

## Features

## Regulated Converter

- 4:1 wide input voltage range
- 1.5kVDC / 1 minute isolation
- UL/IEC/EN60950 and EN50155 certified
- Efficiency up to 93.3%
- OVP, OCP & OTP
- +105°C max case temperature

**RECOM**  
DC/DC Converter

## RPA60-FW

**60 Watt**  
**2" x 1"**  
**Single Output**



### Description

The RPA60-FW series are high power density, wide input voltage range 60W DC/DC converters in an industry standard 2" x 1" case size. Despite their small size, the RPA60-FW converters are fully specified devices with output currents up to 12Amps, up to 93% efficiency, no minimum load, UVLO, 1500VDC / 1 minute isolation, tight regulation and low ripple/noise figures. The trimmable outputs are also fully protected against over-temperature, short circuits, overcurrent and overvoltage. The converters are UL/IEC/EN60950 and EN50155 certified and will find many uses in railway and industrial applications where board space is at a premium.

### Selection Guide

| Part Number                    | nom. Input Voltage Range [VDC] | Output Voltage [VDC] | Output Current [mA] | Input <sup>(1)</sup> Current [mA] | Efficiency <sup>(1)</sup> typ. [%] | Max. Capacitive Load [μF] |
|--------------------------------|--------------------------------|----------------------|---------------------|-----------------------------------|------------------------------------|---------------------------|
| RPA60-2405SFW <sup>(2,3)</sup> | 9-36                           | 5                    | 12000               | 2706                              | 92.4                               | 20000                     |
| RPA60-2412SFW <sup>(2,3)</sup> | 9-36                           | 12                   | 5000                | 2694                              | 92.8                               | 6000                      |
| RPA60-2415SFW <sup>(2,3)</sup> | 9-36                           | 15                   | 4000                | 2662                              | 93.3                               | 4000                      |
| RPA60-2424SFW <sup>(2,3)</sup> | 9-36                           | 24                   | 2500                | 2688                              | 93                                 | 2000                      |

#### Notes:

Note1: Tested at nominal Vin, full load and at +25°C ambient

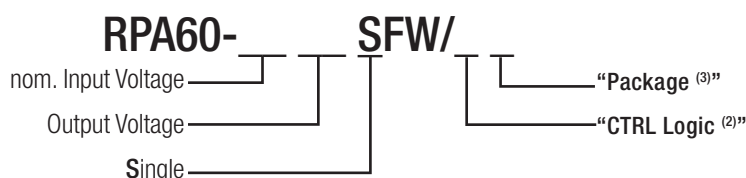


**UL**  
E224736



UL60950-1 certified  
IEC/EN60950 certified  
EN50155 certified

### Model Numbering



#### Notes:

- Note2: part without suffixes is without CTRL pin, trim pin fitted  
add suffix “P” for positive CTRL function (1=ON, 0=OFF), trim pin fitted  
add suffix “N” for negative CTRL function (0=ON, 1=OFF), trim pin fitted  
Note3: add suffix “-HC” for glued Heat-sink (compatible with all other suffixes)

#### Ordering Examples

RPA60-2405SFW = 24VDC input, 5VDC output, single, no CTRL pin  
RPA60-2405SFW/P = 24VDC input, 5VDC output, single, positive CTRL function  
RPA60-2415SFW/N-HC = 24VDC input, 15VDC output, single, negative CTRL function, glued Heat-sink

**SEARCHING FOR  
ALTERNATIVES?**

**Contact RECOM**

<https://recom-power.com/contact.html>



<https://recom-power.com/rec-s-R-REF04-RIA12.html>

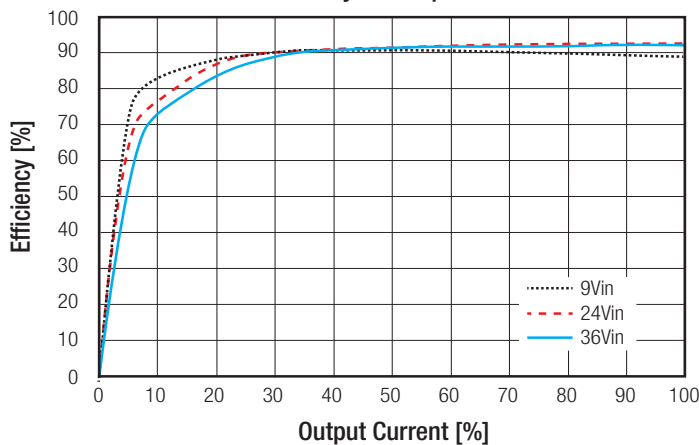
**Specifications** (masured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

**BASIC CHARACTERISTICS**

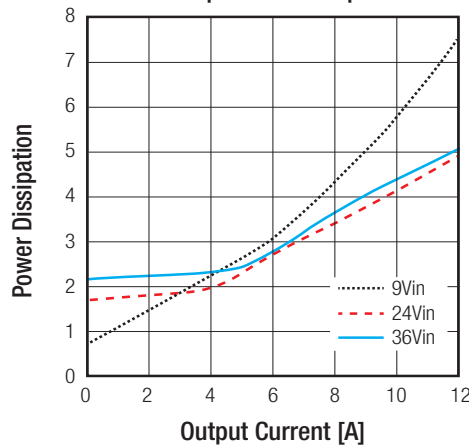
| Parameter                    | Condition                                                   | Min.                  | Typ.                                                                                     | Max.         |
|------------------------------|-------------------------------------------------------------|-----------------------|------------------------------------------------------------------------------------------|--------------|
| Internal Input Filter        |                                                             |                       |                                                                                          | LC Filter    |
| Input Voltage Range          | nom. Vin = 24VDC                                            | 9VDC                  | 24VDC                                                                                    | 36VDC        |
| Input Surge Voltage          | 100ms max.                                                  |                       |                                                                                          | 50VDC        |
| Under Voltage Lockout (UVLO) | DC-DC ON<br>DC-DC OFF                                       | 8VDC<br>7VDC          | 8.5VDC<br>7.5VDC                                                                         | 9VDC<br>8VDC |
| Quiescent Current            | 5Vout<br>12Vout & 15 Vout<br>24Vout                         |                       | 70mA<br>60mA<br>40mA                                                                     |              |
| Output Voltage Trimming      | refer to "OUTPUT VOLTAGE TRIMMING"                          | -10%                  |                                                                                          | +10%         |
| Minimum Load                 |                                                             | 0%                    |                                                                                          |              |
| Start-up time                | Power up<br>Remote ON/OFF                                   |                       | 60ms                                                                                     |              |
| ON/OFF CTRL <sup>(2)</sup>   | Positive Logic                                              | DC-DC ON<br>DC-DC OFF | Open or 2.4VDC < V <sub>CTRL</sub> < 10VDC<br>Short or 0VDC < V <sub>CTRL</sub> < 0.8VDC |              |
|                              | Negative Logic                                              | DC-DC ON<br>DC-DC OFF | Short or 0VDC < V <sub>CTRL</sub> < 0.8VDC<br>Open or 2.4VDC < V <sub>CTRL</sub> < 10VDC |              |
| Standby Current              | DC-DC OFF                                                   |                       | 10mA                                                                                     |              |
| Internal Operating Frequency |                                                             |                       | 330kHz                                                                                   |              |
| Ripple and Noise             | 20MHz BW, 10µF tantalum capacitor and 1µF ceramic capacitor |                       | 100mVp-p                                                                                 |              |

**RPA60-2405SFW**

**Efficiency vs. Output Current**

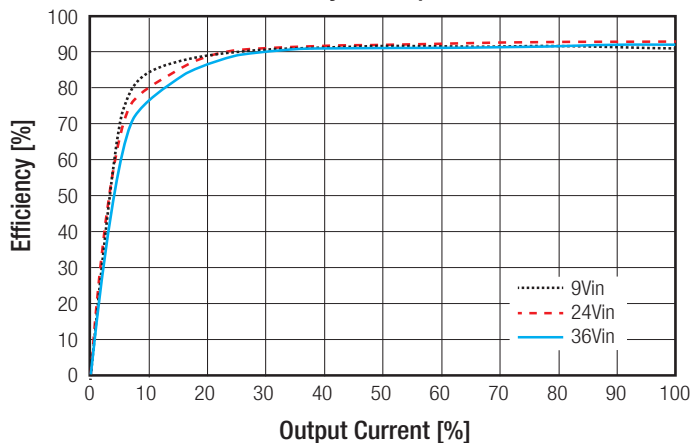


**Power Dissipation vs. Output Current**

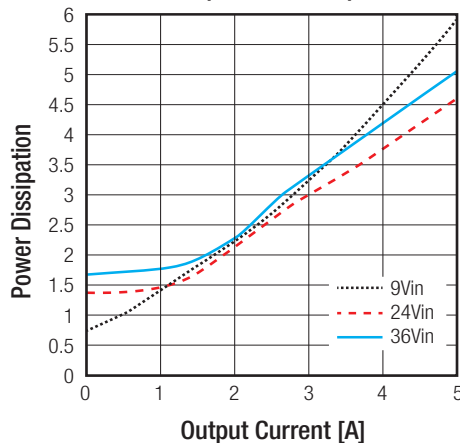


**RPA60-2412SFW**

**Efficiency vs. Output Current**

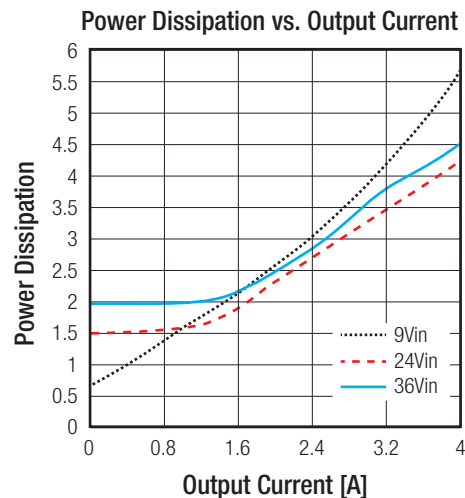
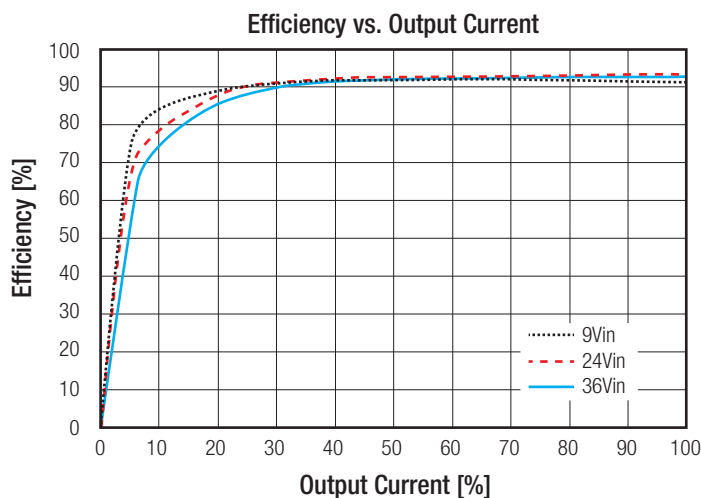
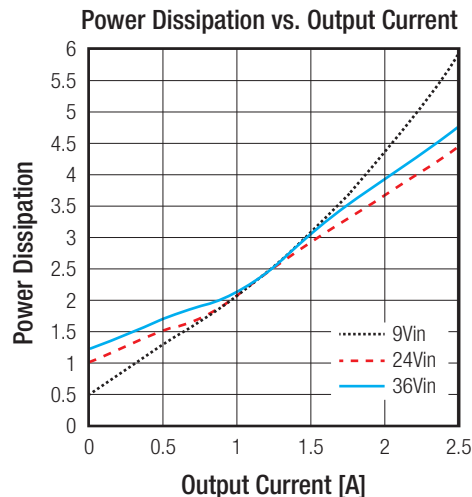
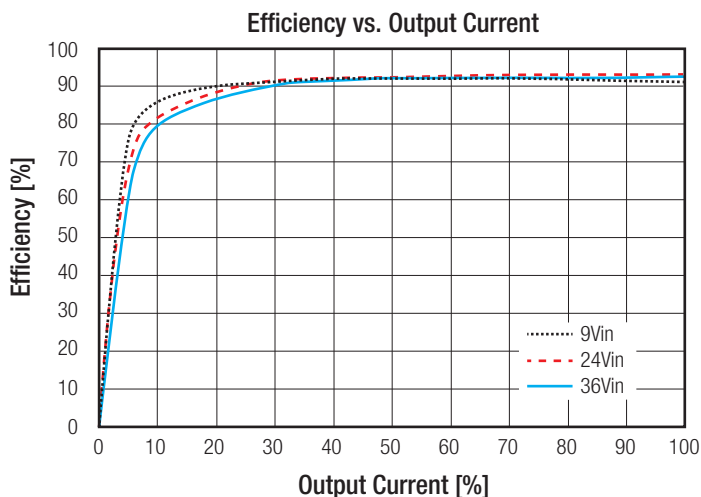


**Power Dissipation vs. Output Current**



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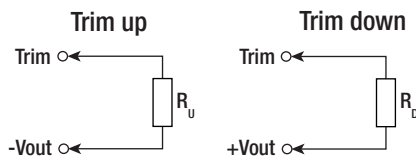
**Specifications** (masured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

**RPA60-2415SFW**

**RPA60-2424SFW**


## OUTPUT VOLTAGE TRIMMING

**Output Voltage Trimming**

RPA60-FW 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.


**RPA60-2405SFW**

|                    |      |      |      |      |      |      |      |      |      |      |       |
|--------------------|------|------|------|------|------|------|------|------|------|------|-------|
| Trim up            | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | [%]   |
| V <sub>out</sub> = | 5.05 | 5.10 | 5.15 | 5.20 | 5.25 | 5.30 | 5.35 | 5.40 | 5.45 | 5.50 | [VDC] |
| R <sub>u</sub> =   | 604  | 243  | 147  | 95.3 | 68.1 | 39.2 | 34.8 | 22.1 | 15   | 8.06 | [kΩ]  |
| Trim down          | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | [%]   |
| V <sub>out</sub> = | 4.95 | 4.90 | 4.85 | 4.80 | 4.75 | 4.70 | 4.65 | 4.60 | 4.55 | 4.50 | [VDC] |
| R <sub>D</sub> =   | 604  | 301  | 169  | 115  | 80.6 | 56.2 | 40.2 | 28   | 15   | 8.06 | [kΩ]  |

continued on next page

**Specifications** (masured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

| RPA60-2412SFW    |       |       |       |       |       |       |       |       |       |       |       |
|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 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 | [VDC] |
| R <sub>u</sub> = | 604   | 255   | 154   | 105   | 75    | 49.9  | 38.3  | 24.9  | 18.2  | 10    | [kΩ]  |
|                  |       |       |       |       |       |       |       |       |       |       |       |
| Trim down        | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | [%]   |
| Vout =           | 11.88 | 11.76 | 11.64 | 11.52 | 11.40 | 11.28 | 11.16 | 11.04 | 10.92 | 10.8  | [VDC] |
| R <sub>d</sub> = | 698   | 301   | 187   | 121   | 84.5  | 60.4  | 45.3  | 30.1  | 20    | 10    | [kΩ]  |
| RPA60-2415SFW    |       |       |       |       |       |       |       |       |       |       |       |
| Trim up          | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | [%]   |
| Vout =           | 15.15 | 15.3  | 15.45 | 15.60 | 15.75 | 15.90 | 16.05 | 16.20 | 16.35 | 16.50 | [VDC] |
| R <sub>u</sub> = | 750   | 309   | 191   | 124   | 71.5  | 59    | 40.2  | 28    | 15    | 8.06  | [kΩ]  |
|                  |       |       |       |       |       |       |       |       |       |       |       |
| Trim down        | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | [%]   |
| Vout =           | 14.85 | 14.70 | 14.55 | 14.40 | 14.25 | 14.10 | 13.95 | 13.80 | 13.65 | 13.50 | [VDC] |
| R <sub>d</sub> = | 698   | 374   | 226   | 150   | 105   | 71.5  | 59    | 32.4  | 20    | 8.06  | [kΩ]  |
| RPA60-2424SFW    |       |       |       |       |       |       |       |       |       |       |       |
| Trim up          | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | [%]   |
| Vout =           | 24.24 | 24.48 | 24.72 | 24.96 | 25.2  | 25.44 | 25.68 | 25.92 | 26.16 | 26.4  | [VDC] |
| R <sub>u</sub> = | 1000  | 511   | 324   | 221   | 162   | 121   | 90.9  | 68.1  | 48.7  | 34.8  | [kΩ]  |
|                  |       |       |       |       |       |       |       |       |       |       |       |
| Trim down        | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | [%]   |
| Vout =           | 23.76 | 23.52 | 23.38 | 23.04 | 22.8  | 22.56 | 22.32 | 22.08 | 21.84 | 21.6  | [VDC] |
| R <sub>d</sub> = | 1500  | 909   | 499   | 324   | 232   | 169   | 124   | 93.1  | 64.9  | 45.3  | [kΩ]  |

**REGULATION**

| Parameter          | Condition                        |                 | Value                              |
|--------------------|----------------------------------|-----------------|------------------------------------|
| Output Accuracy    |                                  |                 | ±1.0% max.                         |
| Line Regulation    | low line to high line, full load |                 | ±0.2% max.                         |
| Load Regulation    |                                  |                 | ±0.5%                              |
| Transient Response | 50%-75% full load                | 5Vout<br>others | ±5.0% Vout typ.<br>±2.5% Vout typ. |
|                    | 25% load step change             |                 | 250µs typ.                         |

**PROTECTION**

| Parameter                         | Condition   |                     | Value                                 |
|-----------------------------------|-------------|---------------------|---------------------------------------|
| Short Circuit Protection (SCP)    | below 100mΩ |                     | continuous, auto recovery             |
| Over Voltage Protection (OVP)     |             |                     | 115%-140% Output Voltage              |
| Over Current Protection (OCP)     |             |                     | 110%-150% Output Current, Hiccup mode |
| Over Temperature Protection (OTP) |             |                     | 115°C ±5°C                            |
| Isolation Voltage <sup>(4)</sup>  | I/P to O/P  | tested for 1 minute | 1.5kVDC                               |
| Isolation Resistance              |             |                     | 20MΩ min.                             |
| Isolation Capacitance             |             |                     | 2200pF typ.                           |
| Insulation Grade                  |             |                     | basic                                 |

**Notes:**

Note4: For repeat Hi-Pot testing, reduce the time and/or the test voltage

Note5: An input fuse is required if the mains supply is not over-current protected. Recommended fuse: 10A slow blow type

**Specifications** (measured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

**ENVIRONMENTAL**

| Parameter                                  | Condition                      |       | Value                                        |
|--------------------------------------------|--------------------------------|-------|----------------------------------------------|
| Operating Temperature Range <sup>(6)</sup> | with derating                  |       | -40°C to refer to "Thermal Calculation"      |
| Maximum Case Temperature                   |                                |       | +105°C                                       |
| Temperature Coefficient                    |                                |       | 0.02%/K                                      |
| Thermal Impedance                          |                                |       | refer to "Table 1: Thermal Impedance"        |
| Operating Altitude                         |                                |       | 4500m                                        |
| Operating Humidity                         |                                |       | 95% RH                                       |
| Shock                                      |                                |       | 5G, 30ms, 6 times along X, Y and Z axis      |
| Vibration                                  |                                |       | 10-500Hz, 2.4G, 30mins along X, Y and Z axis |
| MTBF                                       | according to Telcordia SR332 3 | +25°C | 5997 x 10 <sup>3</sup> hours                 |

**Table 1: Thermal Impedance**

| airflow<br>[m/s] | without Heatsink         |                                      | with Heatsink            |                                      |
|------------------|--------------------------|--------------------------------------|--------------------------|--------------------------------------|
|                  | Rth without PCB<br>[K/W] | Rth with PCB <sup>(6)</sup><br>[K/W] | Rth without PCB<br>[K/W] | Rth with PCB <sup>(6)</sup><br>[K/W] |
| 0.1              | 11.5                     | 7.5                                  | 9.6                      | 6.8                                  |
| 0.2              | 8.9                      | 5.6                                  | 7.4                      | 5.1                                  |
| 0.5              | 6.6                      | 4.1                                  | 5.5                      | 3.8                                  |
| 1.0              | 4.8                      | 3.0                                  | 4.0                      | 2.7                                  |
| 1.5              | 3.9                      | 2.5                                  | 3.3                      | 2.2                                  |
| 2.0              | 3.0                      | 1.9                                  | 2.5                      | 1.7                                  |

**Notes:**

Note6: Test PCB: 160x100mm 105µm (Eurocard), double layer

**Thermal Calculation**

choose your model:

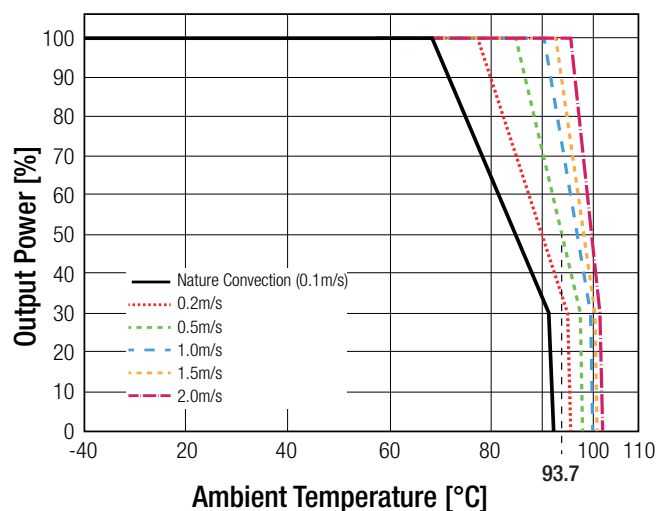
**RPA60-2405SFW (with PCB <sup>(6)</sup>)**

- Load conditions in application (e.g. 50%)
- Airflow conditions in application (e.g. 0.5m/s)
- use Rth from Table1 (4.1K/W)

Calculation:

$$\begin{aligned}
 I_{out} &= 50\% \\
 R_{th} &= 4.1\text{K/W} \\
 P_{DISS} &= 2.75\text{W} \\
 T_{CASEmax} &= 105^\circ\text{C}
 \end{aligned}$$

$$\begin{aligned}
 T_{OVER} &= R_{th} \times P_{Dis} = 4.1\text{K/W} \times 2.75\text{W} = 11.3\text{K} \\
 T_{AMBmax} &= T_{CASEmax} - T_{OVER} = 105^\circ\text{C} - 11.3\text{K} = 93.7^\circ\text{C}
 \end{aligned}$$

**RPA60-2405SFW**


choose your model:

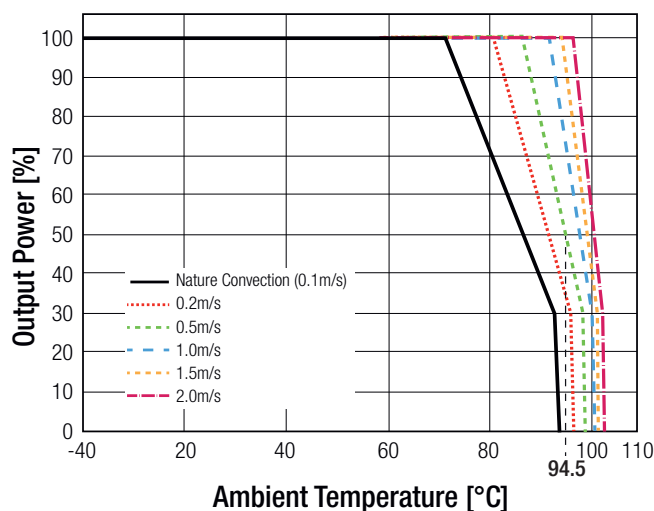
**RPA60-2405SFW-HC (with PCB <sup>(6)</sup>)**

- Load conditions in application (e.g. 50%)
- Airflow conditions in application (e.g. 0.5m/s)
- use Rth from Table1 (3.8K/W)

Calculation:

$$\begin{aligned}
 I_{out} &= 50\% \\
 R_{th} &= 3.8\text{K/W} \\
 P_{DISS} &= 2.75\text{W} \\
 T_{CASEmax} &= 105^\circ\text{C}
 \end{aligned}$$

$$\begin{aligned}
 T_{OVER} &= R_{th} \times P_{Dis} = 3.8\text{K/W} \times 3.04\text{W} = 10.5\text{K} \\
 T_{AMBmax} &= T_{CASEmax} - T_{OVER} = 105^\circ\text{C} - 10.5\text{K} = 94.5^\circ\text{C}
 \end{aligned}$$

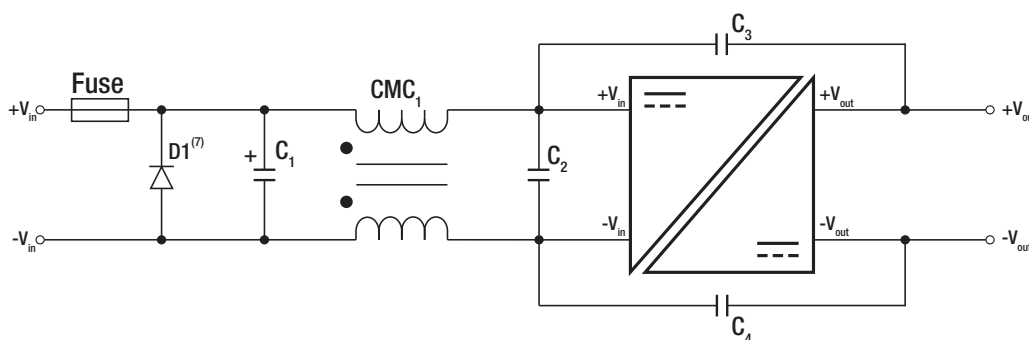
**RPA60-2405SFW-HC**


**Specifications** (masured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

**SAFETY AND CERTIFICATIONS**

| Certificate Type (Safety)                                                            | Report / File Number | Standard                                                                   |
|--------------------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------|
| Information Technology Equipment, General Requirements for Safety                    | E224736-A41          | UL60950-1:2014, 2nd Edition<br>CSA C22.2 No. 60950-1-07: 2014, 2nd Edition |
| IEC/EN Information Technology Equipment - General Requirments for Safety (CB Scheme) | E224736-A41-CB-1     | IEC60950-1: 2005, 2nd Edition + AM2, 2013                                  |
| IEC/EN Information Technology Equipment - General Requirments for Safety             |                      | EN60950-1: 2006, + A2, 2013                                                |
| Railway Applications - Electrical Equipment used on rolling stock                    | 15100173 001         | EN50155, 1st Edition, 2007, Clause 5.4 and 5.5                             |
| RoHS2                                                                                |                      | RoHS 10/10, 2011/65/EU + AM-2015/863                                       |

| EMC Compliance (designed to meet)                                                                                                                                                   | Condition                                                                      | Standard / Criterion           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------|
| Electromagnetic compatibility of multimedia equipment - Emission requirements                                                                                                       | with external filter<br>(see filter suggestion below)                          | EN55032: 2015, Class A         |
| Railway applications - Electromagnetic compatibility Part 3-2: Rolling stock - Apparatus                                                                                            |                                                                                | EN50121-3-2, 2015              |
| Specification for radio disturbance and immunity measuring apparatus and methods Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements |                                                                                | EN55016-2-1, 2009              |
| Specification for radio disturbance and immunity measuring apparatus and methods Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements  |                                                                                | EN55016-2-3, 2010              |
| ESD Electrostatic discharge immunity test                                                                                                                                           | Air ±8kV, Contact ±6kV                                                         | EN61000-4-2, 2009; Criteria A  |
| Radiated, radio-frequency, electromagnetic field immunity test                                                                                                                      | 20V/m, 80-1000MHz<br>10V/m, 1.4-2.0GHz<br>5V/m, 2.0-2.7GHz<br>3V/m, 5.1-6.0GHz | EN61000-4-3, 2006; Criteria A  |
| Fast Transient and Burst Immunity                                                                                                                                                   | ±2kV                                                                           | IEC61000-4-4, 2004; Criteria A |
| Surge Immunity                                                                                                                                                                      | ±1kV                                                                           | EN61000-4-5, 2006; Criteria A  |
| Immunity to conducted disturbances, induced by radio-frequency fields                                                                                                               | 10V                                                                            | EN61000-4-6, 2009; Criteria A  |

**EMC Filtering according to EN50121-3-2 and EN55032 Class A**


| C1                      | C2            | C3/C4          | CMC1       |
|-------------------------|---------------|----------------|------------|
| 100μF/100V electrolytic | 10μF/50V MLCC | 6.8nF/2kV MLCC | 350μH/8.5A |

**Notes:**

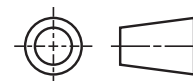
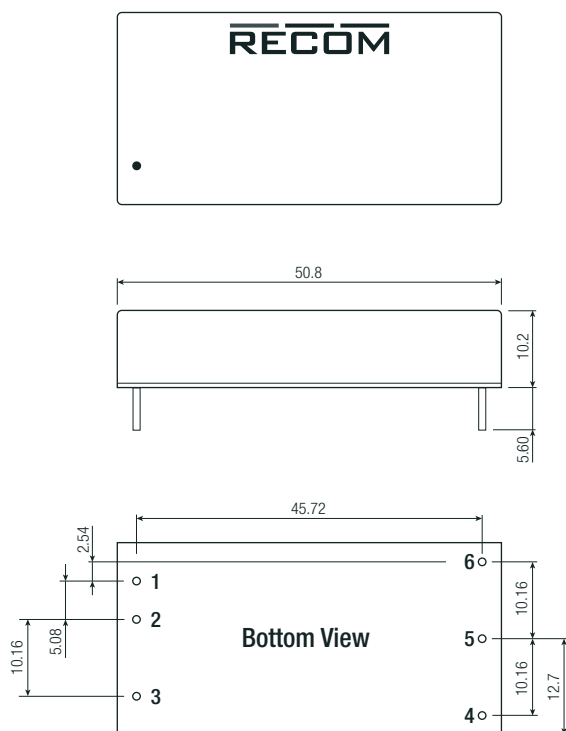
Note7: Diode is only needed for EN50155

**Specifications** (masured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

**DIMENSIONS and PHYSICAL CHARACTERISTICS**

| Parameter          | Type                                | Value                                                               |
|--------------------|-------------------------------------|---------------------------------------------------------------------|
| Material           | case<br>baseplate<br>potting        | al alloy, anodize black<br>non-conductive FR4<br>silicone (UL94-V0) |
| Dimensions (LxWxH) | without Heat-sink<br>with Heat-sink | 50.8 x 25.4 x 10.2mm<br>50.8 x 25.4 x 17.1mm                        |
| Weight             | without Heat-sink<br>with Heat-sink | 35g typ.<br>46g typ.                                                |

**Dimension Drawing (mm)**

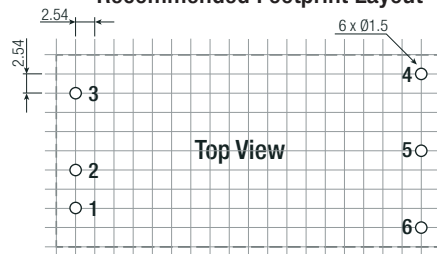


**Pin Connections**

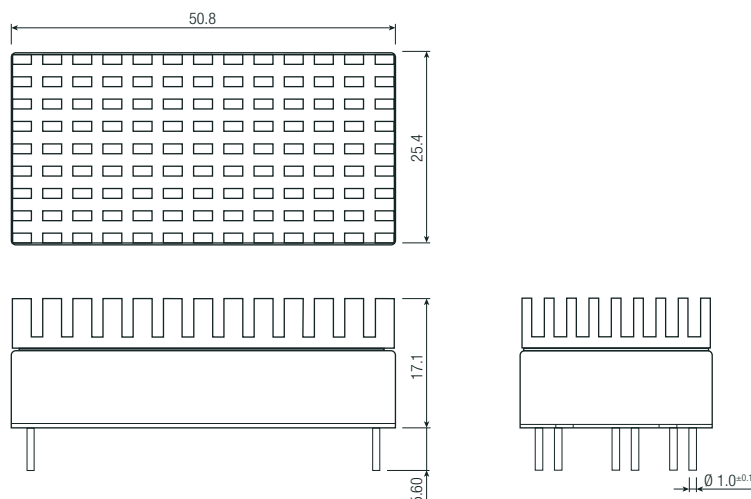
| Pin # | Single              |
|-------|---------------------|
| 1     | +Vin                |
| 2     | -Vin                |
| 3     | CTRL <sup>(2)</sup> |
| 4     | Trim                |
| 5     | -Vout               |
| 6     | +Vout               |

Pin Pitch Tolerance  $\pm 0.25\text{mm}$   
xx.x =  $\pm 0.5\text{mm}$   
xx.xx =  $\pm 0.25\text{mm}$

**Recommended Footprint Layout**



**Dimension Drawing (mm) with Heat-sink**



**Specifications** (masured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

| PACKAGING INFORMATION        |                |                   |                       |
|------------------------------|----------------|-------------------|-----------------------|
| Parameter                    | Type           |                   | Value                 |
| Packaging Dimensions (LxWxH) | tube           | without Heat-sink | 285.0 x 27.6 x 19.0mm |
|                              |                | with Heat-sink    | 285.0 x 27.6 x 25.8mm |
| Packaging Quantity           |                |                   | 5pcs                  |
| Storage Temperature Range    |                |                   | -55°C to +125°C       |
| Storage Humidity             | non-condensing |                   | 5% - 95% RH           |

The product information and specifications may be subject to changes even without prior written notice. The product has been designed for various applications; its suitability lies in the responsibility of each customer. The products are not authorized for use in safety-critical applications without RECOM's explicit written consent. A safety-critical application is an application where a failure may reasonably be expected to endanger or cause loss of life, inflict bodily harm or damage property. The applicant shall indemnify and hold harmless RECOM, its affiliated companies and its representatives against any damage claims in connection with the unauthorized use of RECOM products in such safety-critical applications.