

# RECOM

## DC/DC Converter

## Features

- 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

## Regulated Converter

## RPA60-FW

60 Watt  
 2" x 1"  
 Single Output



UL60950-1 certified  
 IEC/EN60950 certified  
 EN50155 certified

## 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.

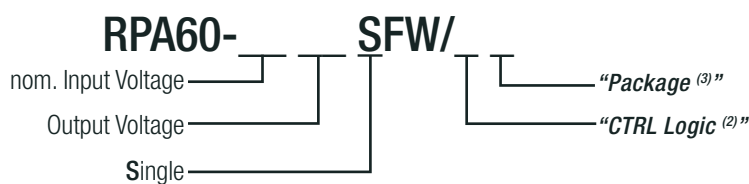
## Selection Guide

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

## 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



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

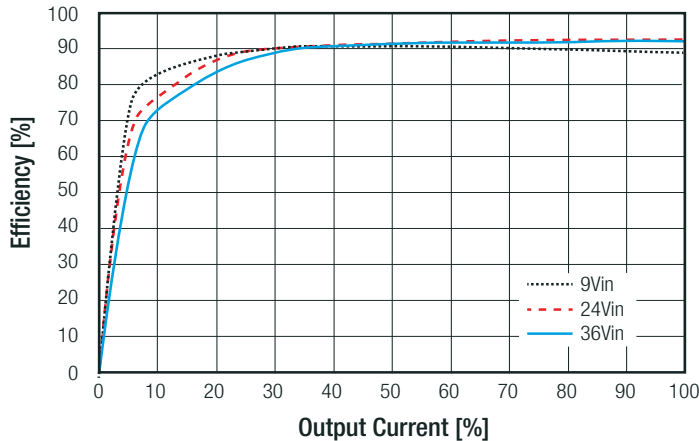
**Specifications** (measured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

### BASIC CHARACTERISTICS

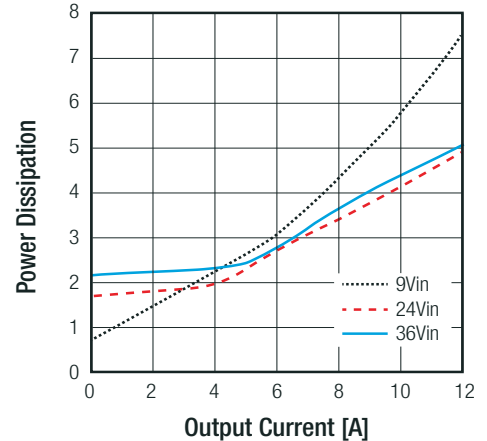
Parameter	Condition	Min.	Typ.	Max.
Internal Input Filter				LC Filter
Input Voltage Range	nom. Vin = 24VDC	9VDC	24VDC	36VDC
Input Surge Voltage	100ms max.			50VDC
Under Voltage Lockout (UVLO)	DC-DC ON	8VDC	8.5VDC	9VDC
	DC-DC OFF	7VDC	7.5VDC	8VDC
Quiescent Current	5Vout		70mA	
	12Vout & 15Vout		60mA	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

#### RPA60-2405SFV

Efficiency vs. Output Current

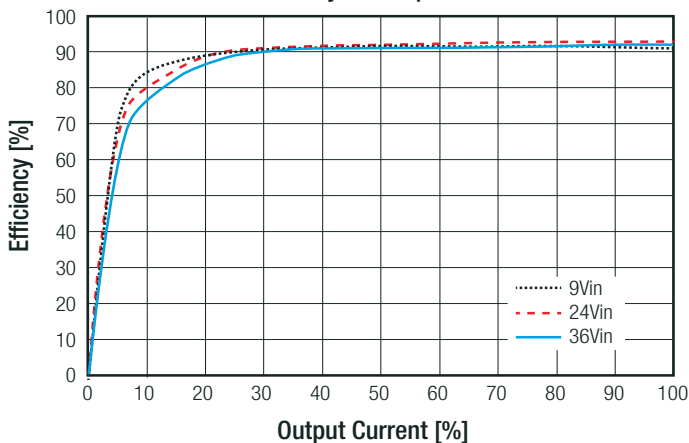


Power Dissipation vs. Output Current

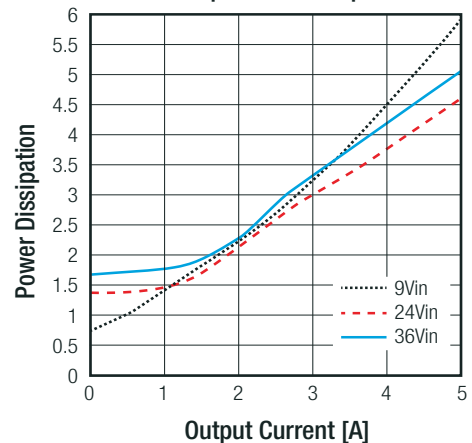


#### RPA60-2412SFV

Efficiency vs. Output Current



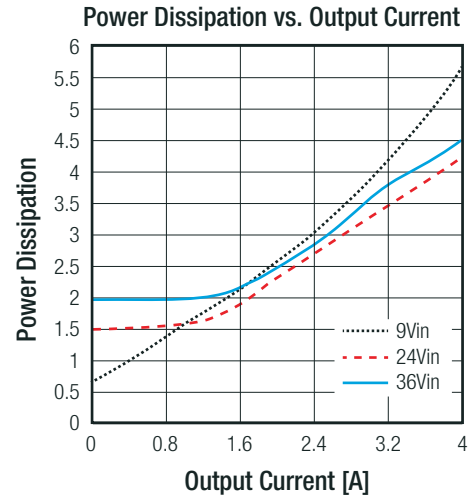
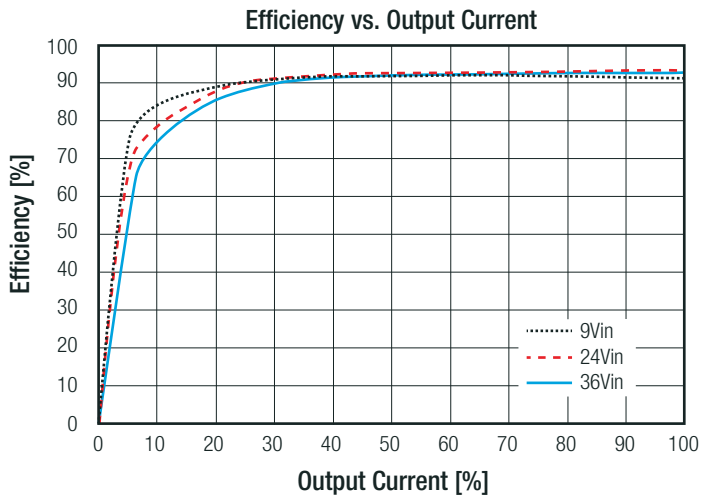
Power Dissipation vs. Output Current



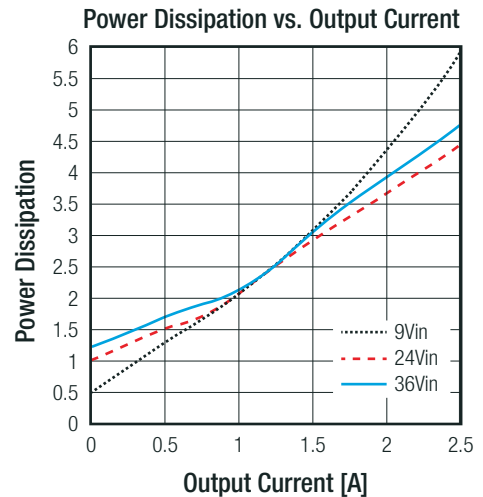
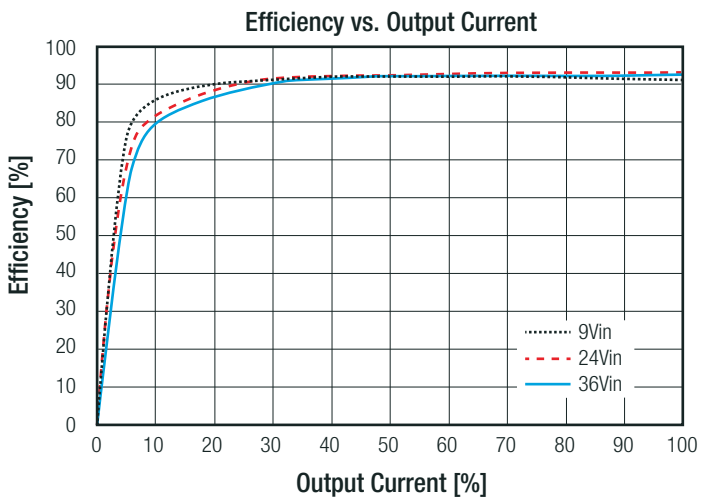
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**Specifications** (measured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

### RPA60-2415SFW



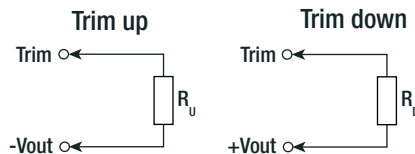
### RPA60-2424SFW



## 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	[%]
Vout =	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	[%]
Vout =	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]

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

<b>RPA60-2412SFW</b>											
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]
<b>RPA60-2415SFW</b>											
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]
<b>RPA60-2424SFW</b>											
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]

<b>REGULATION</b>		
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	±5.0% Vout typ. ±2.5% Vout typ.
	25% load step change	250µs typ.

<b>PROTECTION</b>		
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
Isolation Resistance		10MΩ 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 <i>"Thermal Calculation"</i>
Maximum Case Temperature		+105°C
Temperature Coefficient		0.02%/K
Thermal Impedance		refer to <i>"Table 1: Thermal Impedance"</i>
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 [m/s]	without Heatsink		with Heatsink	
	Rth without PCB [K/W]	Rth with PCB <sup>(6)</sup> [K/W]	Rth without PCB [K/W]	Rth with PCB <sup>(6)</sup> [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:

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

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

choose your model:

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

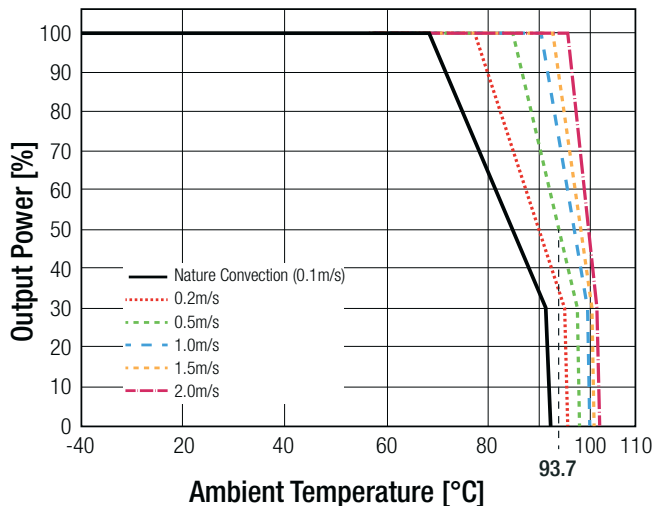
- Load conditions in application (e.g. 50%)
- Airflow conditions in application (e.g. 0.5m/s)
- use Rth from Table1 (3.8K/W)

Calculation:

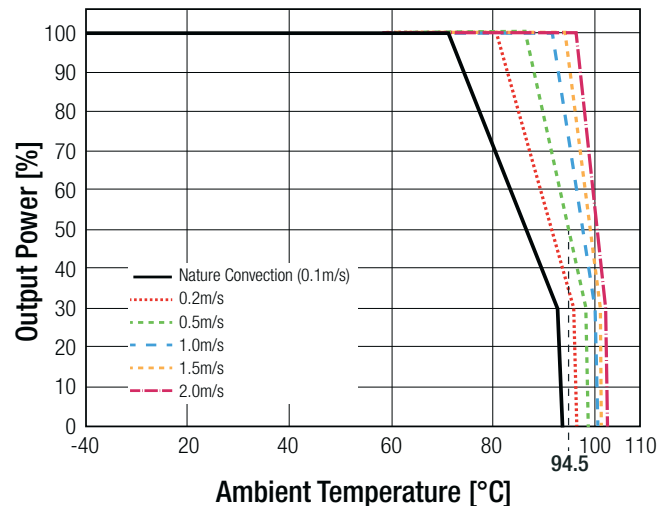
$$\begin{aligned} I_{out} &= 50\% \\ R_{th} &= 3.8\text{K/W} \\ P_{DISS} &= 2.75\text{W} \\ T_{CASEmax} &= 105^\circ\text{C} \end{aligned}$$

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

**RPA60-2405SFW**



**RPA60-2405SFW-HC**



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

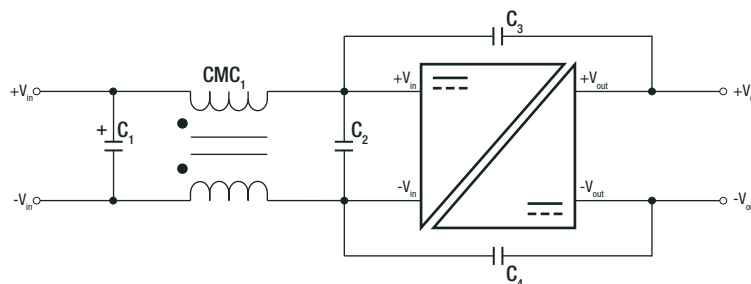
### SAFETY AND CERTIFICATIONS

Certificate Type (Safety)	Report / File Number	Standard
Information Technology Equipment, General Requirements for Safety	E224736-A41	UL60950-1:2014, 2nd Edition CSA C22.2 No. 60950-1-07: 2014, 2nd Edition
IEC/EN Information Technology Equipment - General Requirements for Safety (CB Scheme)	E224736-A41-CB-1	IEC60950-1: 2005, 2nd Edition + AM2, 2013
IEC/EN Information Technology Equipment - General Requirements 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)

EMC Compliance (designed to meet)	Condition	Standard / Criterion
Electromagnetic compatibility of multimedia equipment - Emission requirements	with external filter (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 10V/m, 1.4-2.0GHz 5V/m, 2.0-2.7GHz 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



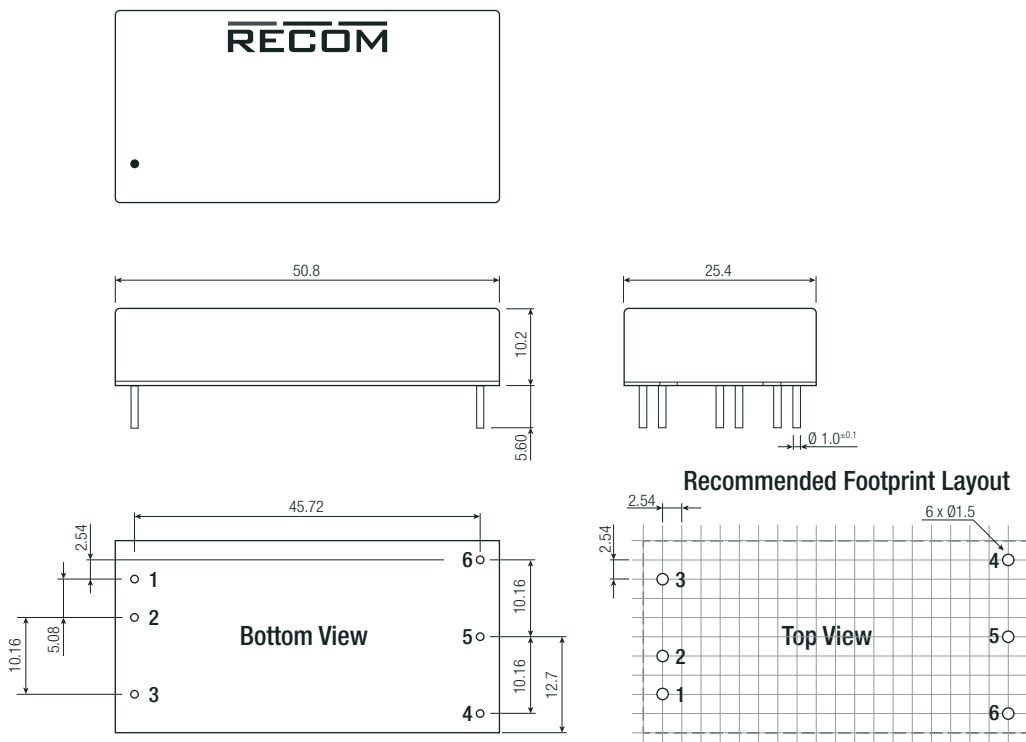
C1	C2	C3/C4	CMC <sub>1</sub>
100µF/100V electrolytic	10µF/50V MLCC	6.8nF/2kV MLCC	350µH/8.5A

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

### DIMENSIONS and PHYSICAL CHARACTERISTICS

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

#### Dimension Drawing (mm)

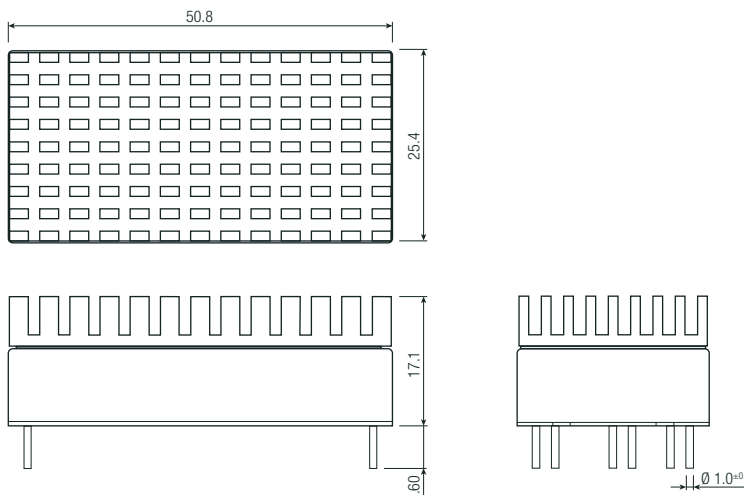


#### Pin Connections

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 =  $\pm 0.25\text{mm}$

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



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

Parameter	Type		Value
	Packaging Dimensions (LxWxH)	tube	
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.