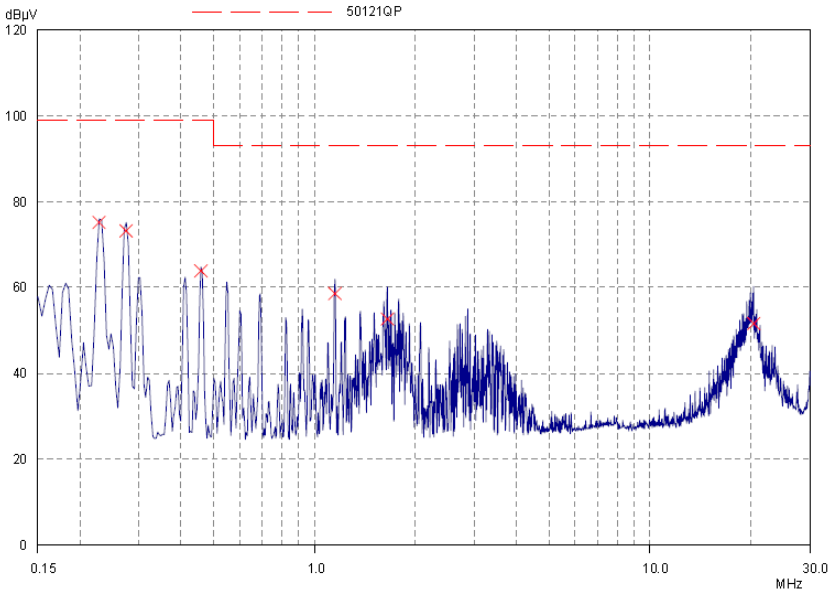
## Specifications (measured @ ta = 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

| EMC Compliance | Condition | Standard / Criterion |
|---|---|---|
| Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus | with external components | EN50121-3-2, 2015 |
| Electromagnetic compatibility of multimedia equipment - Emission requirements | with external components | EN55032 Class B |
| Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement | | EN55011 |
| Fire hazard testing - Part 11-10: Test flames - 50W horizontal and vertical flame test methods | Vertical Flame Test | EN60695-11-10, 2013, HL1, HL2, HL3, V-0 |
| Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods; Glow-wire flammability test method for end-products | 30s ta glow-wire temp., 850°C | EN60695-2-11,2000, HL1, HL2, HL3 |
| Plastics - Determination of burning behaviour by oxygen index - Part 2: Ambient-temperature test | OI% (min) 42.6%<br>OI% (min) 36.8% | EN ISO 4589-2, 2006, HL1, HL2, HL3<br>EN ISO 4589-2, 1999 + A1,2006, HL1, HL2, HL3 |
| ESD Electrostatic discharge immunity test | Air ±8kV, Contact ±6kV | EN61000-4-2, Criteria B |
| Radiated, radio-frequency, electromagnetic field immunity test | 80-1000MHz, 20V/m<br>800-1000MHz, 20V/m<br>1400-2100MHz, 10V/m<br>2100-2500MHz, 5V/m | EN61000-4-3, Criteria A |
| Fast Transient and Burst Immunity | ±2kV | EN61000-4-4, Criteria A |
| Surge Immunity | ±1kV (diff), ±2kV (com) | EN61000-4-5, Criteria B |
| Immunity to conducted disturbances, induced by radio-frequency fields | 10V | EN61000-4-6, Criteria A |

### EMC Filtering according to EN50121-3-2



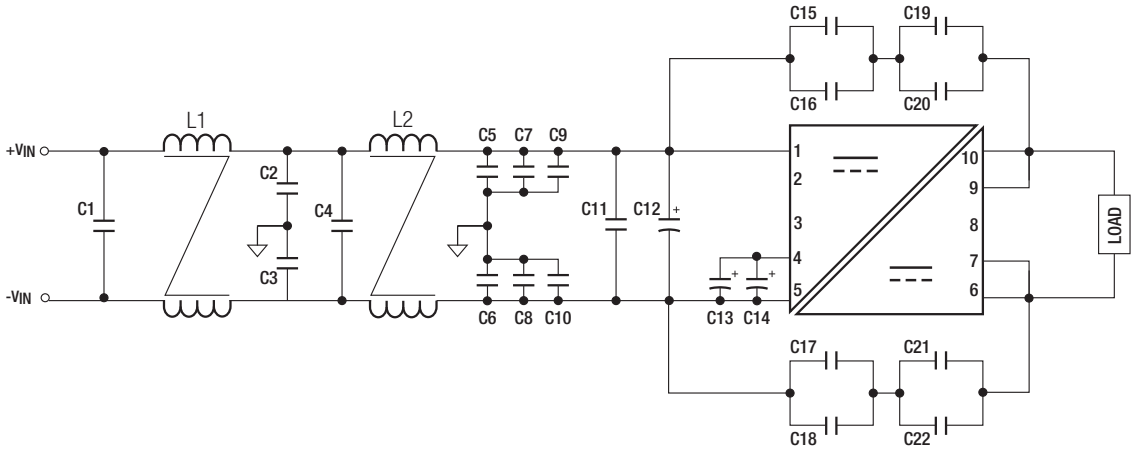

| MOV | C1 | C2, C3, C4, C5 | L1 | C6, C7 | C8 | C9, C10 |
|---|---|---|---|---|---|---|
| EPCOS B72207S0131K101 | 100nF 275VAC | 1000pF, 300VAC | 1mH CMC | 0.47µF 250V | 100µF 200V | 120µF 200V |



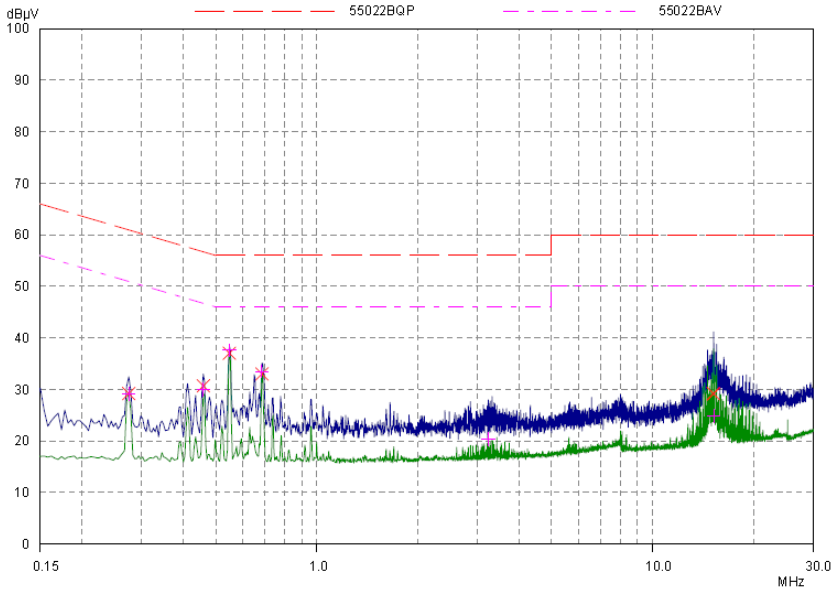

continued on next page

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

### EMC Filtering according to EN55032 Class B




| C1, C4, C11 | L1, L2 | C2, C3, C5, C6, C7, C8, C9, C10 | C12 | C13 C14 | C15, C16, C17, C18, C19, C20, C21, C22, |
|---|---|---|---|---|---|
| 0.47µF, 250V MLCC | 1mH CMC | 1.5pF, 3kV | 100µF 200V | 120µF 200V | 6.8pF, 2kV |



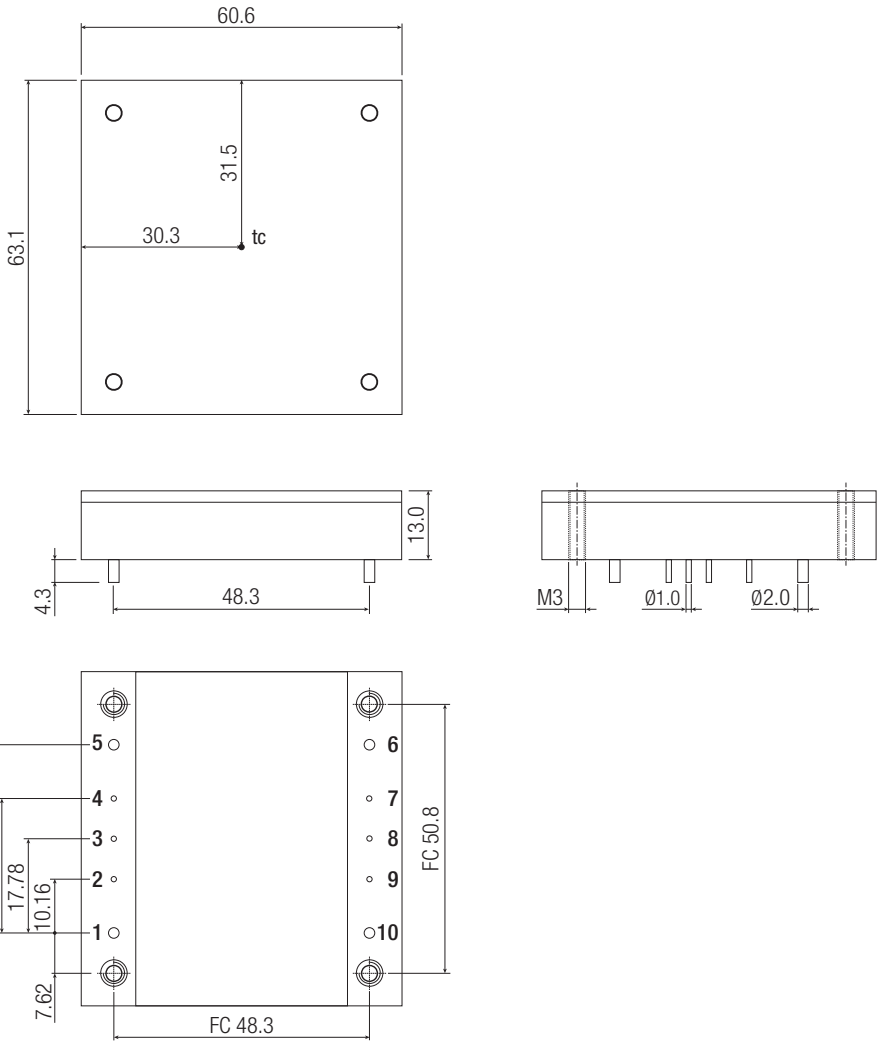

| DIMENSIONS and PHYSICAL CHARACTERISTICS | | |
|---|---|---|
| **Parameter** | **Type** | **Value** |
| Material | Baseplate<br>Case<br>Potting | Aluminum<br>Plastic (UL94V-2)<br>Low Smoke Silicone (UL94V-0) |
| Package Dimensions (LxWxH) | | 60.6 x 63.1 x 13.0mm |
| Package Weight | | 125.0g typ. |

continued on next page

# RPA100H-RUW Series

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

### Dimension Drawing (mm)




**Pin Connections**

| Pin # | Single |
|---|---|
| 1 | +Vin |
| 2 | UVLO |
| 3 | CTRL |
| 4 | Ext. Cap. |
| 5 | -Vin |
| 6 | -Vout |
| 7 | -Sense |
| 8 | Trim |
| 9 | +Sense |
| 10 | +Vout |

Pin Pitch Tolerance ±0.25mm
Pin dimension tolerance ±0.1mm
XX.X ± 0.5mm
XX.XX ± 0.25mm
FC ±0.25mm

| PACKAGING INFORMATION | | |
|---|---|---|
| **Parameter** | **Type** | **Value** |
| Packaging Dimensions (LxWxH) | tube | 355.0 x 63.5 x 20.6mm |
| Packaging Quantity | | 5pcs |
| Storage Temperature Range | | -55°C to +125°C |
| Storage Humidity | | 95% RH |