Features

Regulated Converter

- 12:1 ultra wide input voltage range
- 3kVAC/1 minute reinforced insulation
- High efficiency over entire input voltage range
- -40°C to +85°C temperature range without cooling or derating
- Output voltage sense and trim
- CE marked

RECOM

DC/DC Converter

RP40Q-RUW

40 Watt Quarter Brick Single Output

YEAR 3 warranty

Description

The quarter brick RP40Q series DC/DC converter is designed for railway rolling stock and high voltage battery applications. It has a 12:1 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 5V, 12V, 15V, 24V or 48VDC outputs with sense and trim pins. The converter has a consistently high efficiency over the entire input voltage range and has an operating temperature range from -40°C to +85°C without forced air cooling or derating. The case is fitted with threaded inserts for secure mounting in high shock and vibration environments. The converter is CE marked and comes with a three year warranty.

Selection Guide

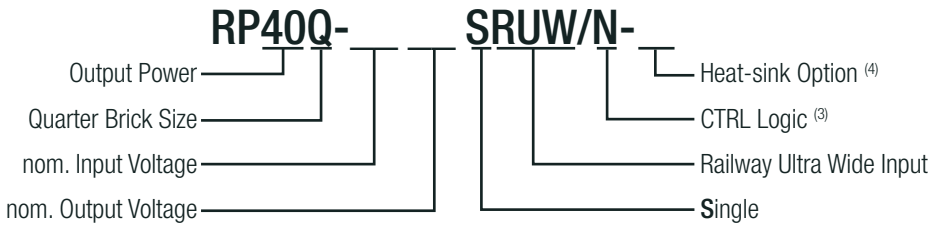
Part Number	Nom. Input Voltage Range [VDC]	Output Voltage [VDC]	Output Current [A]	Efficiency typ. (1) [%]	Max. Capacitive Load (2) [µF]
RP40Q-11005SRUW/N(3,4)	16-160	5	8	91	16000
RP40Q-11012SRUW/N(3,4)	16-160	12	3.33	90	2800
RP40Q-11015SRUW/N(3,4)	16-160	15	2.67	90	1800
RP40Q-11024SRUW/N(3,4)	16-160	24	1.67	90	720
RP40Q-11048SRUW/N(3,4)	16-160	48	0.83	89	180

Notes:

Note1: Efficiency is tested at 48Vin and full load at +25°C ambient

Note2: Max. Cap Load is tested at nominal input and full resistive load

Model Numbering



Notes:

Note3: standard part is with suffix "/N" for negative logic (0=ON, 1=OFF)
or add suffix "/P" for positive logic (1=ON, 0=OFF)
for more details refer to ***"ON/OFF CTRL (5)"***

Note4: add suffix "-HC" for screwed Heat-sink (refer to ***"Dimension Drawing Heat-sink (mm)"***)

Ordering Examples

RP40Q-11005SRUW/N = 110V Input Voltage, 5V Output Voltage, Single, negative logic
RP40Q-11048SRUW/P = 110V Input Voltage, 48V Output Voltage, Single, positive logic
RP40Q-11024SRUW/N-HC = 110V Input Voltage, 24V Output Voltage, Single, negative logic and fitted Heat-sink
RP40Q-11015SRUW/P-HC = 110V Input Voltage, 15V Output Voltage, Single, positive logic and fitted Heat-sink

RoHS 2+ compliant 10 from 10

REACH compliant

CE

c UL us
E196683

IEC/EN62368-1 certified
UL62368-1 certified
CAN/CSA-C22.2 No. 62368-1 certified
EN50155 certified
EN55032 compliant
EN55024 compliant
CE marked

REF DESIGN available

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

SURGE PROTECTOR available

https://recom-power.com/rec-s-RSPxxx-168.html

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

BASIC CHARACTERISTICS

Parameter	Condition		Min.	Typ.	Max.
Internal Input Filter					Pi-Type
Input Voltage Range			16VDC	110VDC	160VDC
Input Surge Voltage	< 1s	nom. Vin = 110VDC			185VDC
Under Voltage Lockout (ULVO)	nom. Vin = 110VDC	DC-DC ON DC-DC OFF	10VDC	11VDC	14VDC 12VDC
Input Current Range	Vin = 16VDC Vin = 110VDC Vin = 160VDC			2.75A 0.4A 0.27A	3.5A
Quiescent Current	nom. Vin = 110VDC			10mA	
Output Voltage Trimming	refer to ***"OUTPUT VOLTAGE TRIMMING"***		-20%		+10%
Minimum Load			0%		
Start-up Time	constant resistive load			75ms	100ms
Rise Time				40ms	
ON/OFF CTRL [5] refer to ***"ON/OFF CTRL"***	Positive Logic	DC-DC ON DC-DC OFF	Open or 3VDC < V_{CTRL} < 12VDC Short or 0VDC < V_{CTRL} < 1.2VDC		
	Negative Logic	DC-DC ON DC-DC OFF	Short or 0VDC < V_{CTRL} < 1.2VDC Open or 3VDC < V_{CTRL} < 12VDC		
Input Current of CTRL pin	drive current	I_{CTRL}	-0.5mA		1mA
Standby Current	DC-DC OFF	I_{in}		1mA	
Internal Operating Frequency				180kHz	
Output Ripple and Noise [6]	measured at 20MHz BW	5Vout 12, 15Vout 24Vout 48Vout		75mVp-p 100mVp-p 200mVp-p 300mVp-p	
Remote Sense [7]	refer to ***"REMOTE SENSE"***				10%

Notes:

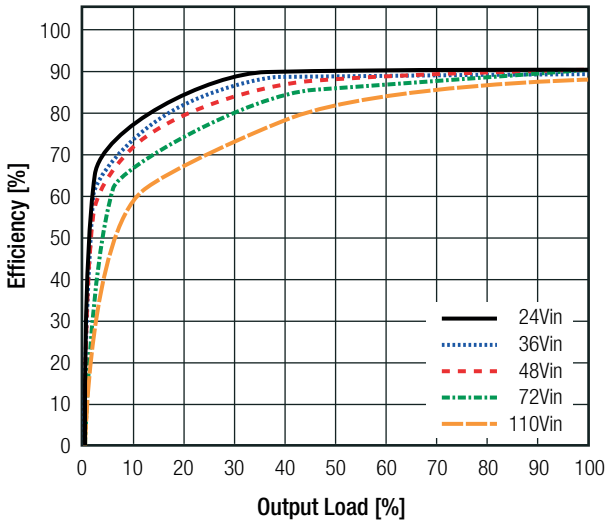
Note5: The ON/OFF control function can be positive or negative logic. The pin voltage is referenced to -Vin

Note6: Measurements are made for 5Vout with a 1µF/25V X7R MLCC and a 22µF/25V E-Cap; for 15Vout with a 22µF/25V X7R MLCC, for 24Vout with a 4.7µF/50V X7R MLCC and for 48Vout with a 2.2µF/100V X7R MLCC

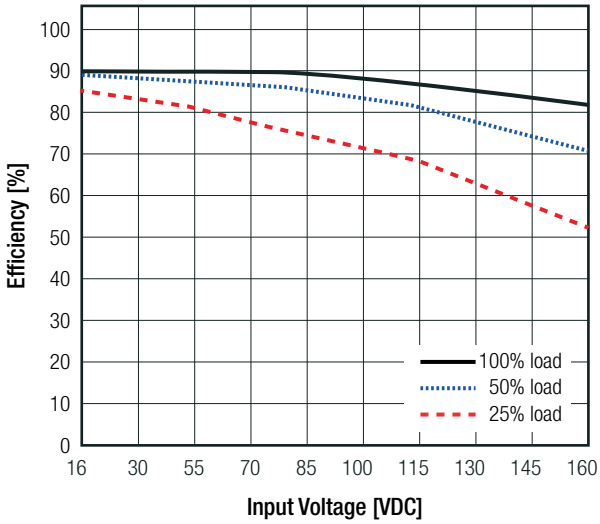
Note7: If not used connect Remote Sense pins to corresponding output pins

RP40Q-11005SRW

Efficiency vs. Output Load



Efficiency vs. Input Voltage



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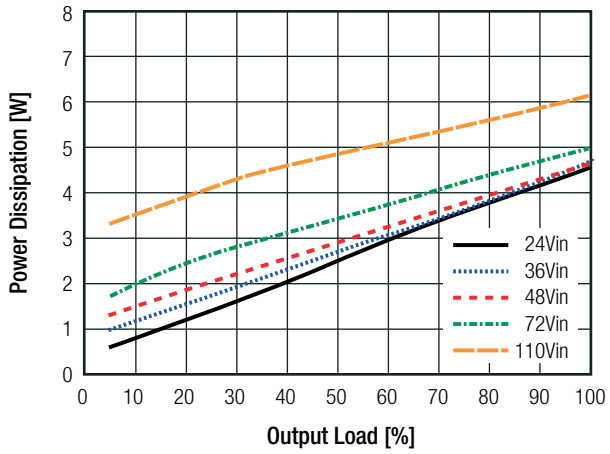
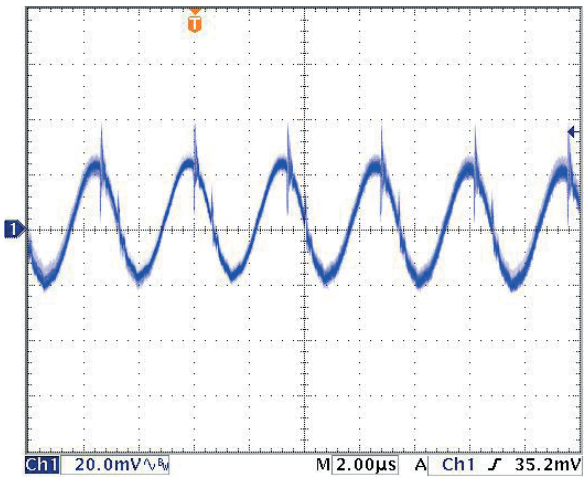
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

RP40Q-11005SRW

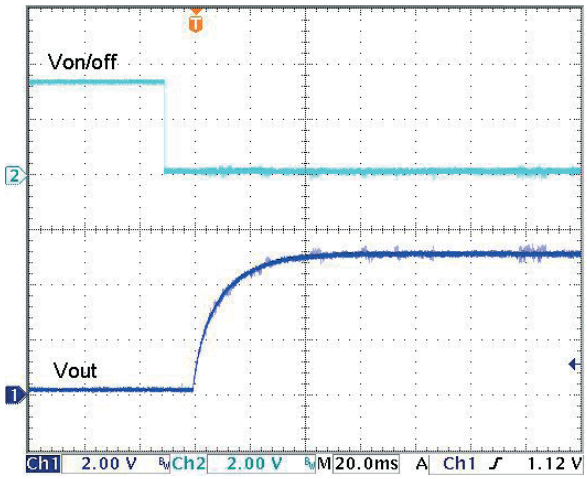
Power Dissipation vs. Output Current



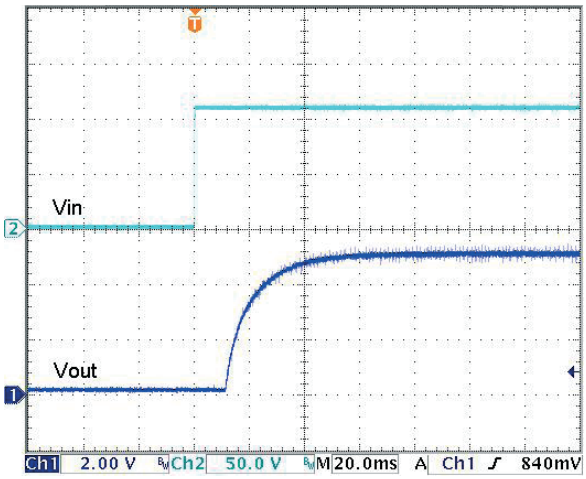
Typical Output Ripple and Noise/full load



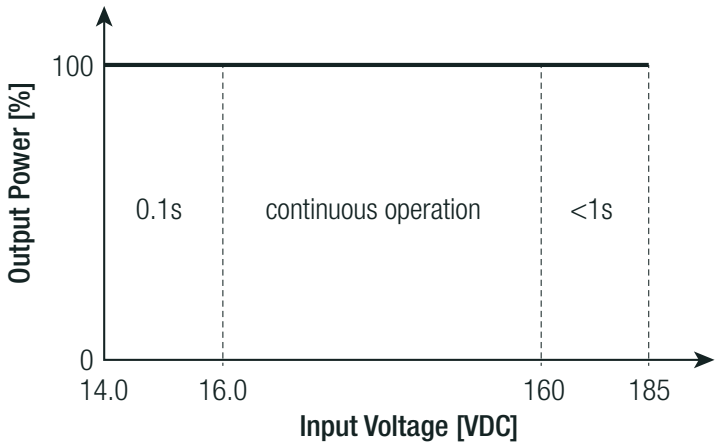
ON/OFF Control Start up Rise Characteristic



Power up Start-up Rise Characteristic



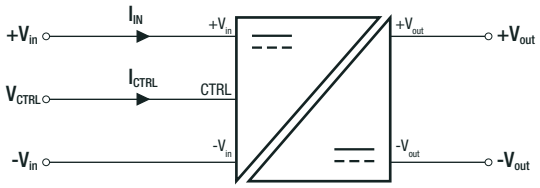
Input Voltage Range



Continuous full power operation is rated between 16V and 160V, including full load start-up.
Once running, the converter will operate for short periods of time over an extended input voltage range down to 14V and up to 185V, thus covering all EN50155 under-voltage and over-voltage transient conditions.

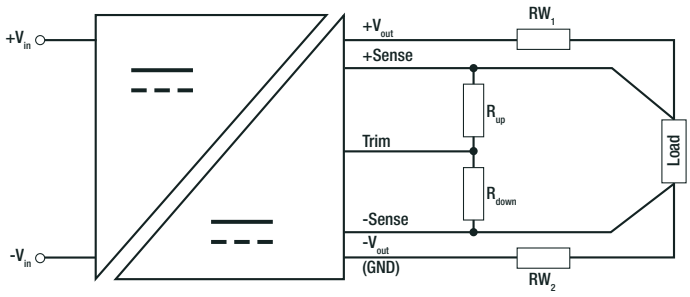
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

ON/OFF CTRL



Positve Logic	DC-DC ON	Open or 3.0VDC < V_{CTRL} < 12VDC
	DC-DC OFF	Short or 0VDC < V_{CTRL} < 1.2VDC
Negativ Logic	DC-DC ON	Short or 0VDC < V_{CTRL} < 1.2VDC
	DC-DC OFF	Open or 3.0VDC < V_{CTRL} < 12VDC

REMOTE SENSE



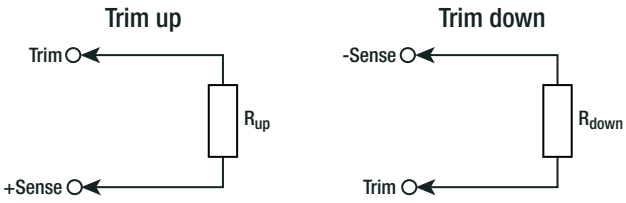
The output voltage can be adjusted by both trim and remote sense. The maximum combined adjustment range is ±10%. Derate the maximum output power if using the trim or sense function to increase the output voltage.

RW_1 ... wire losses +
RW_2 ... wire losses -
R_{up} ... trim up resistor
R_{down}... trim down resistor

OUTPUT VOLTAGE TRIMMING

Output Voltage Trimming

It allows the user to increase or decrease the output voltage of the module. This is accomplished by connecting an external resistor between the Trim pin and either the +Sense or -Sense pins. With an external resistor between the Trim and +Sense pin, the output voltage increases. With an external resistor between the Trim and -Sense pin, the output voltage decreases. The external Trim resistor needs to be at least 1/8W of rated. The values for trim resistors shown in trim tables below are according to standard E96 values; therefore, the specified voltage may slightly vary.



$Vout_{nom}$	= nominal output voltage	[VDC]
ΔVout	= output voltage change	[%]
V_{ref}	= reference voltage	[VDC]
R_{up}	= trim up resistor	[Ω]
R_{down}	= trim down resistor	[Ω]
R_1,R_2,R_3	= internal resistors	[Ω]

$Vout_{nom}$	R_1	R_2	R_3	V_{ref}
5VDC	10k2Ω	511kΩ	5k11	1.225VDC
12VDC				
15VDC				
24VDC				
48VDC				

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

Calculation:

$$R_{up} = \left[\frac{R_3 \times Vout_{nom} \times (100 + \Delta Vout)}{V_{ref} \times \Delta Vout} \right] - \left[\frac{(R_1 \times \Delta Vout) + R_2}{\Delta Vout} \right] \qquad R_{down} = \left[\frac{R_2}{\Delta Vout} \right] - R_1$$

Practical Example RP60Q-xx05SRW +10% / -10%

$$R_{up} = \left[\frac{5k11 \times 5 \times (100 + 10)}{1.225 \times 10} \right] - \left[\frac{(10k2 \times 10) + 511k}{10} \right] = \mathbf{168k\Omega} \qquad R_{down} = \left[\frac{511k}{10} \right] - 10k2 = \mathbf{40k9\Omega}$$

R_{up} according to E96 ≈ **169kΩ**

R_{down} according to E96 ≈ **41k2Ω**

RP40Q-xx05SRW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	5.05	5.10	5.15	5.20	5.25	5.30	5.35	5.4	5.45	5.50	[VDC]
R_{up} (E96) ≈	1M58	806k	536k	402k	324k	247k	237k	205k	187k	169k	[Ω]

RP40Q-xx12SRW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	12.12	12.24	12.36	12.48	12.60	12.72	12.84	12.96	13.08	13.20	[VDC]
R_{up} (E96) ≈	4M53	2M26	1M54	1M15	931k	787k	681k	604k	536k	487k	[Ω]

RP40Q-xx15SRW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	15.15	15.30	15.45	15.60	15.75	15.90	16.05	16.20	16.35	16.50	[VDC]
R_{up} (E96) ≈	5M76	2M94	1M96	1M47	1M21	1M02	866k	768k	698k	619k	[Ω]

RP40Q-xx24SRW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	24.24	24.48	24.72	24.96	25.20	25.44	25.68	25.92	26.16	26.40	[VDC]
R_{up} (E96) ≈	9M53	4M7	3M24	2M94	2M	1M69	1M47	1M27	1M15	1M05	[Ω]

RP40Q-xx48SRW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	48.48	48.96	49.44	49.92	50.40	50.88	51.36	51.84	52.32	52.80	[VDC]
R_{up} (E96) ≈	19M6	9M94	6M65	5M11	4M12	3M4	3M01	2M61	2M37	2M15	[Ω]

Trim Down all Vout's

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
R_{down} (E96) ≈	499k	243k	162k	118k	90k9	75k	63k4	53k6	46k4	41k2	[Ω]

Trim down	11	12	13	14	15	16	17	18	19	20	[%]
R_{down} (E96) ≈	36k5	32k4	28k7	26k1	23k7	21k5	19k6	18k2	16k5	15k4	[Ω]

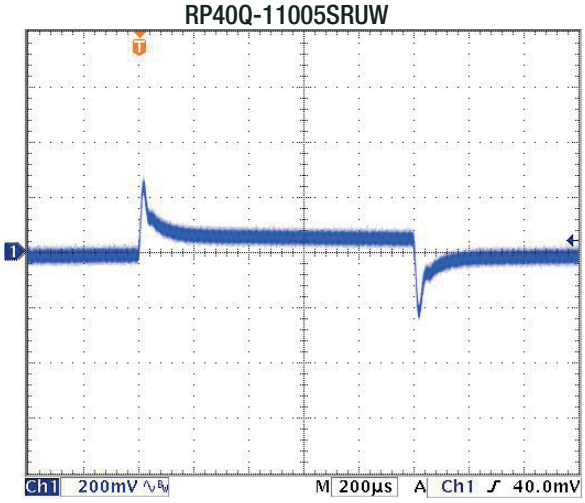
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

REGULATIONS

Parameter	Condition	Value
Output Accuracy		±1.0% max.
Line Regulation	low line to high line	±0.1% max.
Load Regulation	0% load to 100% load	0.1% max.
Transient Response	25% load step change	250µs typ.

Transient Response to Dynamic Load change from 100% to 75% to 100% of Full Load at nom. Vin

RP40Q-11005SRUW



PROTECTION

Parameter	Condition			Value
Short Circuit Protection (SCP)	below 100mΩ			continuous, hiccup mode, automatic recovery
Over Voltage Protection (OVP)				120-135%, hiccup mode
Over Current Protection (OCP)				120-140%, hiccup mode
Over Temperature Protection (OTP)				+115°C ±5°C
Isolation Voltage [8]	nom. Vin = 110Vin	I/P to O/P I/P, O/P to Baseplate	rated for 1 minute rated for 1 minute	3kVAC 1.5kVAC
Isolation Resistance	tested with 500VDC			1GΩ min.
Isolation Capacitance				1000pF max.
Leakage Current				2250µA
Insulation Grade	<2000m >2000m up to 5000m			reinforced (based on Electric Strength Test) funcional isoltaion

Notes:

Note8: For repeat Hi-Pot testing, reduce the time and/or the test voltage

Note9: Refer to local safety regulations if input over-current protection is also required. Recommended fuse: T5A slow blow type

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

ENVIRONMENTAL			
Parameter	**Condition**		**Value**
Operating Temperature Range	refer to ***"Thermal Calculation"***		-40°C to +105°C
Maximum Baseplate Temperature			+110°C
Temperature Coefficient			±0.02%/K
Thermal Impedance	vertical direction by natural convection (0.1m/s)	without Heat-sink with Heat-sink	6.3K/W 5.0K/W
Operating Humidity			5%-95% RH
Thermal Shock			according to EN61373 standard
Vibration			according to EN61373 standard
Fire Protection on Railway Vehicles			according to EN45545 standard
MTBF	according to MIL-HDBK-217F standard, G.B.	+25°C +85°C	880 x 10^3 hours 150 x 10^3 hours

Thermal Calculation

$$R_{th} = \left[\frac{T_{baseplate\ max} - T_{amb}}{P_{diss}} \right]$$

$$P_{diss} = \left[\frac{P_{out\ set}}{\eta} \right] - P_{out\ set}$$

$T_{baseplate\ max.}$ = baseplate temperature [°C]
T_{amb} = ambient temperature [°C]
$P_{out\ nom.}$ = nom. output power [W]
$P_{out\ set}$ = output power set [W]
P_{diss} = internal losses [W]
R_{th} = thermal impedance [K/W]
η = efficiency under given operating conditions [%]

Practical Example:

Take the **RP40Q-11005SRUW** with 48V Input Voltage and 50% load, natural convection 0.1m/s, in vertical application.
What is the maximum ambient operating temperature?

$T_{baseplate\ max.}$ = 110°C
$P_{out\ nom.}$ = 40W
$P_{out\ set}$ = 40 x 0.5 = 20W
R_{th} = 6.3K/W (vertical)
η = 91% (Graph)

$$P_{diss} = \left[\frac{20}{0.91} \right] - 20 = 1.98W$$

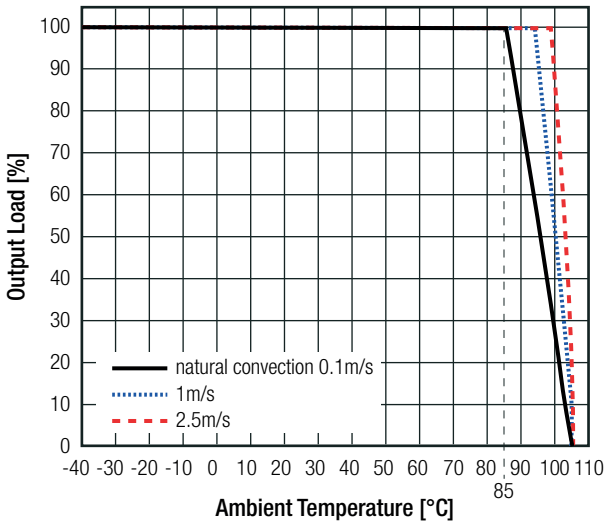
$$R_{th} = \left[\frac{T_{baseplate\ max} - T_{amb}}{P_{diss}} \right]$$

$$6.3 = \frac{110 - T_{amb}}{1.98}$$

$$T_{amb} = \underline{97.5°C}$$

Derating Graph

(@ Chamber - tested with double layer PCB: 160x100mm 105µm Eurocard)



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

Take the **RP40Q-11005SRUW-HC** with 48V Input Voltage, 50% load, natural convection 0.1m/s, in vertical application and Heat-sink.
What is the maximum ambient operating temperature?

$T_{baseplate\ max.}$ = 110°C
$P_{out\ nom.}$ = 40W
$P_{out\ set}$ = 40 x 0.5 = 20W
R_{th} = 5.0K/W (vertical)
η = 91% (Graph)

$$P_{diss} = \left[\frac{20}{0.91}\right] - 20 = 1.98W$$

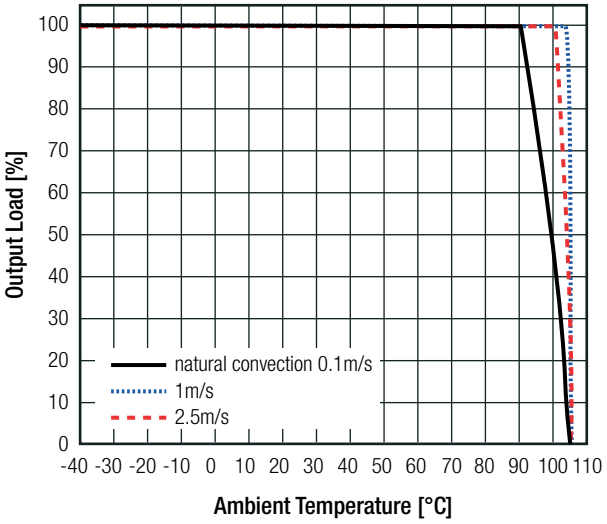
$$R_{th} = \left[\frac{T_{baseplate\ max} - T_{amb}}{P_{diss}}\right]$$

$$5.0 = \frac{110 - T_{amb}}{1.98}$$

$$T_{amb} = \underline{100°C}$$

Derating Graph

(@ Chamber - tested with double layer PCB: 160x100mm 105µm Eurocard)



SAFETY AND CERTIFICATIONS

Certificate Type (Safety)	Report / File Number	Standard
Audio/video, information and communication technology equipment. Safety requirements	LVD1809046-1 + LVD1903037-1-M1	EN62368-1:2014 + A11:2017 IEC62368-1:2014, 2nd Edition
Railway applications - Electrical equipment used on rolling stock	T181022L06-RL	EN50155:2017
Environmental testing Part 2-1: Tests – Test A: Cold		DIN EN60068-2-1:2008-01
Environmental testing Part 2-2: Tests – Test B: Dry heat		DIN EN60068-2-2:2008-05
Environmental testing Part 2-30: Tests - Test Db: Damp heat, cyclic		DIN EN60068-2-30:2006-06
Railway applications – Rolling stock equipment – Shock and vibration tests		EN61373:2010
Audio/video, information and communication technology equipment-Part1: Safety requirements		UL62368-1:2014 CAN/CSA-C22.2 No. 62368-1:2014
Certificate Type (Safety)	**Report / File Number**	**Standard**
RoHS2+		RoHS 2011/65/EU + AM2015/863

EMC Compliance (Railway)	Condition	Standard / Criterion
Railway applications - Electromagnetic compatibility		EN50121-3-2:2016
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement		EN55032:2010
ESD Electrostatic discharge immunity test	Air: ±2, 4, 8kV, Contact: ±2, 4, 6kV	EN61000-4-2:2009, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	20V/m (80-1000MHz) 10V/m (1400-2000MHz) 5V/m (2000-2700MHz) 3V/m (5100-6000MHz)	EN61000-4-3:2006 + A2:2010, Criteria A
Fast Transient and Burst Immunity	DC Power Port: ±2kV	EN61000-4-4:2012, Criteria A
Surge Immunity	DC Power Port: ±2kV	EN61000-4-5:2014, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	DC Power Port: 10V	EN61000-4-6:2014, Criteria A
Power Magnetic Field Immunity	50Hz, 100A/m, 1000A/m	EN61000-4-8:2009, Criteria A
Electromagnetic compatibility of multimedia equipment - Emission requirements	with external filter (see filter suggestion below)	EN55032:2015 + AC:2016-07, Class A

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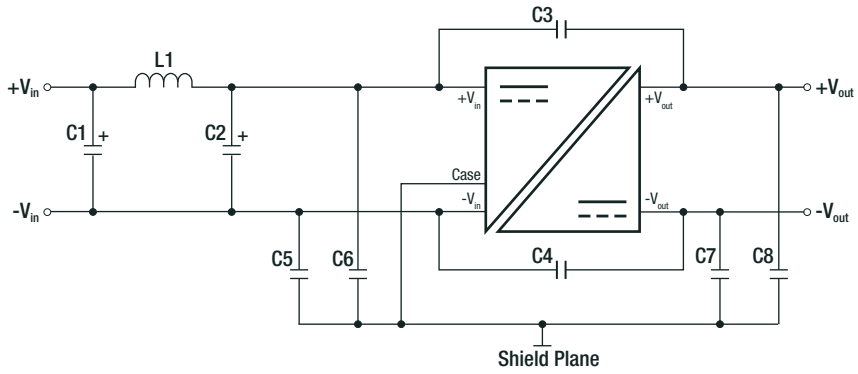
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

EMC Compliance (Multimedia)	Condition	Standard / Criterion
Information technology equipment - Immunity characteristics - Limits and methods of measurement		EN55024:2010 + A1:2015
ESD Electrostatic discharge immunity test	Air: ±2, 4, 8kV, Contact: ±2, 4, 6kV	IEC61000-4-2:2008, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	3V/m (80-1000MHz) 20V/m (80-1000MHz) 10V/m (1400-2000MHz) 5V/m (2000-2700MHz) 3V/m (5100-6000MHz)	IEC61000-4-3:2006 + A2:2010, Criteria A
Fast Transient and Burst Immunity	DC Power Port: ±0.5, 2kV	IEC61000-4-4:2012, Criteria A
Surge Immunity	DC Power Port: L-N ±0.5, 1kV	IEC61000-4-5:2014, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	DC Power Port: 3V, 10V	IEC61000-4-6:2013, Criteria A
Power Magnetic Field Immunity	50, 60Hz, 1, 100, 1000A/m	IEC61000-4-8:2009, Criteria A

Notes:

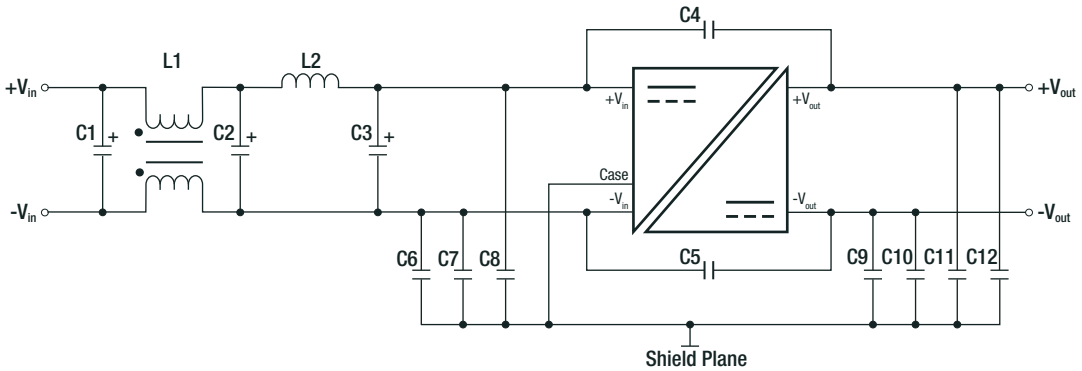
Note10: An external input filter capacitor is required if the module has to meet EN61000-4-4 and EN61000-4-5
Recom suggests: 2 pcs. 150µF/200V connected in parallel

EMC Filtering according to EN55032 Class A



Component List Class A				
C1	L1	C2	C3, C4	C5, C6, C7, C8
47µF, 200V	8.2µH	47µF, 200V	1000pF, 400VAC	1000pF, 250VAC 1808 MLCC

EMC Filtering according to EN55032 Class B



Component List Class B

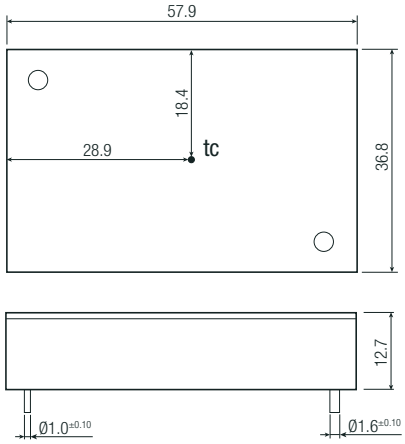
MODEL	C1	L1	C2	L2	C3	C4, C5	C6, C7, C8, C9, C10, C11, C12
RP40Q-110xxSRUW	47µF, 200V	500µH CMC	47µF, 200V	8.2µH	47µF, 200V	1000pF, 400VAC	1000pF, 250VAC 1808 MLCC

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

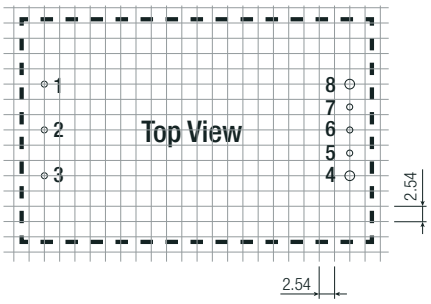
DIMENSIONS and PHYSICAL CHARACTERISTICS

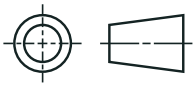
Parameter	Type	Value
Material	baseplate case potting PCB	aluminum plastic, (UL94V-0) low smoke silicone, (UL94V-0) FR4, (UL94V-1)
Dimensions (LxWxH)	without Heat-sink with Heat-sink	57.9 x 36.8 x 12.7mm 57.9 x 36.8 x 25.4mm
Weight	without Heat-sink with Heat-sink	64.0g typ. 88.0g typ.

Dimension Drawing (mm)



Recommend Footprint Details



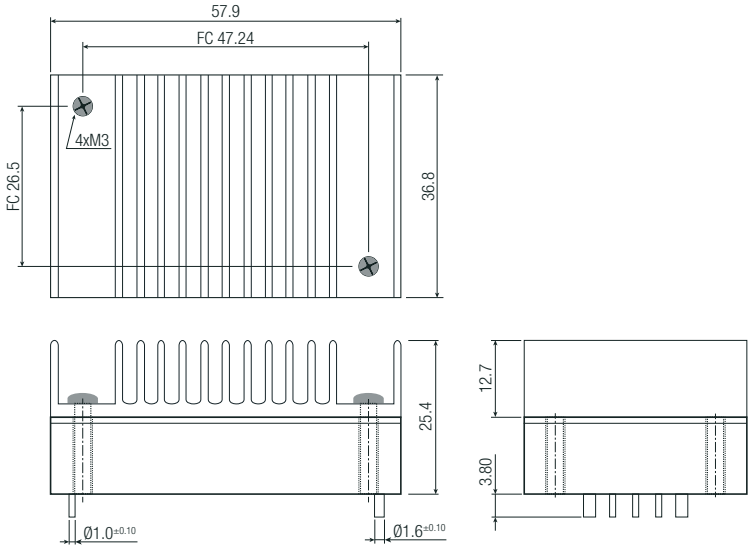


Pin Informations

Pin #	Single
1	+Vin
2	CTRL
3	-Vin
4	-Vout
5	-Sense
6	Trim
7	+Sense
8	+Vout

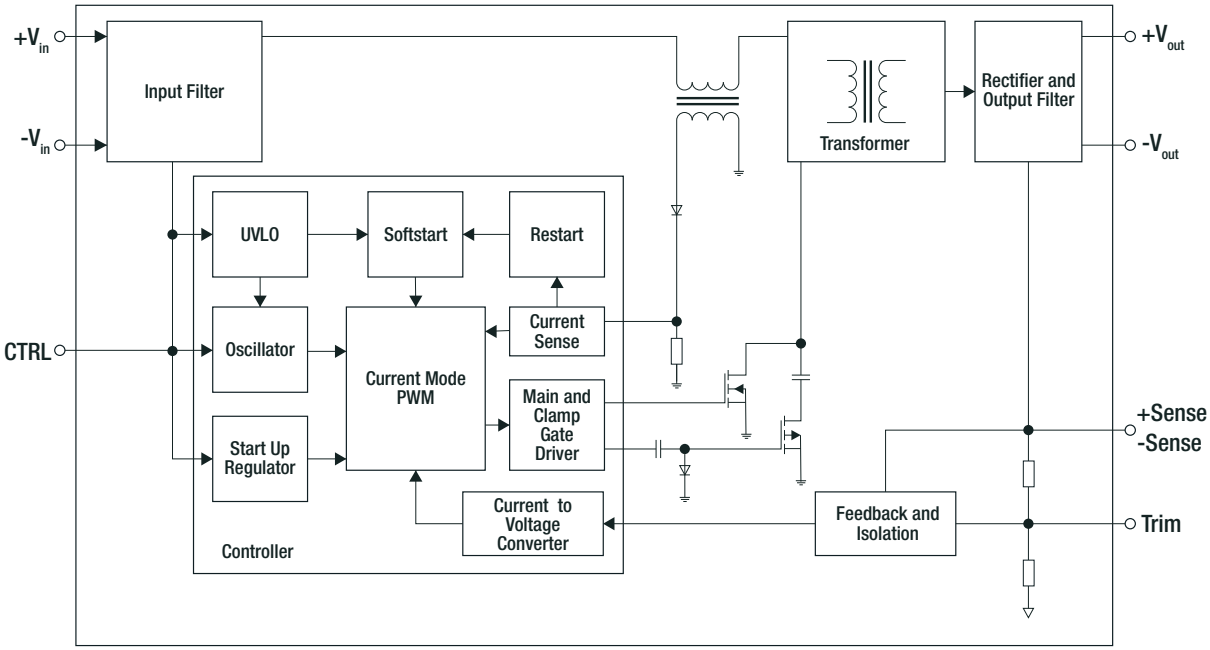
recommended tightening torque: 0.34Nm
FC= Fixing Centers for Heat-sink
xx.x ± 0.5mm
xx.xx ± 0.25mm

Dimension Drawing Heat-sink (mm)



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

BLOCK DIAGRAM



PACKAGING INFORMATION

Parameter	Type		Value
Packaging Dimension	tray	without Heat-sink	157.0 x 88.0 x 23.0mm
		with Heat-sink	157.0 x 88.0 x 35.0mm
Packaging Quantity			2pcs
Storage Temperature Range			-55°C to +125°C
Storage Humidity	non-condensing		5% - 95% RH

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