# Features

# Regulated Converter

- 10:1 ultra wide input voltage range
- 3kVAC/1 minute reinforced insulation
- UL/IEC/EN60950-1 certified
- CE marked, CB report
- Efficiency up to 93%
- -40°C to +97°C baseplate temperature range

RECOM
DC/DC Converter

# RPA100H-RUW

## 100 Watt Half Brick Single Output

3 YEAR warranty


c UL us
E224736

UL60950-1 certified
CAN/CSA No. 60950-1-07
IEC/EN60950-1 certified*
EN50155 compliant
CB report

* 15Vout and 48Vout pending

## 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 in a single product (including EN50155 transients) and offers isolated and regulated 12V, 15V, 24V or 48VDC 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 baseplate cooled). The case is fitted with threaded inserts to allow secure mounting to the PCB or bulkhead for use in high shock and vibration environments. The converter is certified to UL/IEC/EN60950 and comes with a three year warranty.

## Selection Guide

| Part Number | Input Voltage Range [1] [VDC] | Output Voltage [VDC] | Output Current [A] | Efficiency typ. [2] [%] | Max. Capacitive Load [3] [µF] |
|---|---|---|---|---|---|
| RPA100H-11012SRUW[4] | 16.5-140 | 12 | 8.5 | 90 | 2200 |
| RPA100H-11015SRUW[4] | 16.5-140 | 15 | 6.7 | 93 | 2200 |
| RPA100H-11024SRUW[4] | 16.5-140 | 24 | 4.2 | 88 | 1000 |
| RPA100H-11048SRUW[4] | 16.5-140 | 48 | 2.1 | 90 | 100 |

**Notes:**

Note1: Refer to input voltage graph on page PB-3

Note2: Efficiency is tested at nominal input (110V) and full load at +25°C ambient

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

## Model Numbering

RPA100H-__ __ SRUW/__

- Input Voltage
- Output Voltage
- Single
- CTRL Logic [4]
- Railway Ultra Wide Input

**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: add 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 (110V), full load and after warm-up unless otherwise stated)

| BASIC CHARACTERISTICS | | | | |
|---|---|---|---|---|
| **Parameter** | **Condition** | **Min.** | **Typ.** | **Max.** |
| Internal Input Filter | | | | Pi-Type |
| Input Voltage Range | | 16.5VDC | 110VDC | 140VDC |
| Input Surge Voltage | <1s | | | 156VDC |
| Under Voltage Lockout (UVLO) [5] | 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 = 16.5V | 7A | 7.2A | 7.5A |

**Notes:**

Note5: please refer to Under Voltage Lockout Adjustability on page PB-3

**continued on next page**

# RPA100H-RUW Series

## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

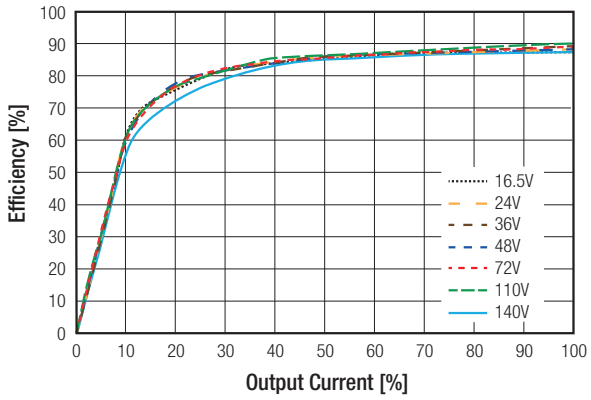
| BASIC CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Condition** | | **Min.** | **Typ.** | **Max.** |
| Quiescent Current | Vin = 110V | 12, 15, 24Vout<br>48Vout | 30mA<br>50mA | 60mA<br>80mA | 90mA<br>150mA |
| Output Voltage Trimming | | | -20% | | +10% |
| Minimum Load | | | 0% | | |
| Start-up Time | | | 200ms | | 460ms |
| Rise Time | Vout from 10% to 90% | | | 50ms | 100ms |
| ON/OFF Control (6) | 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>0.1mA |
| Standby Current | | | | 20mA | |
| Internal Operating Frequency | | | | 140kHz | |
| Output Ripple & Noise | 20MHz BW limited | | | 250mVp-p | |
| Remote Sense (6) | | | | | ±10% |

**Notes:**

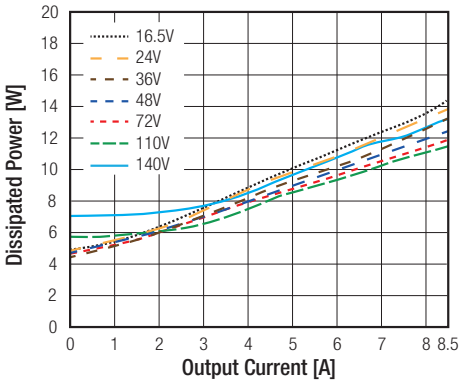
Note6: see page PB-5

### RPA100H-11012SRUW

Efficiency vs. Output Current

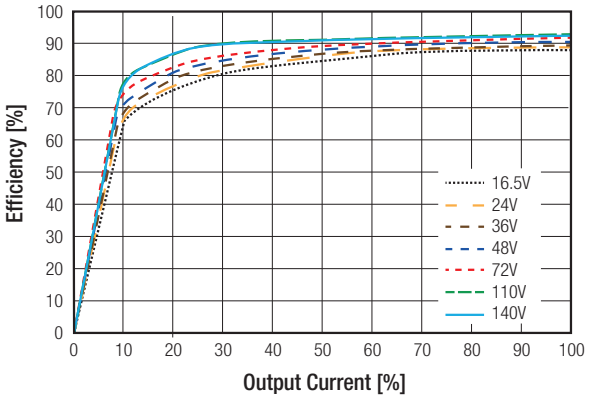



Power Dissipation vs. Output Current

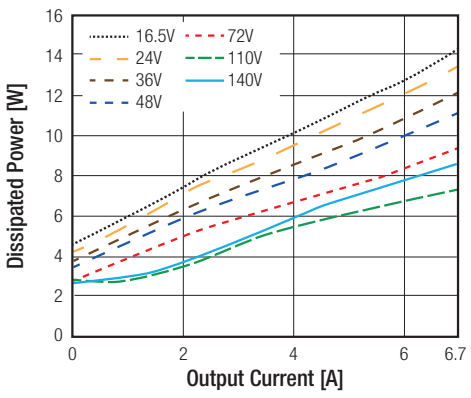



### RPA100H-11015SRUW

Efficiency vs. Output Current




Power Dissipation vs. Output Current

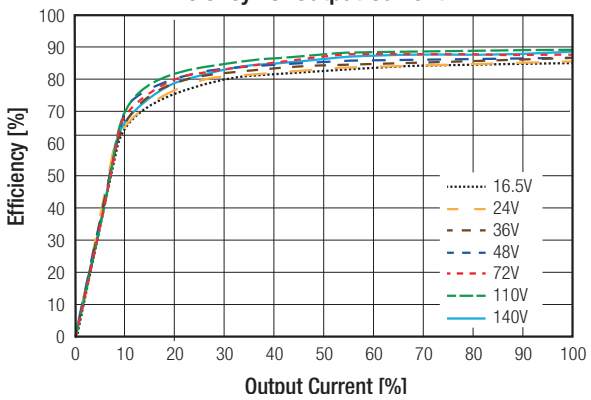



continued on next page

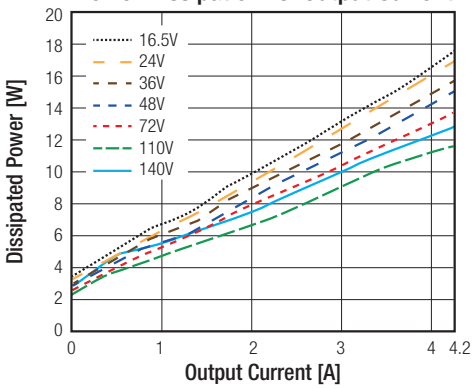
## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

### RPA100H-11024SRUW

Efficiency vs. Output Current

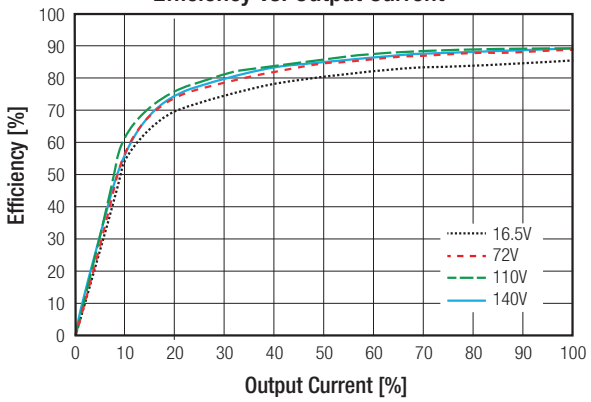



Power Dissipation vs. Output Current

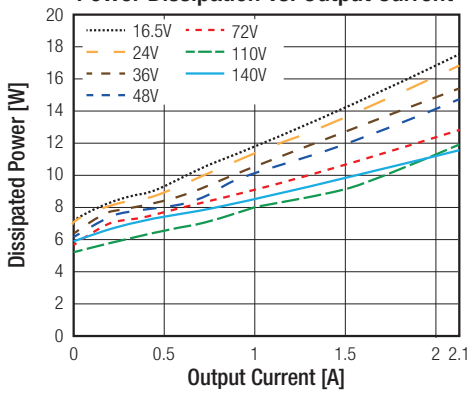



### RPA100H-11048SRUW

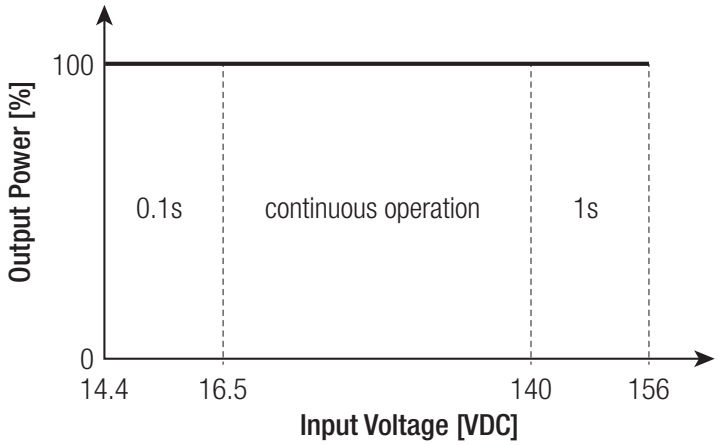
Efficiency vs. Output Current




Power Dissipation vs. Output Current

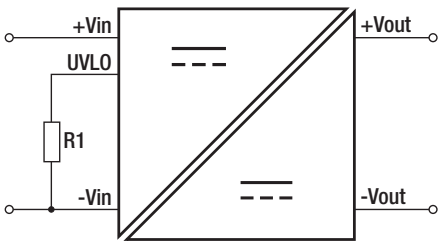



### Input Voltage Range




Continuous full power operation is rated between 16.5V and 140V, 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 ADJUSTABILITY




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

| Nom. Input Voltage [VDC] | 24 | 36 | 48 | 72 | 110 |
|---|---|---|---|---|---|
| Turn Off Threshold [VDC] | 14±0.4V | 20.6±1V | 27.5±1V | 40±1V | 64±2V |
| Turn On Threshold [VDC] | 16±0.4V | 24±1V | 32±1V | 46.5±1V | 74±2V |
| Resistor R1 [kΩ] | open | 24.9 | 12.4 | 6.19 | 3.48 |

## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

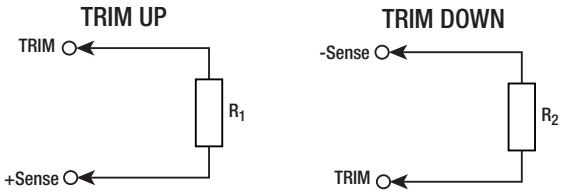
## OUTPUT VOLTAGE TRIMMING

### 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; they also can be calculated with below shown equation.

### Trim Calculation

Vout = nom. Output Voltage
ΔVout = Output Voltage Change in %
$R_{up}$ = trim up resistor
$R_{down}$ = trim down resistor




**Trim up**

**12Vout**

$$R_{up} = \left[ \frac{45}{\Delta Vout} + 40 \right] k\Omega$$

**24Vout**

$$R_{up} = \left[ \frac{95}{\Delta Vout} + 90 \right] k\Omega$$

**15Vout**

$$R_{up} = \left[ \frac{57.46}{\Delta Vout} + 52.35 \right] k\Omega$$

**48Vout**

$$R_{up} = \left[ \frac{195}{\Delta Vout} + 190 \right] k\Omega$$

**Trim down**

$$R_{down} = \left[ \frac{5.11}{\Delta Vout} - 10.22 \right] k\Omega$$

**Practical Example**

**Trim Up:**

Vout = 12V, ΔVout = +10% (13.2V)

$$R_{up} = \left[ \frac{45}{10\%} + 40 \right] k\Omega = 490k\Omega \quad (E96 = 490)$$

**Trim down:**

Vout = 24V, ΔVout = -8% (22V)

$$R_{down} = \left[ \frac{5.11}{8\%} - 10.22 \right] k\Omega = 53.66k\Omega \quad (E96 = 53.6)$$

### Trim up

**RPA100H-11012SRUW**

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

**RPA100H-11015SRUW**

| Trim up | [%] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vout = | [VDC] | 15.15 | 15.30 | 15.45 | 15.60 | 15.75 | 15.90 | 16.05 | 16.20 | 16.35 | 16.50 |
| $R_1$ = | [kΩ] | 5760 | 2940 | 1960 | 1500 | 1210 | 1010 | 866 | 768 | 681 | 619 |

**RPA100H-11024SRUW**

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

**RPA100H-11048SRUW**

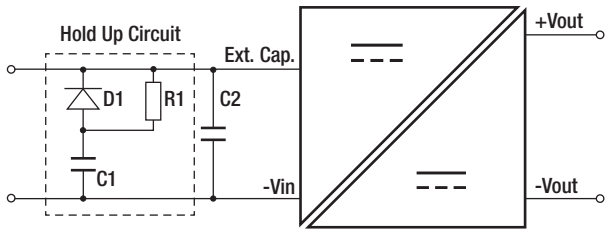
| Trim up | [%] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vout = | [VDC] | 48.48 | 48.96 | 49.44 | 49.92 | 50.40 | 50.88 | 51.36 | 51.84 | 52.32 | 52.80 |
| $R_1$ = | [kΩ] | 19600 | 9880 | 6650 | 5110 | 4120 | 3480 | 3010 | 2610 | 2370 | 2150 |

**Trim down RPA100H series**

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

## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

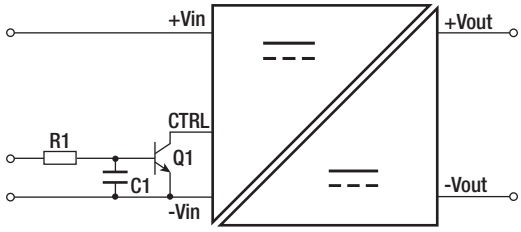
### EXTERNAL CAPACITOR




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

| C1 | 24Vin | 36Vin | 48Vin | 72Vin | 96Vin | 110Vin |
|---|---|---|---|---|---|---|
| For 10ms | 2400µF | 2400µF | 2400µF | 2400µF | 820µF | 560µF |
| For 30ms | 7200µF | 7200µF | 7200µF | 7200µF | 2460µF | 1680µF |

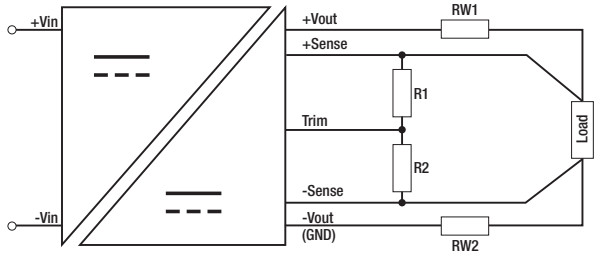
### ON/OFF CONTROL




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

### REGULATION

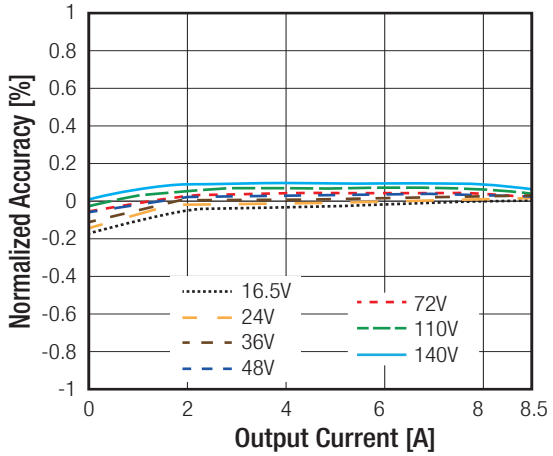
| Parameter | Condition | | Value |
|---|---|---|---|
| Output Accuracy | | | ±1.0% max. |
| Line Regulation | Vin = 16.5 to 140V, Io = full load | | ±0.01% typ. to ±0.2% max. |
| Load Regulation | 10 - 90% load | | ±0.05% typ. to ±0.2% max. |
| Transient Response | 25% load step change | 12Vout | 450mV/40µs typ. |
| | | 15Vout | 450mV/30µs typ. |
| | | 24Vout | 500mV/20µs typ. |
| | | 48Vout | 600mV/10µs typ. |

continued on next page

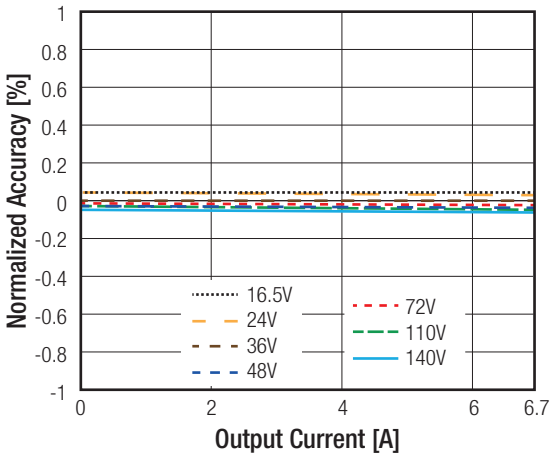
## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

Accuracy vs. Load

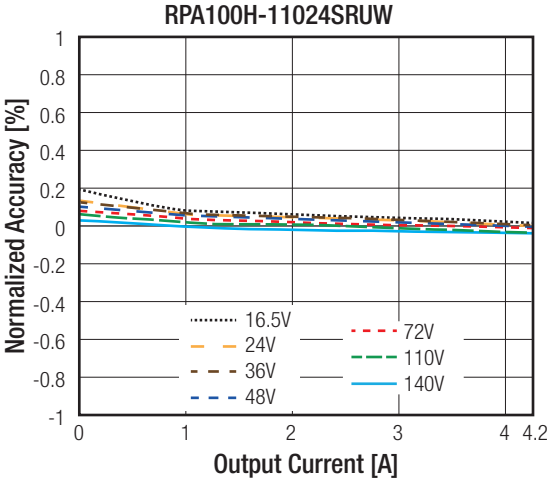
RPA100H-11012SRUW



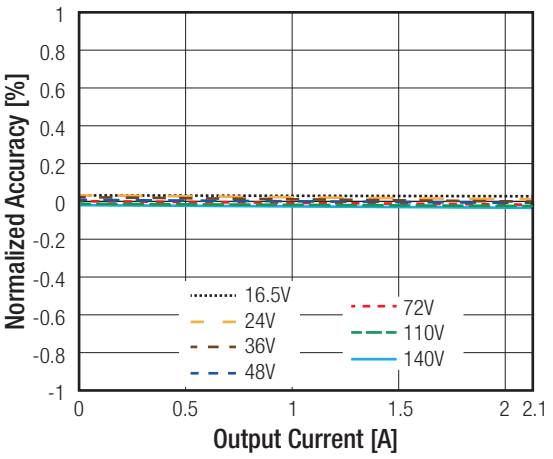

RPA100H-11015SRUW




RPA100H-11024SRUW




RPA100H-11048SRUW




| PROTECTION | | | | |
|---|---|---|---|---|
| **Parameter** | **Condition** | | | **Value** |
| Over Voltage Protection (OVP) | | | | 110-130%, automatic recovery |
| Over Current Protection (OCP) | | | | hiccup mode, automatic recovery |
| Over Temperature Protection (OTP) | @ tc point | | | +105°C, automatic recovery after cooling down |
| Isolation Voltage (7) | I/P to O/P, O/P to baseplate | rated for 1 minute | 12, 15, 24Vout | 4.242kVDC |
| | | | 48Vout | 3kVDC |
| Isolation Resistance | | | | 10MΩ typ. |
| Isolation Capacitance | | | | 500pF |
| Leakage Current | | | | 0.42mA |
| Insulation Grade | | | | reinforced |

**Notes:**

Note7: For repeat Hi-Pot testing, reduce the time and/or the test voltage

Note8: An input fuse is required if the mains supply is not over-current protected. Recommended fuse T20A slow blow type

## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

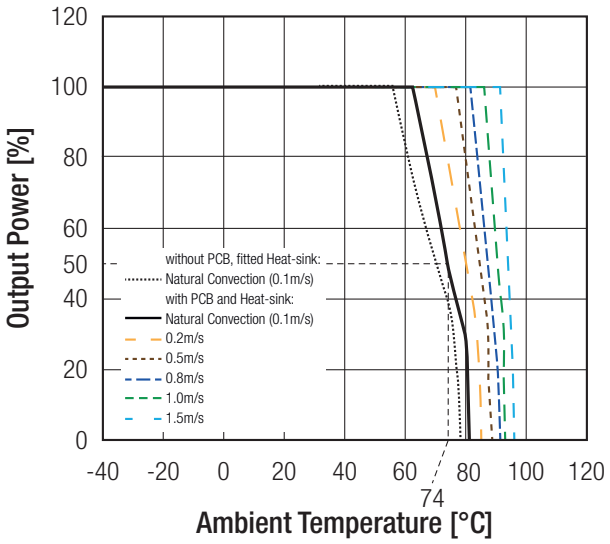
| ENVIRONMENTAL | | |
|---|---|---|
| **Parameter** | **Condition** | **Value** |
| Operating Temperature Range | refer to derating graphs | -40°C to +97°C |
| Maximum Baseplate Temperature | | +100°C |
| Temperature Coefficient | | 0.007%/°C |
| Thermal Impedance | | refer to Rth tables |
| Operating Altitude | | 5000m |
| Operating Humidity | | 5%-95% RH |
| Pollution Degree (PD) | | PD2 |
| Fire protection on Railway Vehicles | refer to page PB-9 | according to EN45545-2 standard |
| MTBF | according to Telcordia SR332 Issue 2 Method I, 25°C | 1480 x $10^3$ hours |

**Notes:**

Note9: Following calculations are made with RPA100H-11012SRUW/P.
Test PCB: Eurocard 160x100mm 105µm copper, 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 |



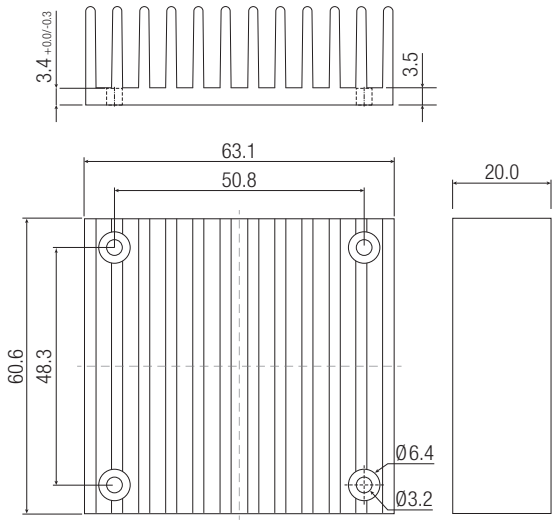

### Thermal Calculation Example

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)

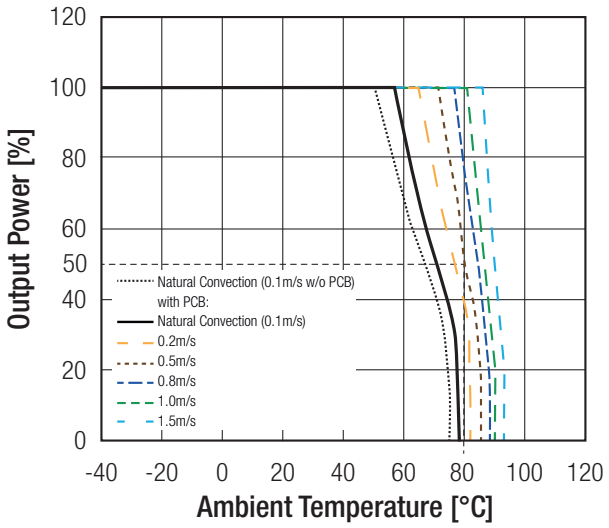



continued on next page

## Specifications (measured @ Ta = 25°C, nom. Vin (110V), 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 Example

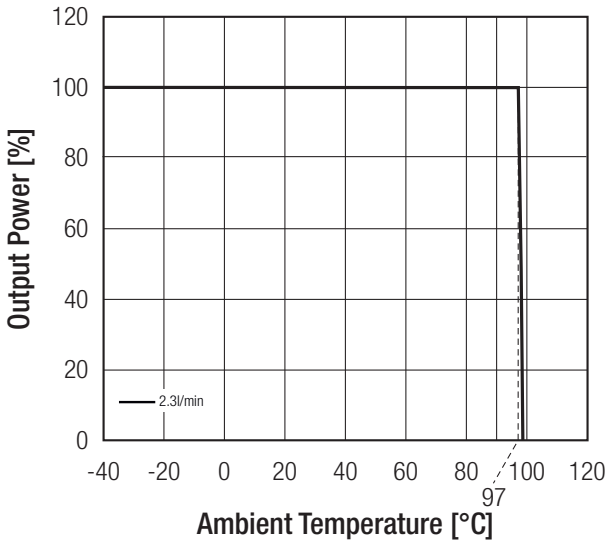
Iout = 50%
$R_{th}$ = 2.5°C/W
$P_{DISS}$ = 7.87W
$T_{ICmax}$ = 100°C

$T_{OVER}$ = $R_{th}$ 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 | |
|---|---|
| liquid flow [l/min] | Rth [°C/W] |
| 2.3 | 0.31 |




### Thermal Calculation Example

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:**

Note10: For further details 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 and E224736-A57 | UL60950-1, 2nd Edition: 2014<br>CAN/CSA-C22.2 No. 60950-1-07, 2nd Edition: 2014 |
| IEC/EN Information Technology Equipment - General Requirments for Safety (CB Scheme) | E224736-A54-CB-1 (15Vout and 48Vout pending) | IEC60950-1: 2005, 2nd Edition + AM2: 2013 |
| IEC/EN Information Technology Equipment - General Requirments for Safety | | EN60950-1: 2006 + A2: 2013 |

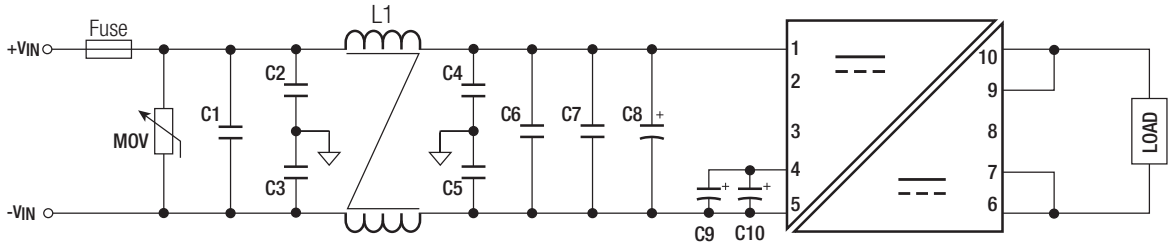
continued on next page

## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

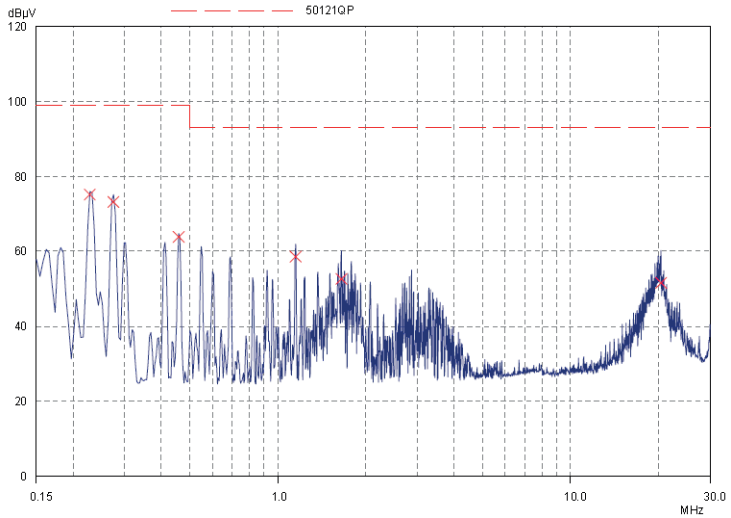
| | | |
|---|---|---|
| Fire hazard testing - Part 11-10: Test flames - 50W horizontal and vertical flame test methods | Vertical Flame Test | EN60695-11-10: 2013, HL1, HL2, HL3, V-0 |
| Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods; Glow-wire flammability test method for end-products | Glow-Wire Flammability Test 30s ta, 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 |
| Railway Applications - Electrical Equipment used on rolling stock | | EN50155:2007 |
| Railway applications - Fire protection on railway vehicles Part 2: Requirements for fire behaviour of materials and components | | EN45545-2:2013 + A1:2015 |
| RoHS | | RoHS 2011/65/EU |

| EMC Compliance | Condition | Standard / Criterion |
|---|---|---|
| Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus | with external components | EN50121-3-2:2015 |
| 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 |
| Electromagnetic compatibility of multimedia equipment - Emission requirements | with external components | EN55032, Class B |

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



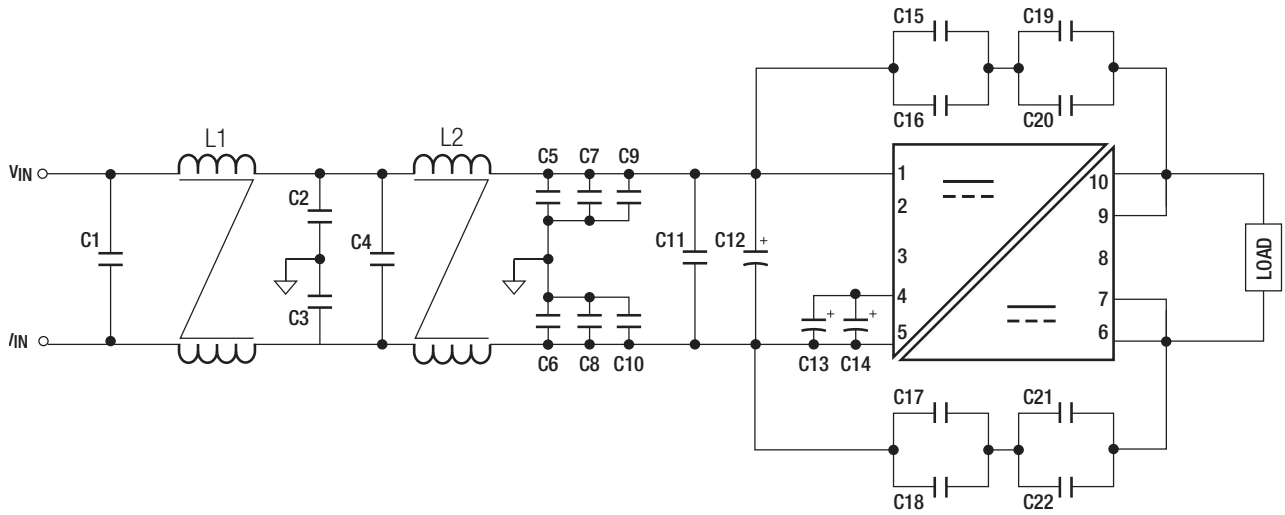

| MOV | C1 | C2, C3, C4, C5 | L1 | C6, C7 | C8 | C9, C10 |
|---|---|---|---|---|---|---|
| EPCOS B72207S0131K101 | 100nF 275VAC | 1000pF, 300VAC | 1mH CMC | 0.47µF 250V | 100µF 200V | 120µF 200V |



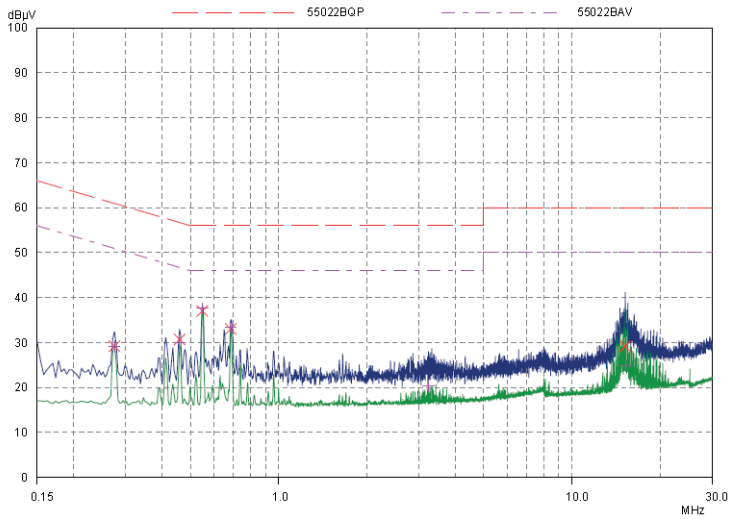

continued on next page

## Specifications (measured @ Ta = 25°C, nom. Vin (110V), 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 |
|---|---|---|---|---|---|
| 0.47µF, 250V MLCC | 1mH CMC | 1.5pF, 3kV | 100µF 200V | 120µF 200V | 6.8pF, 2kV |



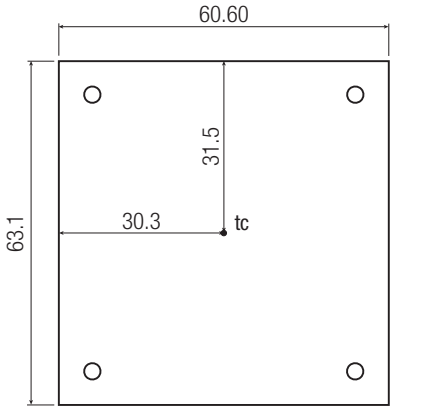

| DIMENSIONS and PHYSICAL CHARACTERISTICS | | |
|---|---|---|
| **Parameter** | **Type** | **Value** |
| Material | baseplate<br>case<br>potting | aluminum<br>plastic (UL94V-2)<br>low smoke silicone (UL94V-0) |
| Package Dimensions (LxWxH) | | 60.6 x 63.1 x 13.0mm |
| Package Weight | | 125.0g typ. |

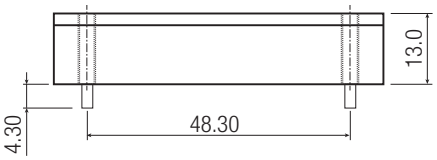
continued on next page

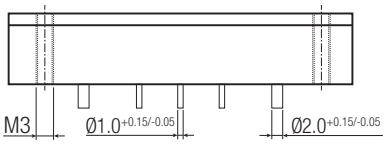
# RPA100H-RUW Series

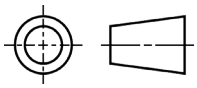
## Specifications (measured @ Ta = 25°C, nom. Vin (110V), full load and after warm-up unless otherwise stated)

### Dimension Drawing (mm)



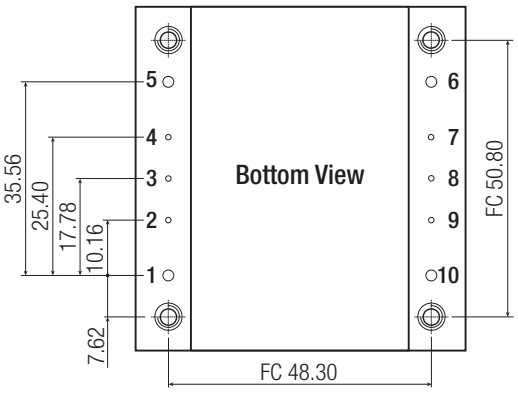



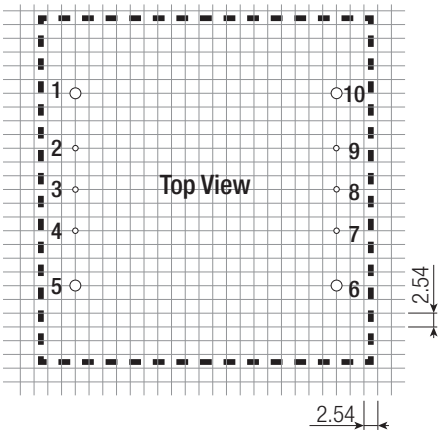
**Pin Connections**

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

XX.X ± 0.5mm
XX.XX ± 0.25mm
FC= fixing center

### Recommended Footprint Details




| 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 |