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# Features

# Regulated Converters

- 4:1 Wide Input Range
- 3kVAC Reinforced Insulation for 110Vin  
2.25kVDC Basic Insulation for 24Vin & 48Vin
- Efficiency up to 90%
- No Minimum Load Required
- EN50155 Certified
- IEC/EN60950-1 Certified



## RP90Q-RW

**90 Watt  
Quarter  
Brick  
Single Output**



### Description

The quarter-brick RP90Q series DC/DC converters are designed for railway rolling stock and high voltage battery applications. Each series has three 4:1 input voltage range options to cover all input voltages from 9VDC up to 160VDC with isolated and regulated 5V to 48VDC outputs. The converters have high efficiencies and metal base-plates to permit a wide operating temperature range from -40°C to +85°C (when mounted on a suitable heatsink). 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 converters are EN50155 and IEC/EN60950 certified. The RP90Q-RW series have a three year warranty.

### Selection Guide

Part Number	Input Voltage Range [VDC]	Output Voltage [VDC]	Output Current [mA]	Input <sup>(1)</sup> Current [mA]	Output Power [W]	Efficiency <sup>(1)</sup> typ. [%]	Max. Capacitive Load [µF]
RP90Q-2405SRW <sup>(2,3)</sup>	9-36	5	18000	4213	90	89	36000
RP90Q-2412SRW <sup>(2,3)</sup>	9-36	12	7500	4213	90	89	6250
RP90Q-2415SRW <sup>(2,3)</sup>	9-36	15	6000	4213	90	89	4000
RP90Q-2424SRW <sup>(2,3)</sup>	9-36	24	3700	4157	89	89	1540
RP90Q-2448SRW <sup>(2,3)</sup>	9-36	48	1800	4090	86.5	88	380
RP90Q-4805SRW <sup>(2,3)</sup>	16.5-75	5	18000	2107	90	89	36000
RP90Q-4812SRW <sup>(2,3)</sup>	16.5-75	12	7500	2107	90	89	6250
RP90Q-4815SRW <sup>(2,3)</sup>	16.5-75	15	6000	2083	90	90	4000
RP90Q-4824SRW <sup>(2,3)</sup>	16.5-75	24	3700	2055	89	90	1540
RP90Q-4848SRW <sup>(2,3)</sup>	16.5-75	48	1800	2000	86.5	90	380
RP90Q-11005SRW <sup>(2,3)</sup>	40-160	5	17000	868	85	89	34000
RP90Q-11012SRW <sup>(2,3)</sup>	40-160	12	7000	858	84	89	5830
RP90Q-11015SRW <sup>(2,3)</sup>	40-160	15	5500	843	82.5	89	3670
RP90Q-11024SRW <sup>(2,3)</sup>	40-160	24	3500	858	84	89	1460
RP90Q-11048SRW <sup>(2,3)</sup>	40-160	48	1800	882	86.5	89	380

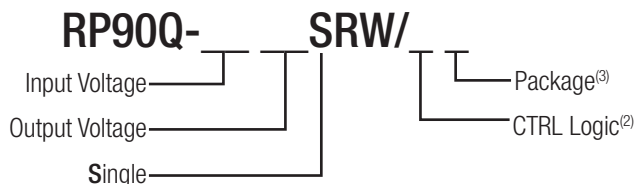
#### Notes:

Note1: Efficiency is tested by nominal Vin, full load and at 25°C.



EN50155 Certified  
IEC/EN60950-1 Certified

### Model Numbering



#### Ordering Examples

RP90Q-2405SRW/N = 24V Input, 5V Output, Single, Neg. CTRL function

RP90Q-11012SRW/P = 110V Input, 12V Output, Single, Pos. CTRL function

RP90Q-2405SRW/N-HC = 24V Input, 5V Output, Single, Neg. CTRL function, with premounted Heat-sink

#### Notes:

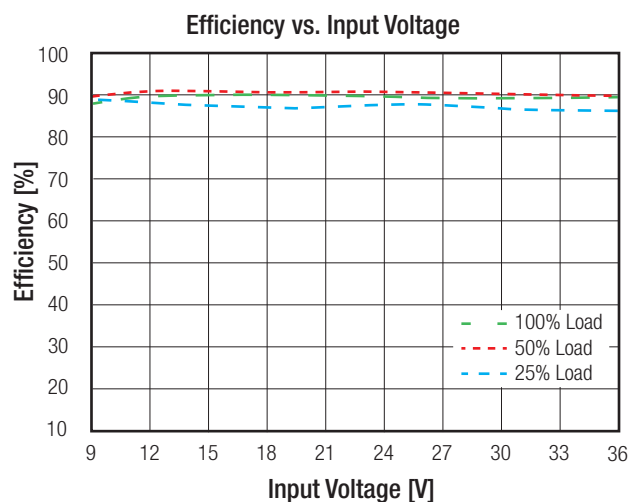
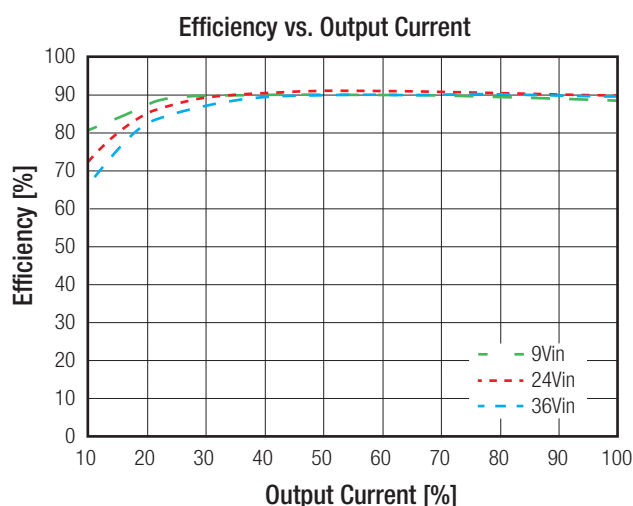
Note2: standard part is with suffix "P" for positive logic (1=ON, 0=OFF) or add suffix "N" instead for negative logic (0=ON, 1=OFF)

Note3: add suffix "-HC" for premounted Heat-sink (compatible with all other suffixes)

**Specifications** measured @ $t_a = 25^\circ\text{C}$ , resistive load, nominal  $V_{in}$  and rated  $I_{out}$  unless otherwise noted

BASIC CHARACTERISTICS					
Parameter	Condition		Min.	Typ.	Max.
Internal Input Filter					Pi-Type
Input Voltage Range	nom $V_{in} = 24\text{V}$ nom $V_{in} = 48\text{V}$ nom $V_{in} = 110\text{V}$		9VDC 16.5VDC 40VDC	24VDC 48VDC 110VDC	36VDC 75VDC 160VDC
Input Surge Voltage	$V_{in} = 24\text{V}$ , 1s max. $V_{in} = 48\text{V}$ , 1s max. $V_{in} = 110\text{V}$ , 1s max.				50VDC 100VDC 185VDC
Quiescent Current	$V_{in} = 24\text{V}$ $V_{in} = 48\text{V}$ $V_{in} = 110\text{V}$			25ma 15mA 8mA	
Start-up time	Power up ON/OFF Control			75ms 75ms	100ms 100ms
Internal Operating Frequency			270kHz	300kHz	330kHz
Minimum Load			0%		
Ripple and Noise	Measured by 20MHz BW with a 22 $\mu\text{F}$ /25V X7R MLCC with a 22 $\mu\text{F}$ /25V X7R MLCC with a 4.7 $\mu\text{F}$ /50V X7R MLCC with a 2.2 $\mu\text{F}$ /100V X7R MLCC	5 $V_{out}$ 12, 15 $V_{out}$ 24 $V_{out}$ 48 $V_{out}$		75mVp-p 100mVp-p 200mVp-p 300mVp-p	
Under Voltage Lockout (UVLO)	$V_{in} = 24\text{V}$	DC-DC ON DC-DC OFF	7.3VDC		9VDC 8.1VDC
	$V_{in} = 48\text{V}$	DC-DC ON DC-DC OFF	15.5VDC		18VDC 16.3VDC
	$V_{in} = 110\text{V}$	DC-DC ON DC-DC OFF	33VDC		43VDC 36VDC
ON/OFF Control	Positive Logic	DC-DC ON DC-DC OFF		Open or $3.0\text{V} < V_r < 12\text{V}$ Short or $0\text{V} < V_r < 1.2\text{V}$	
	Negative Logic	DC-DC ON DC-DC OFF		Short or $0\text{V} < V_r < 1.2\text{V}$ Open or $3.0\text{V} < V_r < 12\text{V}$	
Input Current of CTRL pin			-0.5mA		1mA
Standby Current				3mA	
Output Trim			-20%		+10%
Remote Sense	% of set $V_{out}$				10%

### RP90Q-2405SRW

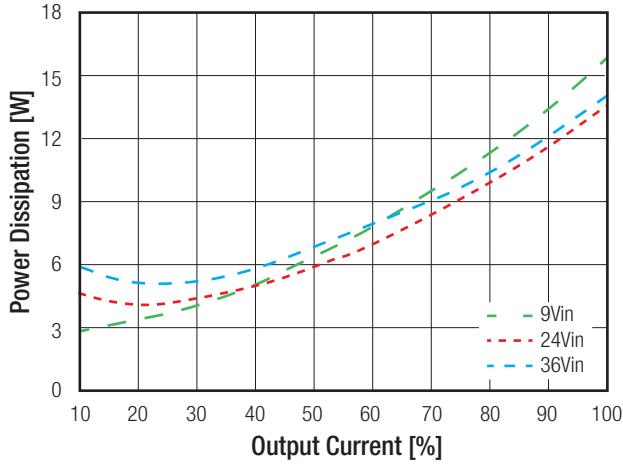


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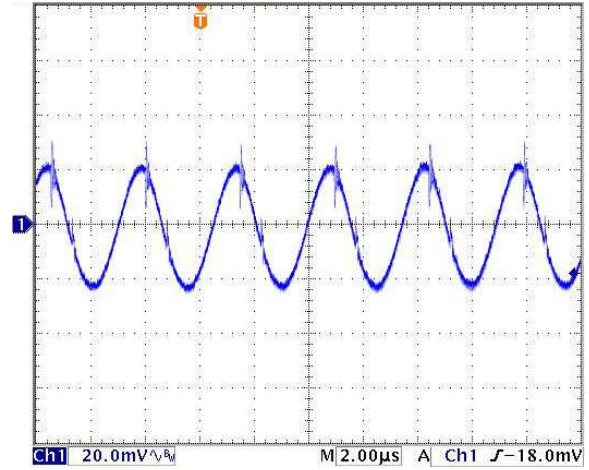
Specifications measured @ $t_a = 25^\circ\text{C}$ , resistive load, nominal  $V_{in}$  and rated  $I_{out}$  unless otherwise noted

RP90Q-2405SRW

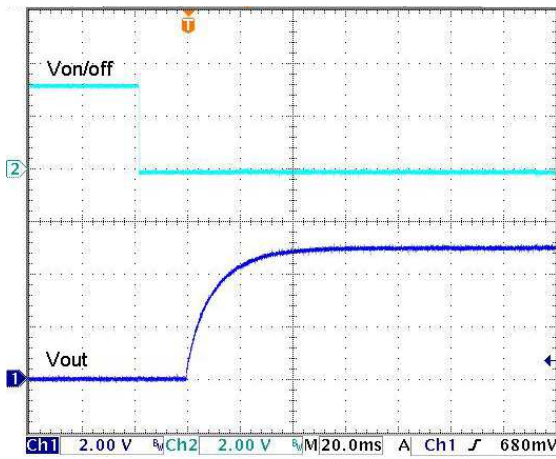
Power Dissipation vs. Output Current



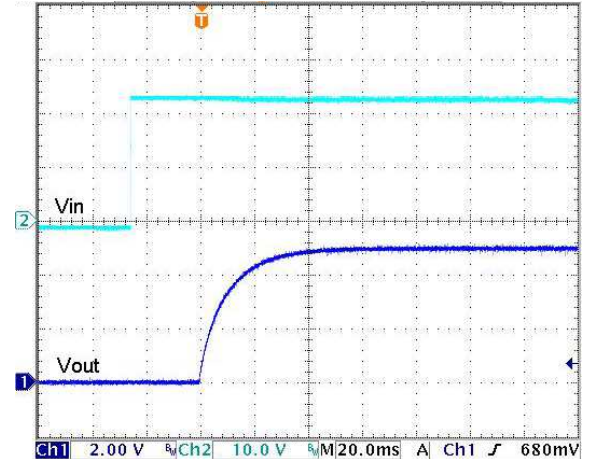
Typical Output Ripple and Noise/full load



ON/OFF Control Start up Rise Characteristic

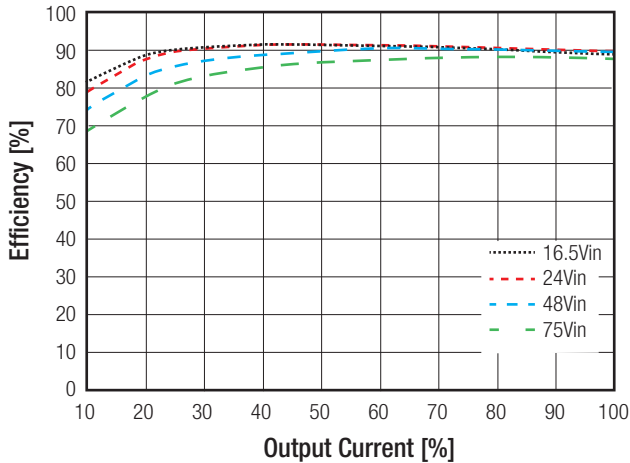


Power up Start-up Rise Characteristic

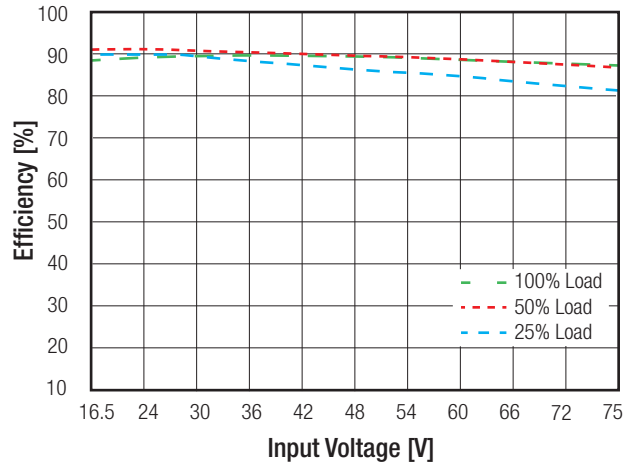


RP90Q-4805SRW

Efficiency vs. Output Current



Efficiency vs. Input Voltage

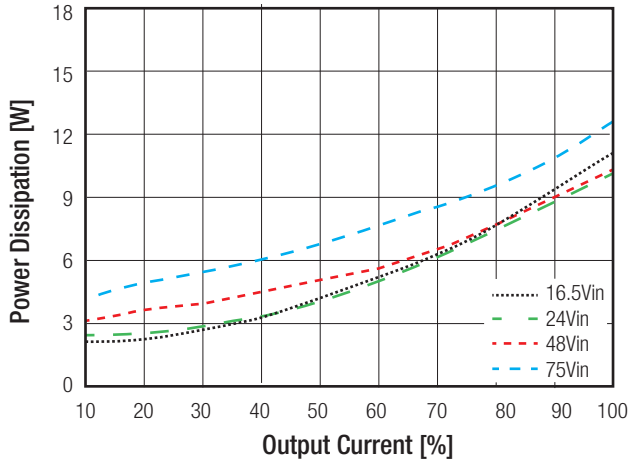


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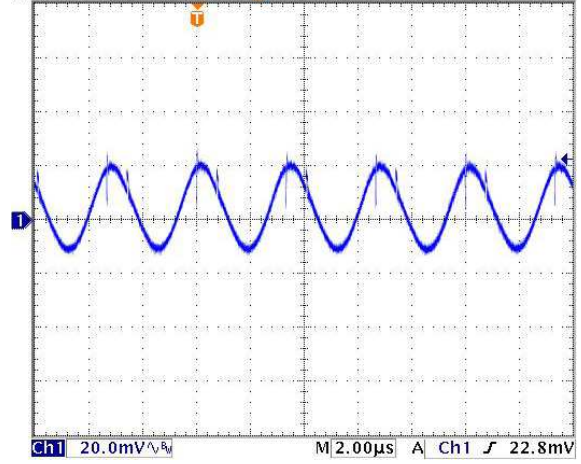
**Specifications** measured @ $t_a = 25^\circ\text{C}$ , resistive load, nominal  $V_{in}$  and rated  $I_{out}$  unless otherwise noted

## RP90Q-4805SRW

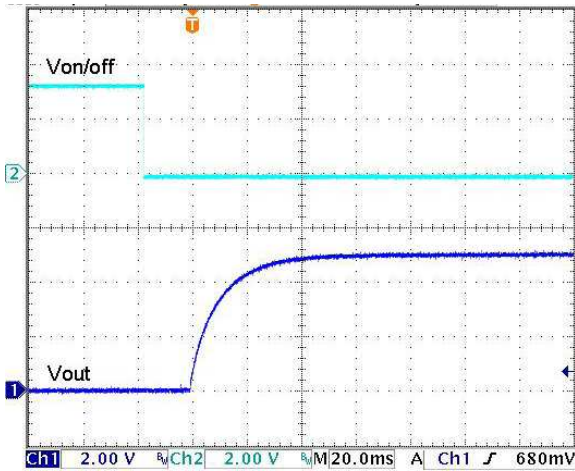
Power Dissipation vs. Output Current



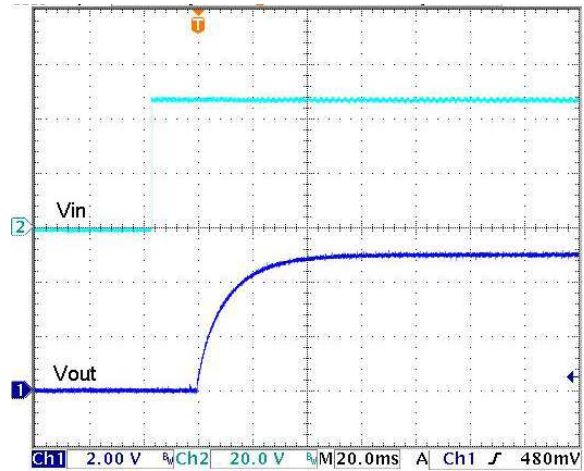
Typical Output Ripple and Noise/full load



ON/OFF Control Start up Rise Characteristic

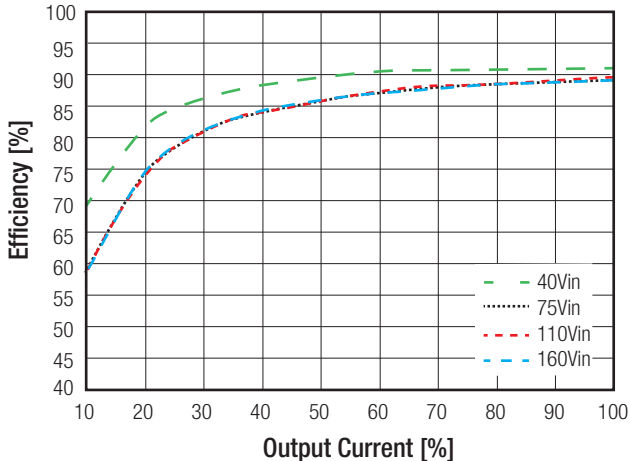


Power up Start-up Rise Characteristic

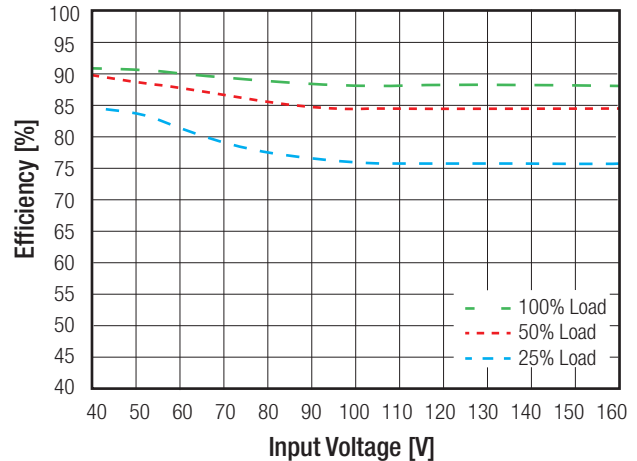


## RP90Q-11005SRW

Efficiency vs. Output Current



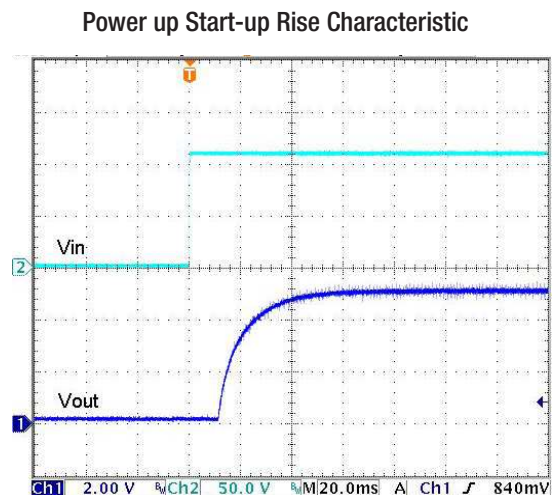
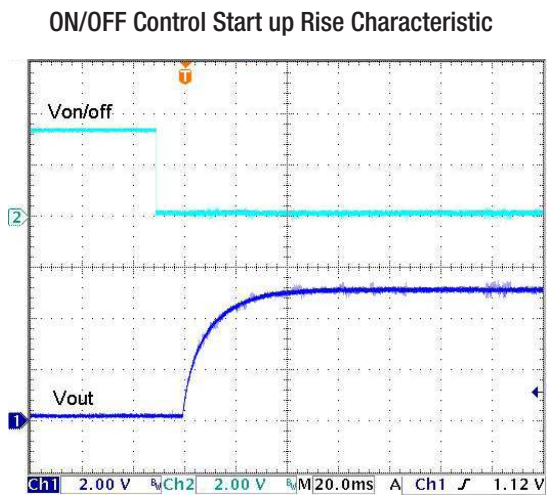
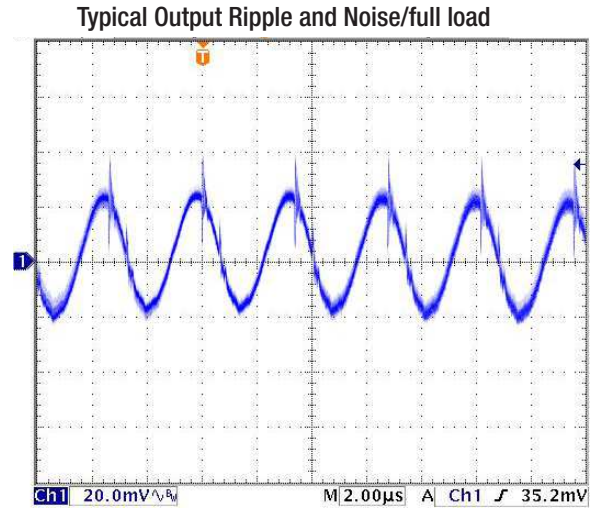
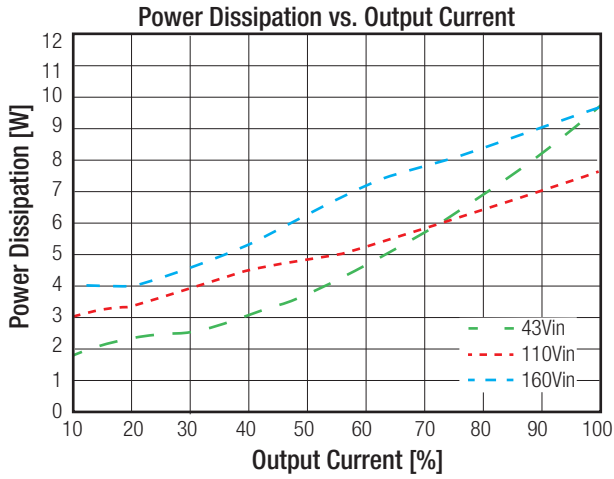
Efficiency vs. Input Voltage



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Specifications measured @ $t_a = 25^\circ\text{C}$ , resistive load, nominal  $V_{in}$  and rated  $I_{out}$  unless otherwise noted

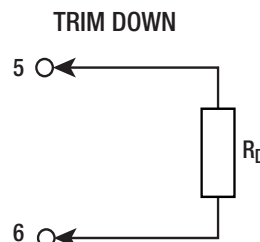
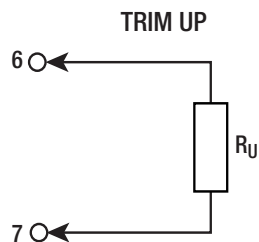
RP90Q-11005SRW



**OUTPUT TRIM**

**Output Voltage Trimming**

RP90Q-RW 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.



Specifications (measured @ ta= 25°C, nominal input voltage, full load and after warm-up)

## OUTPUT TRIM

### Trim Calculation

$$R_1 = \left[ \frac{511 \cdot V_{out} + 5.11 \Delta V_{out} \cdot V_{out}}{1.225 \cdot \Delta V_{out}} - \frac{(511 + 10.22 \Delta V_{out})}{\Delta V_{out}} \right] k\Omega$$

$$R_2 = \left[ \frac{511}{\Delta V_{out}} - 10.22 \right] k\Omega$$

V<sub>out</sub> = Output Voltage  
 ΔV<sub>out</sub> = Output Voltage Trim in %  
 R<sub>1</sub> = trim up resistor  
 R<sub>2</sub> = trim down resistor

### Practical Example:

#### Trim Up:

V<sub>out</sub> = 5V, ΔV<sub>out</sub> = 10% (5.5V)

$$R_1 = \left[ \frac{511 \cdot V_{out} + 5.11 \Delta V_{out} \cdot V_{out}}{1.225 \cdot \Delta V_{out}} - \frac{(511 + 10.22 \Delta V_{out})}{\Delta V_{out}} \right] k\Omega = \frac{511 \cdot 5 + 5.11 \cdot 10 \cdot 5}{1.225 \cdot 10} - \frac{511 + 10.22 \cdot 10}{10} = 229.43 - 61.32 = 169 k\Omega$$

#### Trim down:

V<sub>out</sub> = 5V, ΔV<sub>out</sub> = -10% (4.5V)

$$R_2 = \left[ \frac{511}{\Delta V_{out}} - 10.22 \right] k\Omega = \frac{511}{10} - 10.22 = 41.2 k\Omega$$

### RP90Q-xx05SRW

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	5.4	5.45	5.50	Volts
R <sub>1</sub> =	1580	806	536	402	324	247	237	205	187	169	KOhms

### RP90Q-xx12SRW

Trim up	1	2	3	4	5	6	7	8	9	10	%
V <sub>out</sub> =	12.12	12.24	12.36	12.48	12.60	12.72	12.84	12.96	13.08	13.20	Volts
R <sub>1</sub> =	4530	2320	1540	1150	931	787	681	604	536	487	KOhms

### RP90Q-xx15SRW

Trim up	1	2	3	4	5	6	7	8	9	10	%
V <sub>out</sub> =	15.15	15.30	15.45	15.60	15.75	15.90	16.05	16.20	16.35	16.50	Volts
R <sub>1</sub> =	5760	2940	1960	1470	1210	1020	866	768	698	619	KOhms

### RP90Q-xx24SRW

Trim up	1	2	3	4	5	6	7	8	9	10	%
V <sub>out</sub> =	24.24	24.48	24.72	24.96	25.20	25.44	25.68	25.92	26.16	26.40	Volts
R <sub>1</sub> =	9530	4870	3240	2940	2000	1690	1470	1270	1150	1050	KOhms

### RP90Q-xx48SRW

Trim up	1	2	3	4	5	6	7	8	9	10	%
V <sub>out</sub> =	48.48	48.96	49.44	49.92	50.40	50.88	51.36	51.84	52.32	52.80	Volts
R <sub>1</sub> =	19600	9945	6650	5110	4120	3400	3010	2610	2370	2150	KOhms

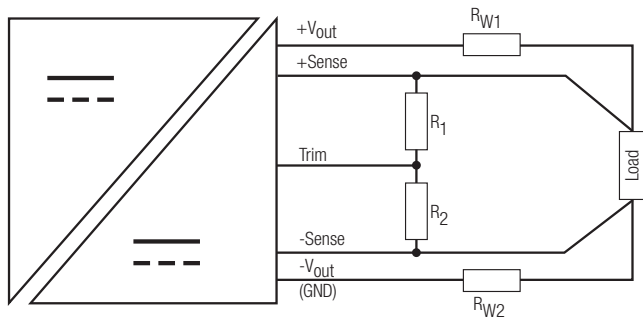
### Trim Down all Vout's

Trim down	1	2	3	4	5	6	7	8	9	10	%
R <sub>2</sub> =	499	243	162	118	909	75	63.4	53.6	46.4	41.2	KOhms
Trim down	11	12	13	14	15	16	17	18	19	20	%
R <sub>2</sub> =	36.5	32.4	28.7	26.1	23.7	21.5	19.6	18.2	16.5	15.4	KOhms

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Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

## Remote Sense



The output voltage can be adjusted by both trim and remote sense. The maximum combined adjustment range  $\pm 10\%$ . Derate the maximum output power if using the trim or sense function.

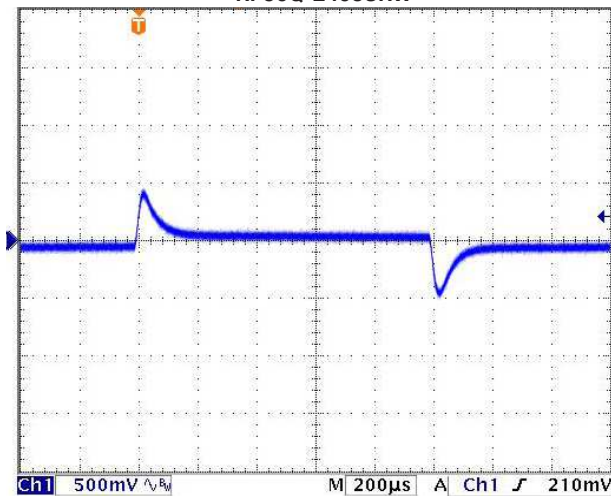
- $R_{W1}$  ... wire losses +
- $R_{W2}$  ... wire losses -
- $R_1$  ... trim up resistor
- $R_2$  ... trim down resistor

## REGULATIONS

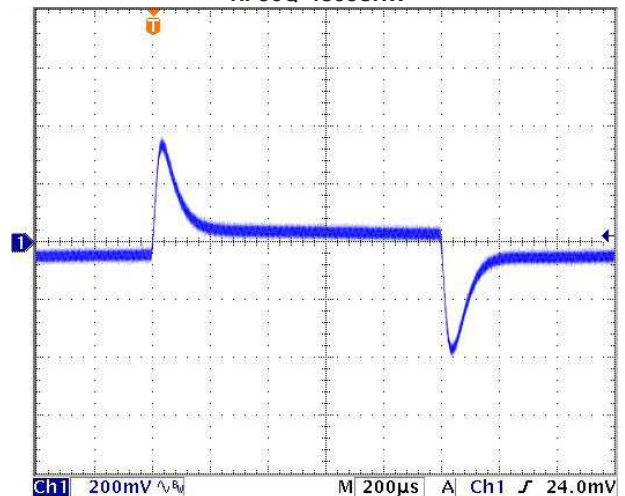
Parameter	Condition	Value
Output Accuracy		$\pm 1.0\%$
Line Regulation	low line to high line at full load	$\pm 0.1\%$
Load Regulation	0% to 100% load	$5V_{out}$ $\pm 0.2\%$ others $\pm 0.1\%$
Transient Response	25% load step change	250 $\mu\text{s}$ typ.

Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load at nom.  $V_{in}$

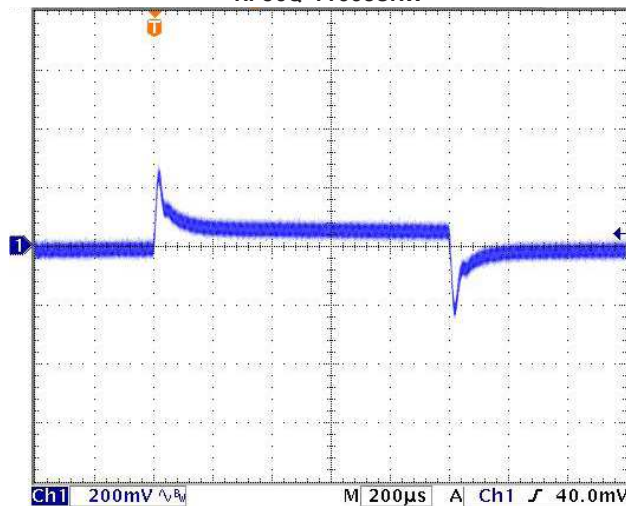
RP90Q-2405SRW



RP90Q-4805SRW



RP90Q-11005SRW





**Specifications** (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

PROTECTIONS		
Parameter	Condition	Value
Short Circuit Protection (SCP)	below 100mΩ	continuous, automatic recovery
Over Voltage Protection (OVP)	% of nom. Vout	115%-130%, Hiccup Mode
Over Load Protection (OLP)	% Iout rated	110%-140%, Hiccup Mode
Over Temperature Protection (OTP)		+110°C
Isolation Voltage	110Vin I/P to O/P I/P or O/P to Baseplate	3kVDC/1minute 1.5kVDC/1minute
	24Vin, 48Vin I/P to O/P I/P or O/P to Baseplate	2.25kVDC/1minute 2.25kVDC/1minute
Isolation Resistance	500 VDC	1GΩ min.
Isolation Capacitance		1500pF max.
Isolation Grade	110Vin	Reinforced Insulation
	24Vin, 48Vin	Basic Insulation

**Notes:**

Note4: An input fuse is required if the mains supply isn't over-current protected. Recommended fuse: T35A slow blow.

ENVIRONMENTAL		
Parameter	Condition	Value
Operating Baseplate Temperature Range		-40°C to +100°C
Maximum Case Temperature		100°C
Temperature Coefficient		±0.02%/°C max.
Thermal Impedance	vertical direction by natural convection (0.1m/s) without Heat-sink	9°C/W
	vertical direction by natural convection (0.1m/s) with Heat-sink	7.5°C/W
Operating Humidity		5% - 95% RH
Pollution Degree		PD2
Shock		according to EN61373 standard
Thermal Shock		according to MIL-STD-810F standard
Vibration		according to EN61373 standard
Fire protection on railway vehicles		according to EN45545-2, 2013 standard
MTBF	according to MIL-HDBK-217F standard, 25°C	507.0 x 10 <sup>3</sup> hours

**Thermal Calculation**

$$R_{th\text{case-ambient}} = 9^\circ\text{C/W (vertical)}$$

$$R_{th\text{case-ambientHC}} = 7.5^\circ\text{C/W (vertical)}$$

$$R_{th\text{case-ambient}} = \frac{T_{\text{case}} - T_{\text{ambient}}}{P_{\text{dissipation}}}$$

$$P_{\text{dissipation}} = P_{\text{IN}} - P_{\text{OUT}} = \frac{P_{\text{OUTapp}}}{\eta} - P_{\text{OUTapp}}$$

- $T_{\text{case}}$  = Case Temperature
- $T_{\text{ambient}}$  = Environment Temperature
- $P_{\text{dissipation}}$  = Internal losses
- $P_{\text{IN}}$  = Input Power
- $P_{\text{OUT}}$  = Output Power
- $\eta$  = Efficiency under given Operating Conditions
- $R_{th\text{case-ambient}}$  = Thermal Impedance

**Practical Example:**

Take the RP90Q-2405SRW with 9V input Voltage and 50% load. What is the maximum ambient operating temperature? Use converter vertical in application without airflow.

$$Eff_{\text{min}} = 89\% @ V_{\text{nom}}$$

$$P_{\text{OUT}} = 90\text{W}$$

$$P_{\text{OUTapp}} = 90 \times 0.5 = 45\text{W}$$

$$\eta = 91\% \text{ (Efficiency vs. Load Graph)}$$

$$P_{\text{dissipation}} = \frac{45}{0.91} - 45 = 4.45\text{W}$$

**without Heat-sink**

$$R_{th} = \frac{T_{\text{casemax}} - T_{\text{amb}}}{P_{\text{dissipation}}} \rightarrow 9^\circ\text{C/W} = \frac{100 - T_{\text{amb}}}{4.45\text{W}}$$

$$T_{\text{amb}} = 60^\circ\text{C}$$

**with Heat-sink**

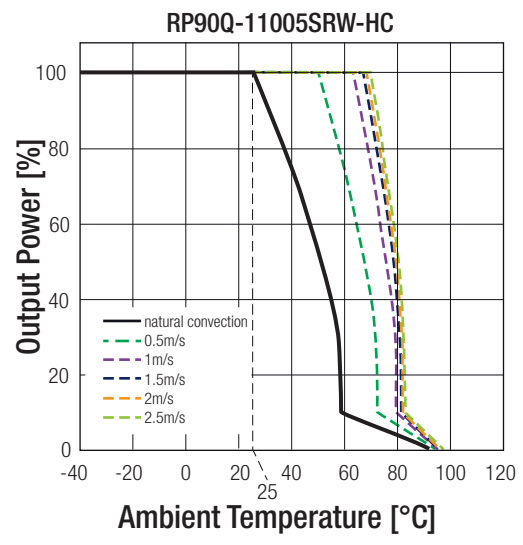
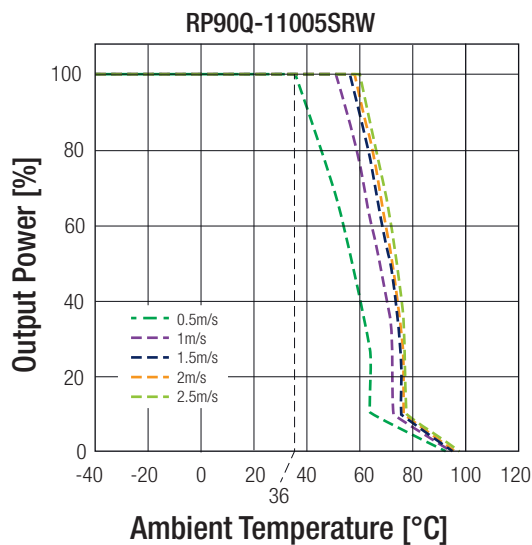
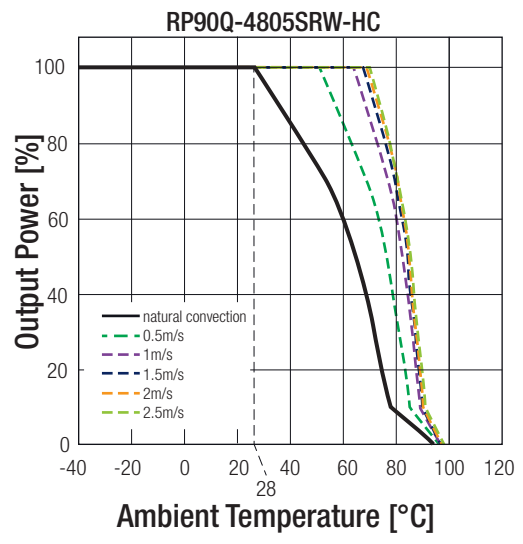
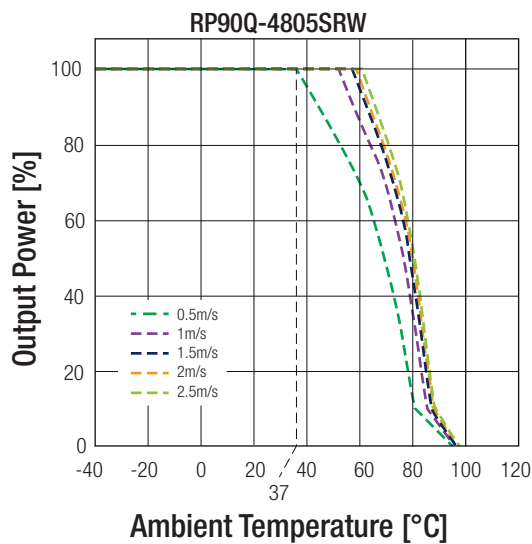
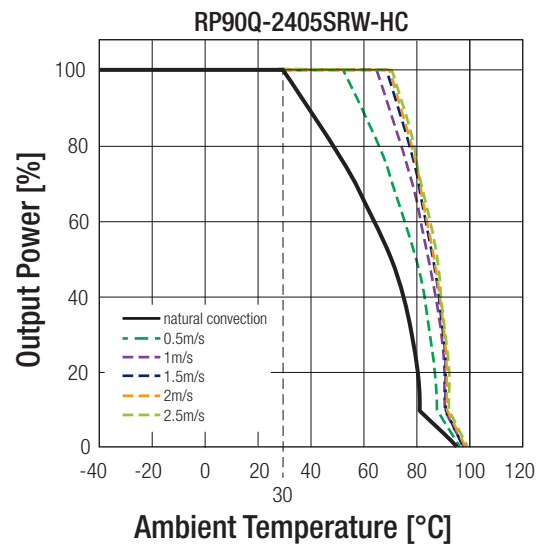
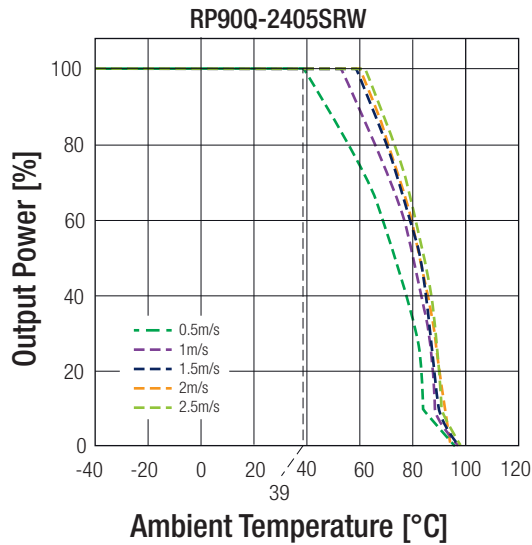
$$R_{thHC} = \frac{T_{\text{casemax}} - T_{\text{amb}}}{P_{\text{dissipation}}} \rightarrow 7.5^\circ\text{C/W} = \frac{100 - T_{\text{amb}}}{4.45\text{W}}$$

$$T_{\text{ambHC}} = 66^\circ\text{C}$$

continued on next page

Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

Derating Graph<sup>5)</sup>  
(@ Chamber - tested with forced convection)



Notes:

Note5: Derating graphs are valid only for the shown part numbers. If you need detailed derating-information about a part-number not shown here please contact our technical support service at [techsupportAT@recom-power.com](mailto:techsupportAT@recom-power.com)

Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

### SAFETY AND CERTIFICATIONS

Certificate Type (Safety)	Report / File Number	Standard
IEC/EN Information Technology Equipment - General Requirements for Safety	TW1608086-001	IEC60950-1, 2nd Edition, 2005 EN60950-1, 2nd Edition, 2006
Railway Applications - Electrical Equipment used on rolling stock	TW1608078-001	EN50155, 2007

EMI Compliance	Condition	Standard / Criterion
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	with external filter	EN55022, Class A and Class B
Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement		EN55011, Class A and Class B
ESD Electrostatic discharge immunity test	Air $\pm 8\text{kV}$ and Contact $\pm 6\text{kV}$	EN61000-4-2, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	20 V/m	EN61000-4-3, Criteria A
Fast Transient and Burst Immunity <sup>(6)</sup>	$\pm 2\text{kV}$	EN61000-4-4, Criteria A
Surge Immunity <sup>(6)</sup>	EN55024 & EN50155 $\pm 2\text{kV}$	EN61000-4-5, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	10 Vr.m.s	EN61000-4-6, Criteria A
Power Magnetic Field Immunity	100A/m continuous; 1000A/m 1s	EN61000-4-8, Criteria A

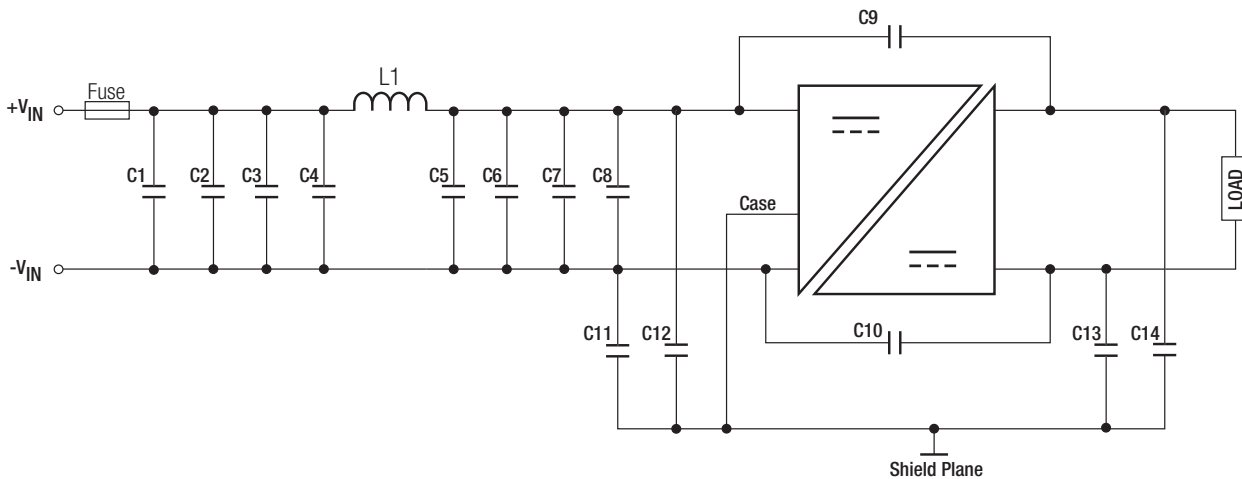
#### Notes:

Note6: An external input filter capacitor is required if the module has to meet EN61000-4-4 and EN61000-4-5.

The **24Vin** and **48Vin** version recommend 2pcs of aluminium electrolytic capacitor to connect in parallel.  
Recom suggest: Nippon Chemi-con KY series, 220 $\mu\text{F}$ /100V.

The **110Vin** version recommend 2pcs of aluminium electrolytic capacitor to connect in parallel.  
Recom suggest: Nippon Chemi-con KXJ series, 150 $\mu\text{F}$ /200V

#### EMI Filtering according to EN55022/11 Class A and EN50121-1 (24Vin and 48Vin)



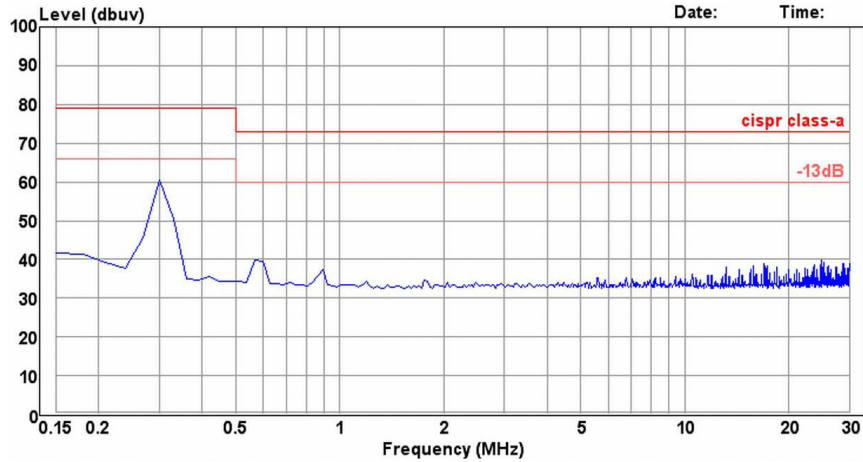
MODEL	C1	C2, C3, C4	C5	C6, C7, C8	C9 to C14	L1
RP90Q-24xxSRW	N/A	6.8 $\mu\text{F}$ , 50V 1812 MLCC	N/A	6.8 $\mu\text{F}$ , 50V 1812 MLCC	1000pF, 3kV 1808 MLCC	0.68 $\mu\text{H}$ , 17A SMD Inductor
RP90Q-48xxSRW	4.7 $\mu\text{F}$ , 100V 1812 MLCC	4.7 $\mu\text{F}$ , 100V 1812 MLCC	4.7 $\mu\text{F}$ , 100V 1812 MLCC	4.7 $\mu\text{F}$ , 100V 1812 MLCC	1000pF, 3kV 1808 MLCC	3.3 $\mu\text{H}$ , 10A SMD Inductor

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Specifications (measured @ ta= 25°C, nominal input voltage, full load and after warm-up)

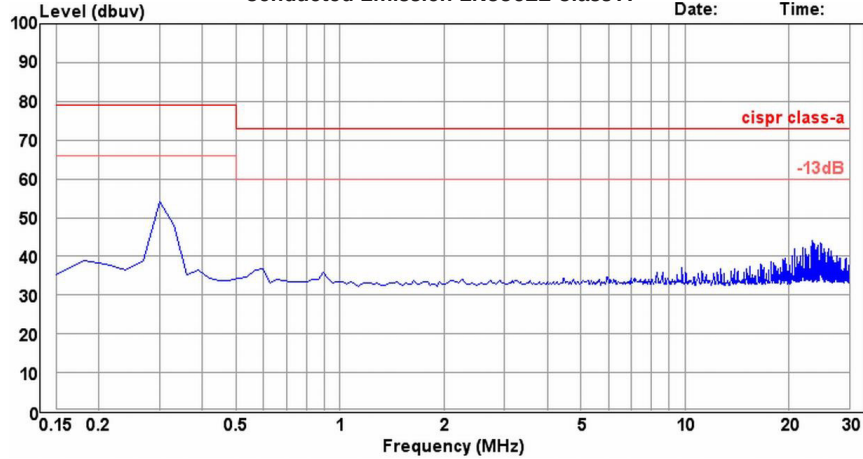
RP90Q-2405SRW

Conducted Emission EN55022 Class A

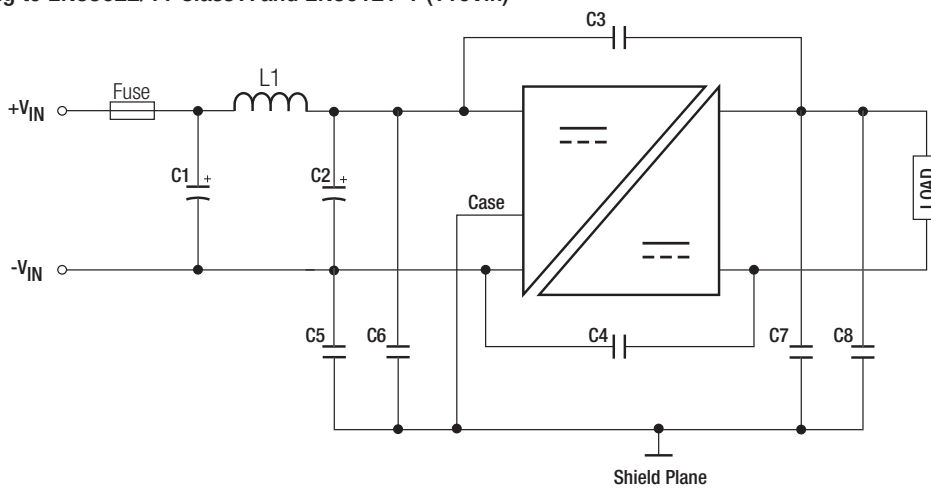


RP90Q-4805SRW

Conducted Emission EN55022 Class A



EMI Filtering according to EN55022/11 Class A and EN50121-1 (110Vin)

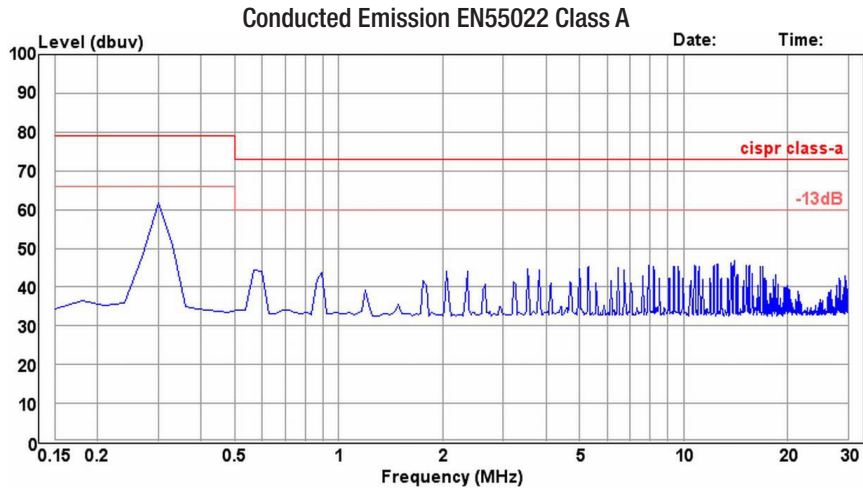


MODEL	C1, C2	C3 to C8	L1
RP90Q-110xxSRW	39µF, 250V Al cap. (lie down) Rubycon BXF	1000pF, 3kV 1808 MLCC	30.1µH, 5A SMD Inductor

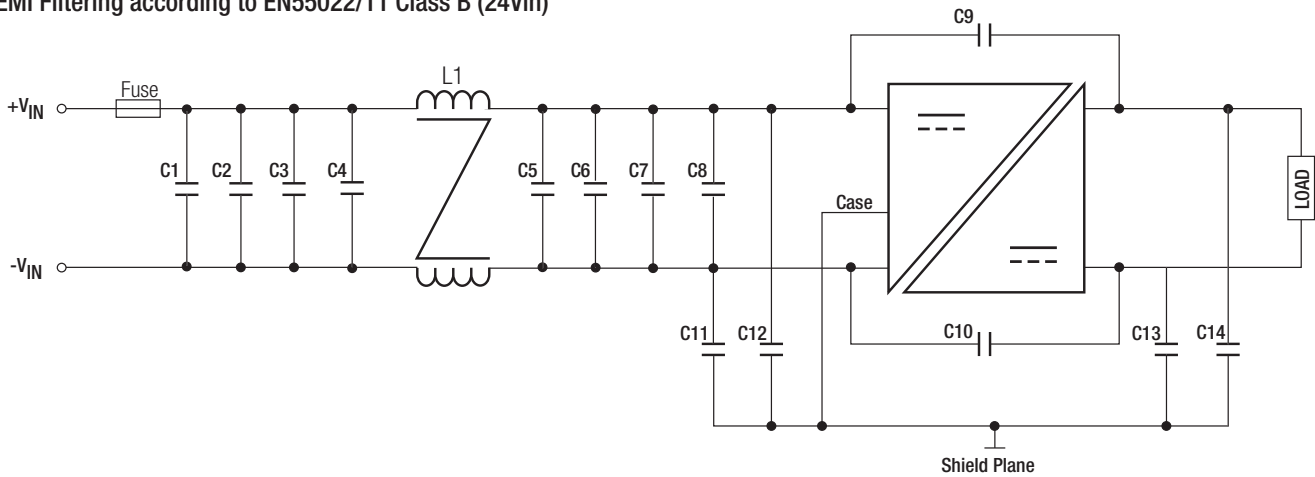
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Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

RP90Q-11005SRW

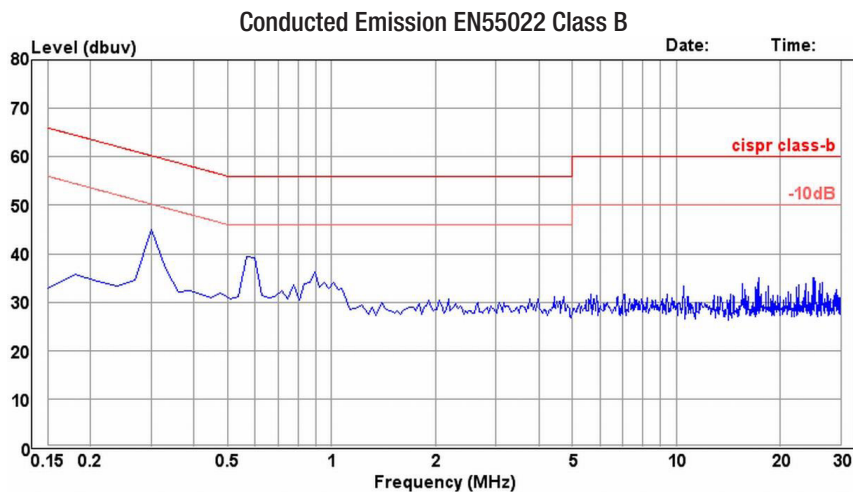


EMI Filtering according to EN55022/11 Class B (24Vin)



MODEL	C1 to C8	C9, C10, C13, C14	C11, C12	L1
RP90Q-24xxSRW	10 $\mu\text{F}$ , 50V 1812 MLCC	1000pF, 3kV 1808 MLCC	2200pF, 3kV 1812 MLCC	285 $\mu\text{H}$ CMC

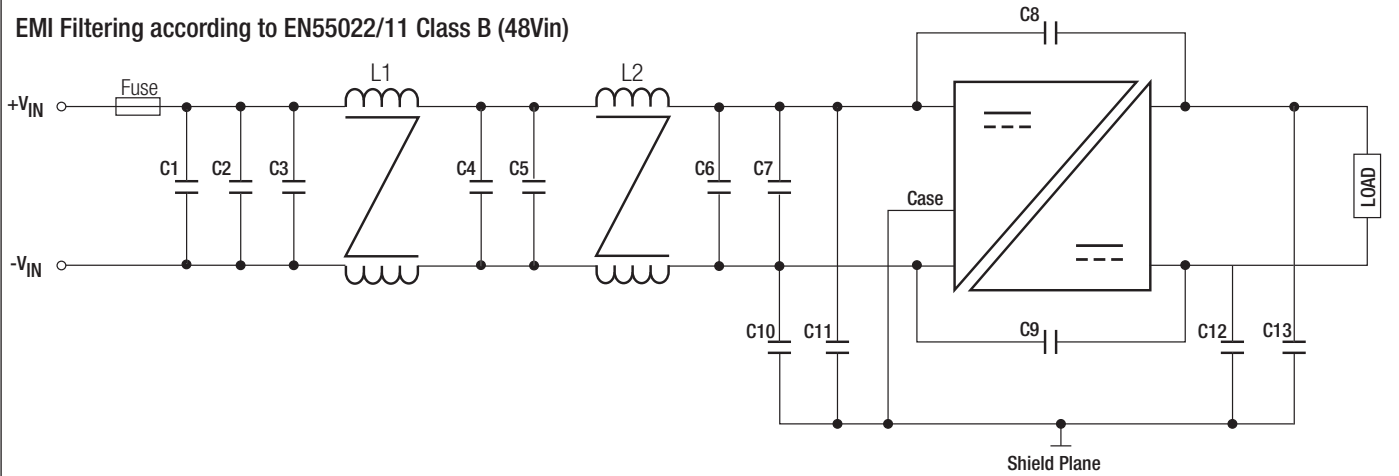
RP90Q-2405SRW



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Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

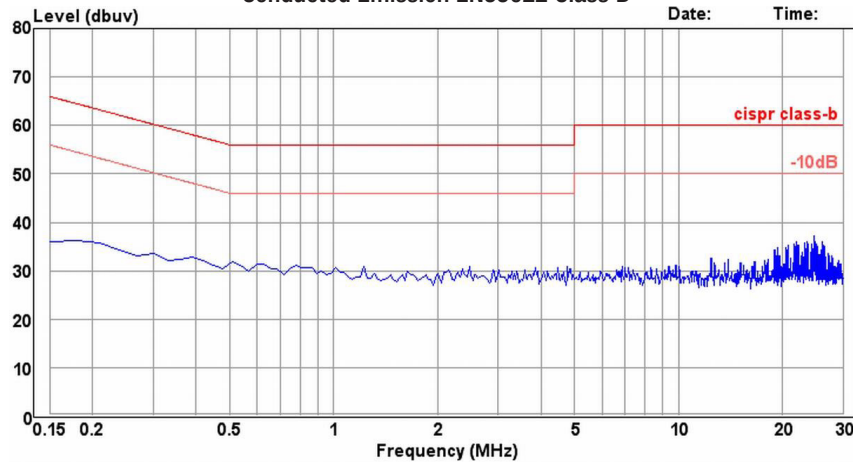
### EMI Filtering according to EN55022/11 Class B (48Vin)



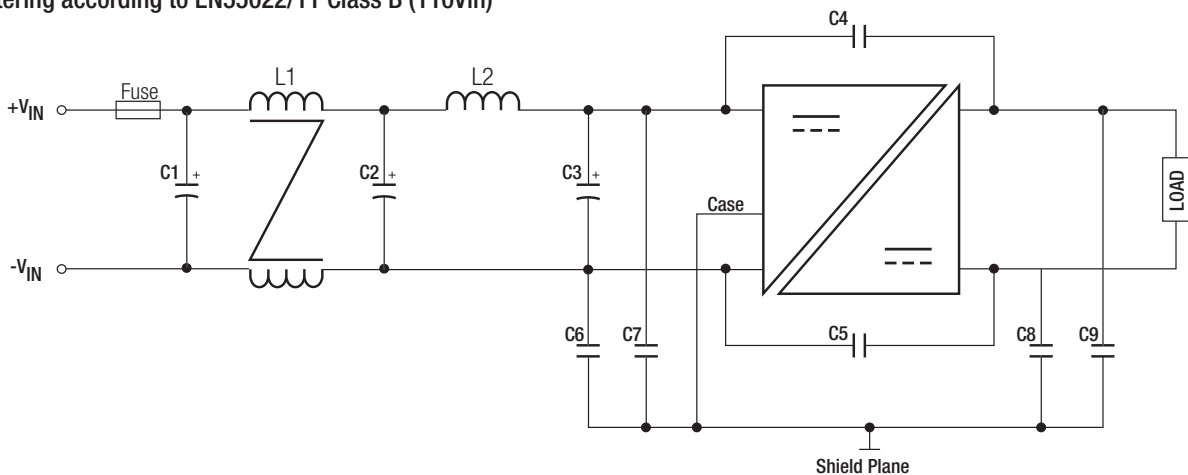
MODEL	C1 to C7	C8 to C13	L1	L2
RP90Q-48xxSRW	4.7 $\mu\text{F}$ , 100V 1812 MLCC	1000pF, 3kV 1808 MLCC	620 $\mu\text{H}$ CMC	285 $\mu\text{H}$ CMC

### RP90Q-4805SRW

### Conducted Emission EN55022 Class B



### EMI Filtering according to EN55022/11 Class B (110Vin)



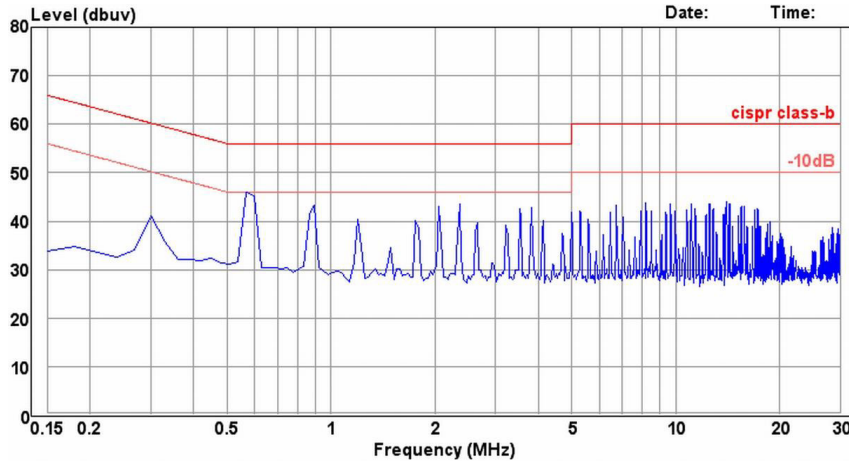
MODEL	C1, C2, C3	C4 to C9	L1	L2
RP90Q-110xxSRW	39 $\mu\text{F}$ , 250V Al cap. (lie down) Rubycon BXF	1000pF, 3kV 1808 MLCC	735 $\mu\text{H}$ CMC	30.1 $\mu\text{H}$ , 5A SMD Inductor

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Specifications (measured @  $t_a = 25^\circ\text{C}$ , nominal input voltage, full load and after warm-up)

RP90Q-110xxSRW

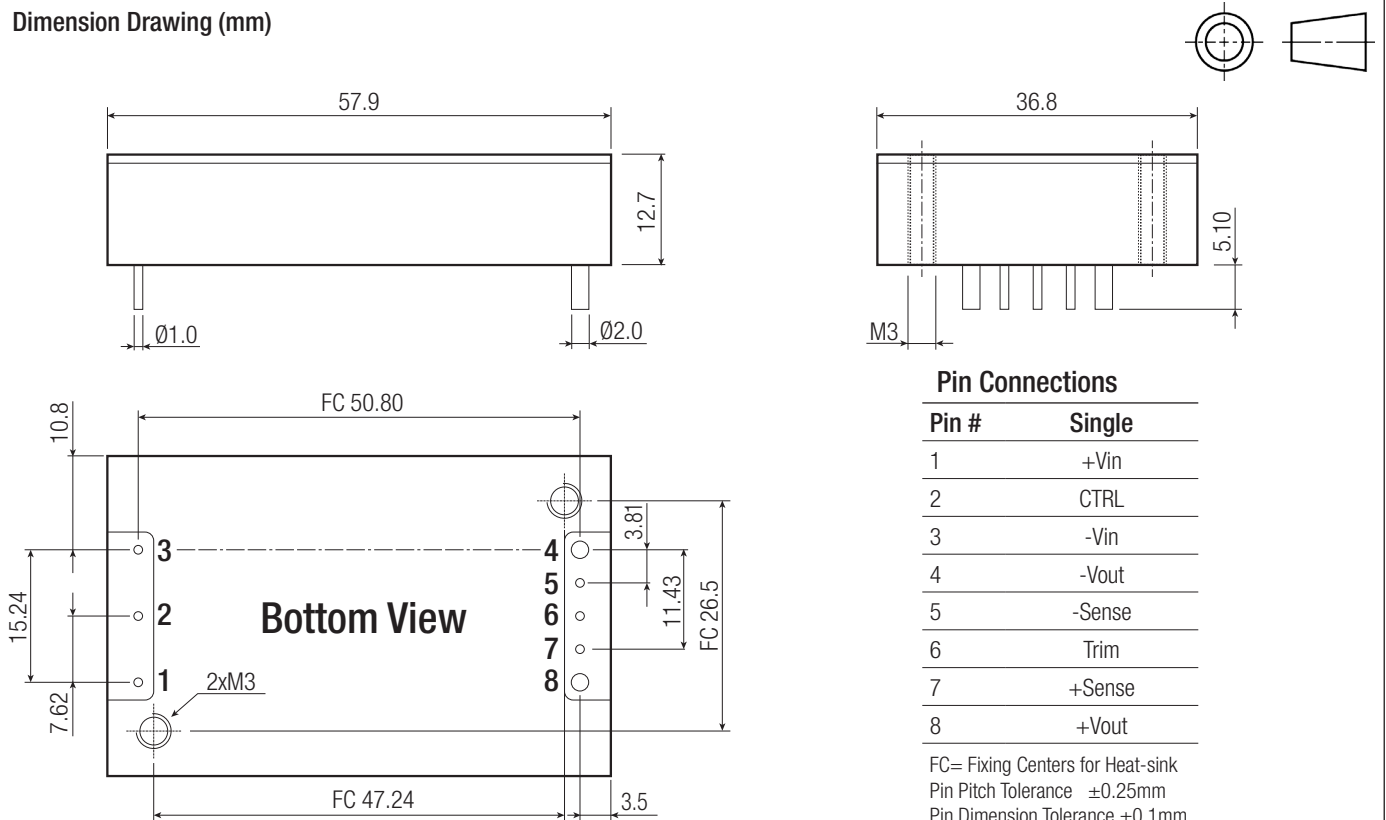
Conducted Emission EN55022 Class B



**DIMENSIONS and PHYSICAL CHARACTERISTICS**

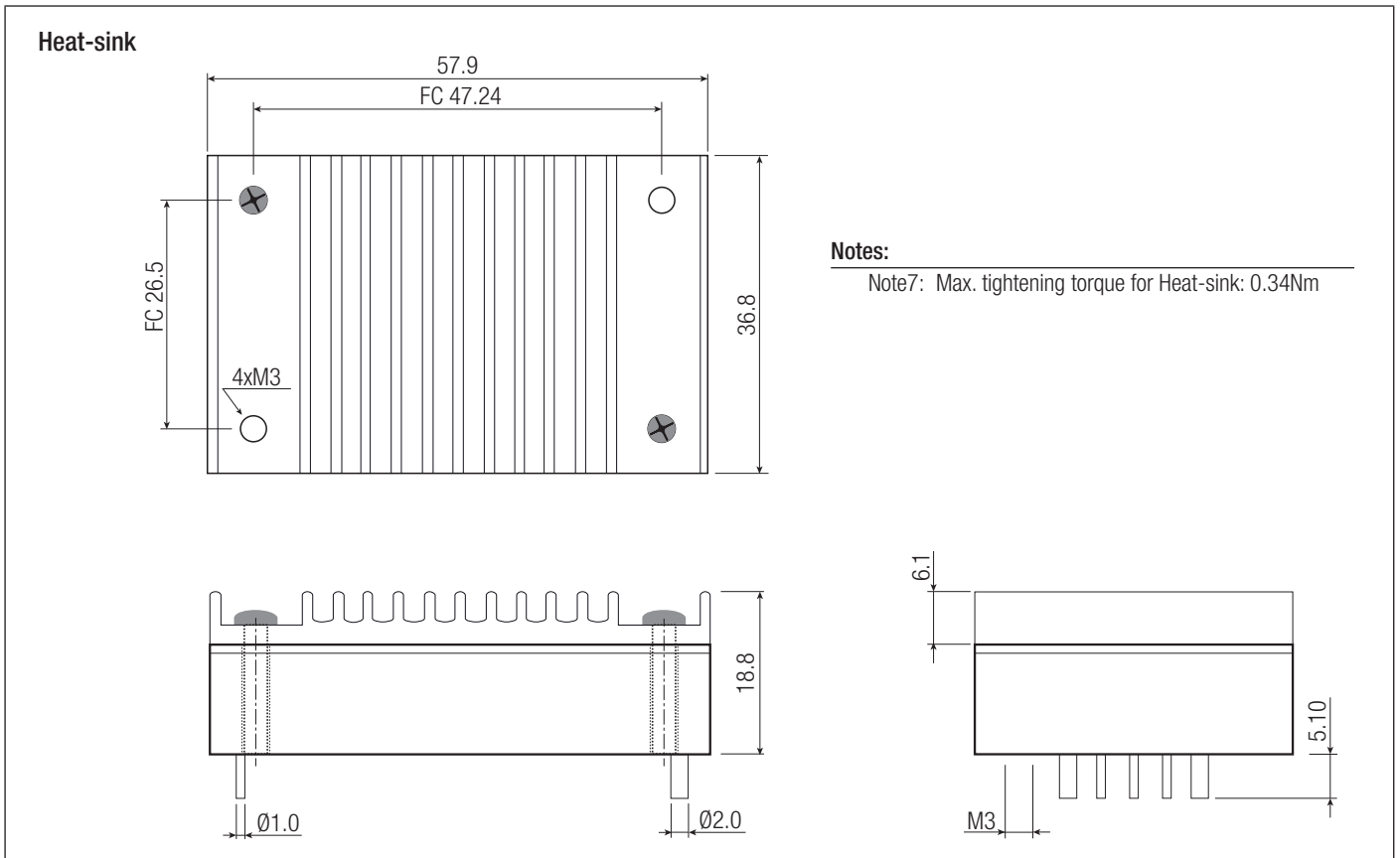
Parameter	Type	Value
Material	Case	Plastic
	Baseplate	Aluminium
	Potting	Silicone (UL94 V-0)
Packaging Dimension (LxWxH)	without Heat-sink	57.9 x 36.6 x 12.7mm
	with Heat-sink	57.9 x 36.6 x 18.8mm
Packaging Weight	without Heat-sink	64g
	with Heat-sink	88g

**Dimension Drawing (mm)**



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Specifications (measured @ ta= 25°C, nominal input voltage, full load and after warm-up)



**PACKAGING INFORMATION**

Parameter	Type		Value
Packaging Dimension	Tray	without Heat-sink	157.0 x 88.0 x 12.8mm
		with Heat-sink	157.0 x 88.0 x 24.8mm
Packaging Quantity			2pcs
Storage Temperature Range			-55°C to +125°C
Storage Humidity			5% - 95% RH

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