

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



60 Watt
2" x 1"
Single Output



A black rectangular module with the 'RUBICON' logo in blue and red. Below the logo, it says 'RTP450-FM series'. On the right side, there is a 'CE' mark and a small circular logo.



UL[®]
C US
E224736



UL60950-1 certified
IEC/EN60950 certified
EN50155 certified

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

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

RPA60- **SFW/**

nom. Input Voltage ———— **“Package”⁽³⁾**

Output Voltage ———— **“CTRL Logic”⁽²⁾**

Single ————

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)

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



PD-1

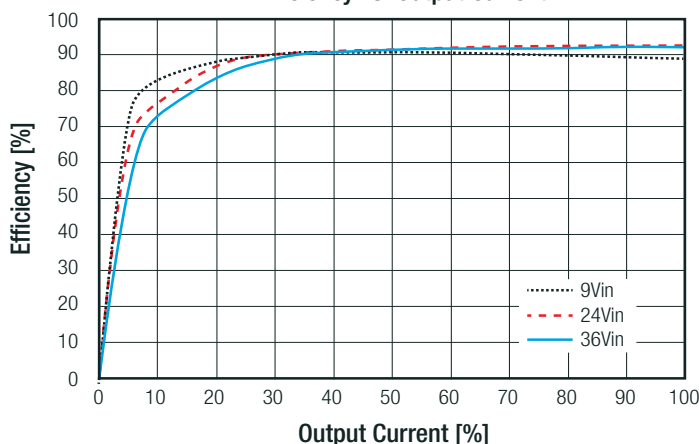
Specifications (measured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

BASIC CHARACTERISTICS

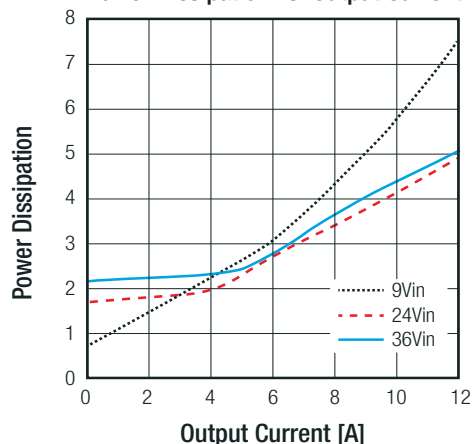
Parameter	Condition	Min.	Typ.	Max.
Internal Input Filter				LC Filter
Input Voltage Range	nom. Vin = 24VDC	9VDC	24VDC	36VDC
Input Surge Voltage	100ms max.			50VDC
Under Voltage Lockout (UVLO)	DC-DC ON DC-DC OFF	8VDC 7VDC	8.5VDC 7.5VDC	9VDC 8VDC
Quiescent Current	5Vout 12Vout & 15 Vout 24Vout		70mA 60mA 40mA	
Output Voltage Trimming	refer to "OUTPUT VOLTAGE TRIMMING"	-10%		+10%
Minimum Load		0%		
Start-up time	Power up Remote ON/OFF		60ms	
ON/OFF CTRL ⁽²⁾	Positive Logic	DC-DC ON DC-DC OFF	Open or 2.4VDC < V _{CTRL} < 10VDC Short or 0VDC < V _{CTRL} < 0.8VDC	
	Negative Logic	DC-DC ON DC-DC OFF	Short or 0VDC < V _{CTRL} < 0.8VDC Open or 2.4VDC < V _{CTRL} < 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	

RPA60-2405SFW

Efficiency vs. Output Current

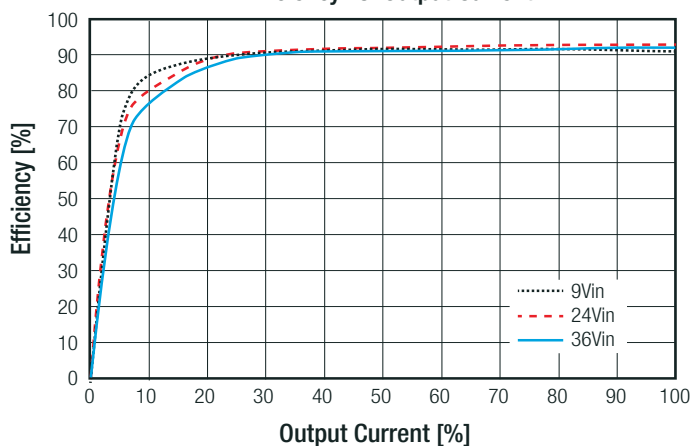


Power Dissipation vs. Output Current

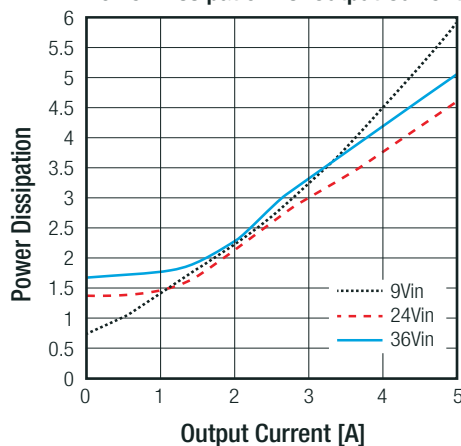


RPA60-2412SFW

Efficiency vs. Output Current



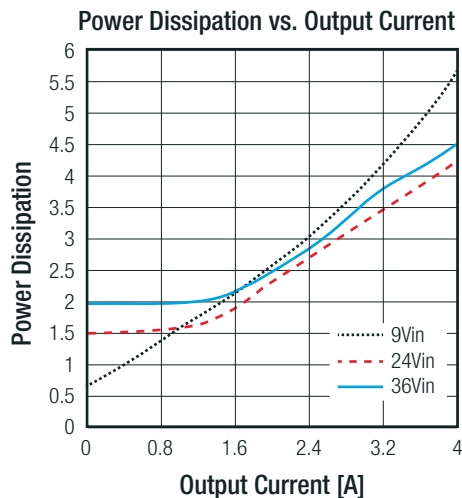
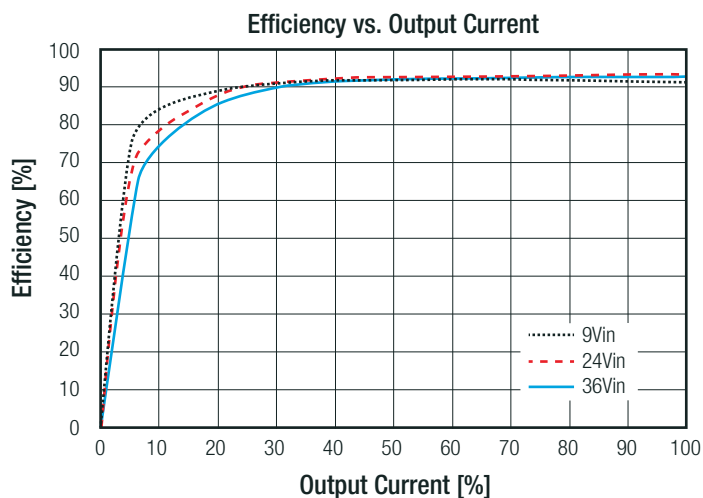
Power Dissipation vs. Output Current



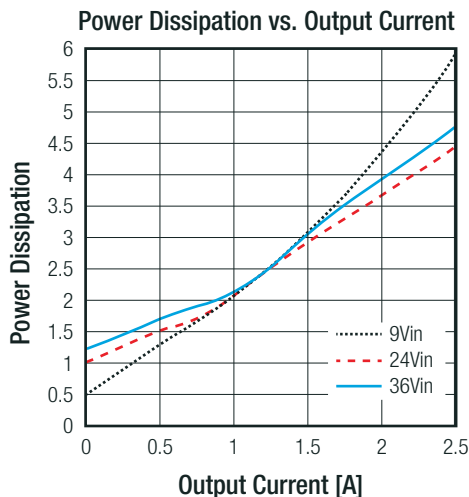
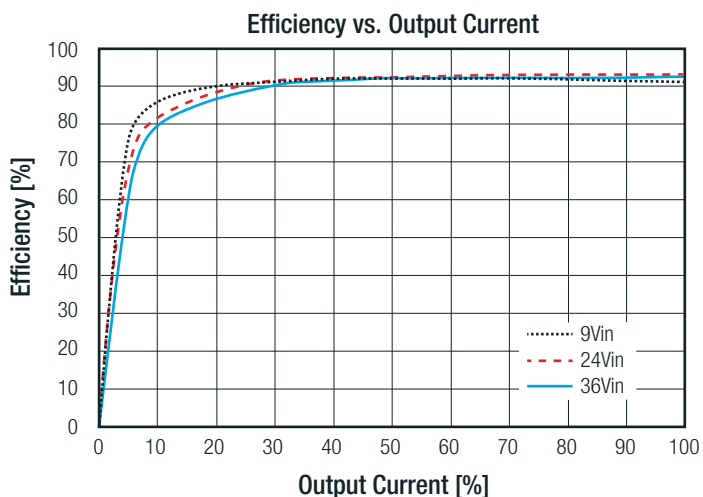
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Specifications (measured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

RPA60-2415SFW



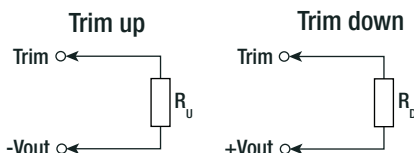
RPA60-2424SFW



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]
Ru =	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]
Rd =	604	301	169	115	80.6	56.2	40.2	28	15	8.06	[kΩ]

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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 _u =	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 _d =	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 _u =	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 _d =	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 _u =	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 _d =	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 others	±5.0% Vout typ. ±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 ⁽⁴⁾	I/P to O/P tested for 1 minute	1.5kVDC
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 ⁽⁶⁾	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 ³ hours

Table 1: Thermal Impedance

	without Heatsink		with Heatsink	
airflow [m/s]	Rth without PCB [K/W]	Rth with PCB ⁽⁶⁾ [K/W]	Rth without PCB [K/W]	Rth with PCB ⁽⁶⁾ [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 ⁽⁶⁾)

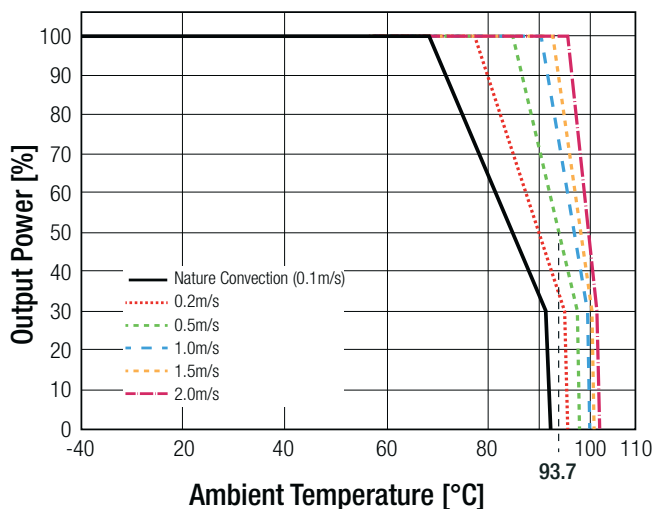
- Load conditions in application (e.g. 50%)
- Airflow conditions in application (e.g. 0.5m/s)
- use Rth from Table1 (4.1K/W)

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 ⁽⁶⁾)

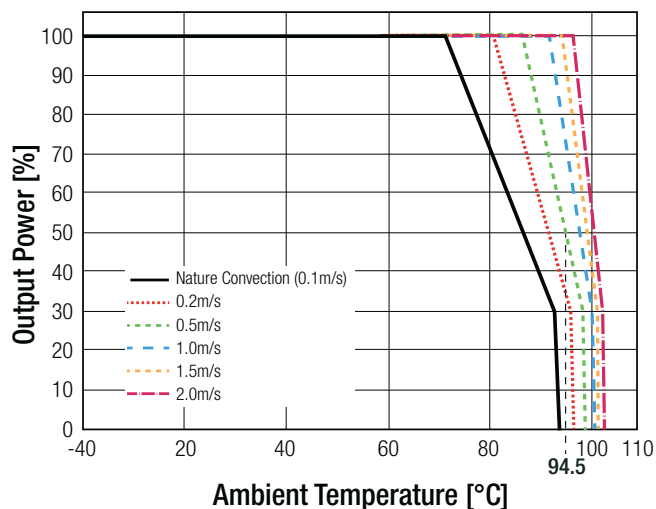
- Load conditions in application (e.g. 50%)
- Airflow conditions in application (e.g. 0.5m/s)
- use Rth from Table1 (3.8K/W)

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



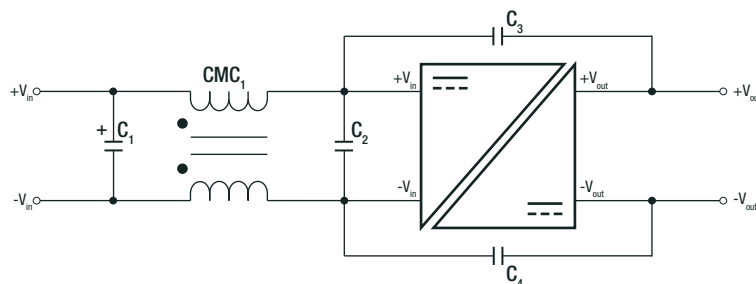
Specifications (masured @Ta = 25°C, resistive load, nominal Vin and rated Iout unless otherwise noted)

SAFETY AND CERTIFICATIONS

Certificate Type (Safety)	Report / File Number	Standard
Information Technology Equipment, General Requirements for Safety	E224736-A41	UL60950-1:2014, 2nd Edition 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 (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



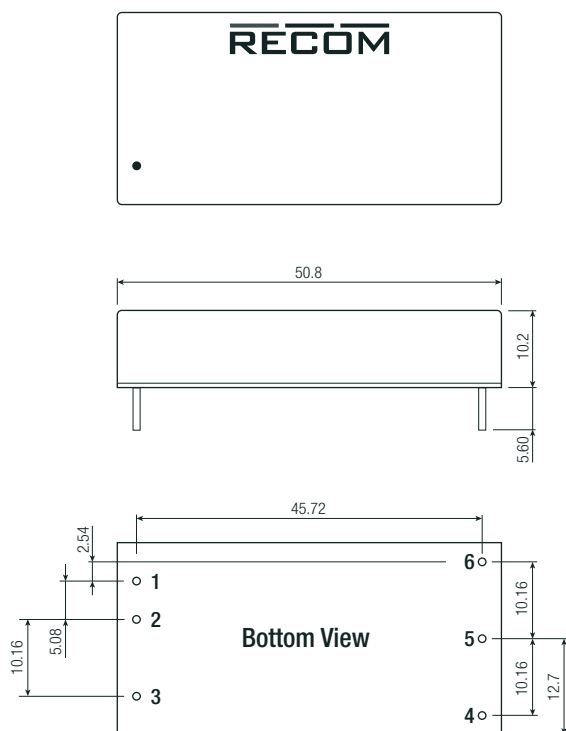
C1	C2	C3/C4	CMC ₁
100µF/100V electrolytic	10µF/50V MLCC	6.8nF/2kV MLCC	350µH/8.5A

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)

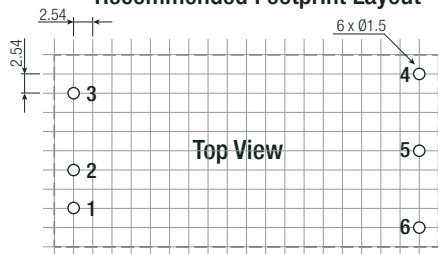


Pin Connections

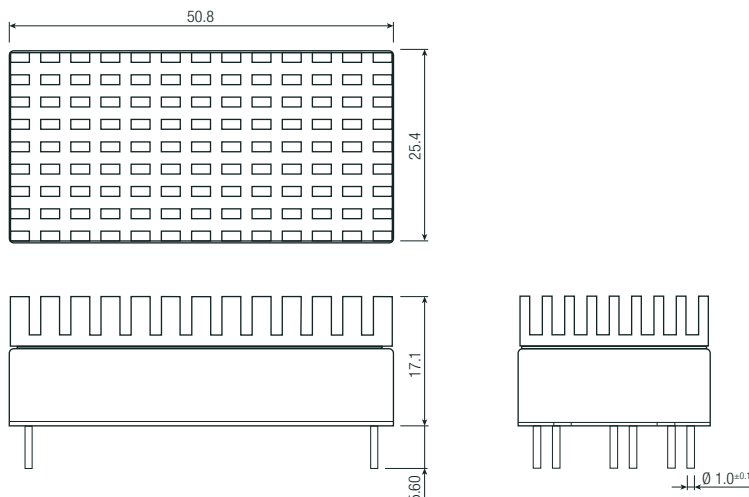
Pin #	Single
1	+Vin
2	-Vin
3	CTRL ⁽²⁾
4	Trim
5	-Vout
6	+Vout

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 (measured @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

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