Features

- 12:1 ultra wide input voltage range
- 3kVDC/1 minute reinforced insulation
- High efficiency over entire input voltage range
- -40°C to +68°C temperature range without cooling or derating
- Output voltage sense and trim
- CE marked

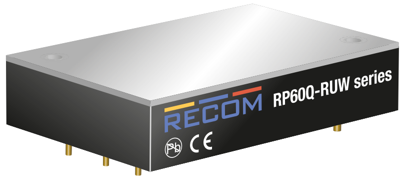
Regulated Converter

RECOM

DC/DC Converter

RP60Q-RUW

60 Watt Quarter Brick Single Output



IEC/EN62368-1 pending
EN60950-1 pending
EN50155 pending
EN55032
EN55024
CE marked

Description

The quarter-brick RP60Q 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 +68°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.

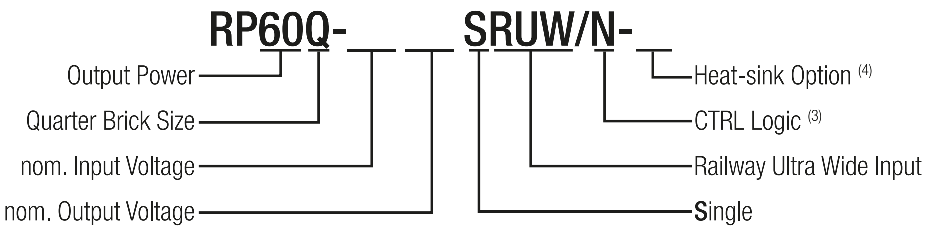
Selection Guide

Part Number	Nom. Input Voltage Range [VDC]	Output Voltage [VDC]	Output Current [A]	Efficiency typ. (1) [%]	Max. Capacitive Load (2) [µF]
RP60Q-11005SRUW/N(3,4)	16-160	5	12	90	24000
RP60Q-11012SRUW/N(3,4)	16-160	12	5	89	4200
RP60Q-11015SRUW/N(3,4)	16-160	15	4	90	2700
RP60Q-11024SRUW/N(3,4)	16-160	24	2.5	90	1100
RP60Q-11048SRUW/N(3,4)	16-160	48	1.25	89	260

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 (1=ON, 0=OFF) or add suffix "/P" for positive logic (0=ON, 1=OFF)
Note4: add suffix "-HC" for screwed Heat-sink

Ordering Examples

RP60Q-11005SRUW/N = 110V Input Voltage, 5V Output Voltage, Single,negative logic
RP60Q-11048SRUW/P = 110V Input Voltage, 48V Output Voltage, Single, positive logic
RP60Q-11024SRUW/N-HC = 110V Input Voltage, 24V Output Voltage, Single, negative logic and fitted Heat-sink
RP60Q-11015SRUW/P-HC = 110V Input Voltage, 15V Output Voltage, Single, positive logic and fitted Heat-sink

SURGE PROTECTOR available

https://www.recom-power.com/pdf/Powerline_DC-DC/RSPxxx-168.pdf

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			4.2A 0.6A 0.45A	5.2A
Quiescent Current	nom. Vin = 110VDC			10mA	
Output Voltage Trimming			-20%		+10%
Minimum Load			0%		
Start-up Time	constant resistive load			75ms	100ms
Rise Time				40ms	
ON/OFF Control (5)	Positive Logic	DC-DC ON DC-DC OFF			Open or 3 < V_{CTRL} < 12VDC Short or 0 < V_{CTRL} < 1.2VDC
	Negative Logic	DC-DC ON DC-DC OFF			Short or 0 < V_{CTRL} < 1.2VDC Open or 3 < V_{CTRL} < 12VDC
Input Current of CTRL pin			-0.5mA		1mA
Standby Current	DC-DC OFF			4mA	
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)					10%

Notes:

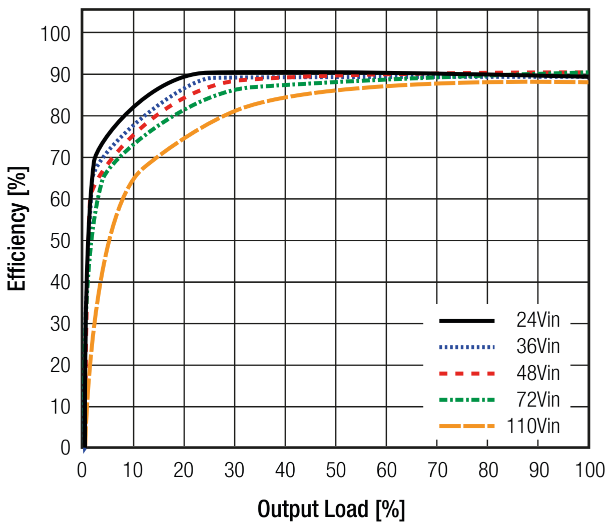
Note5: The ON/OFF control function can be positive or negative logic. The pin voltage is referenced to -Vin pin

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

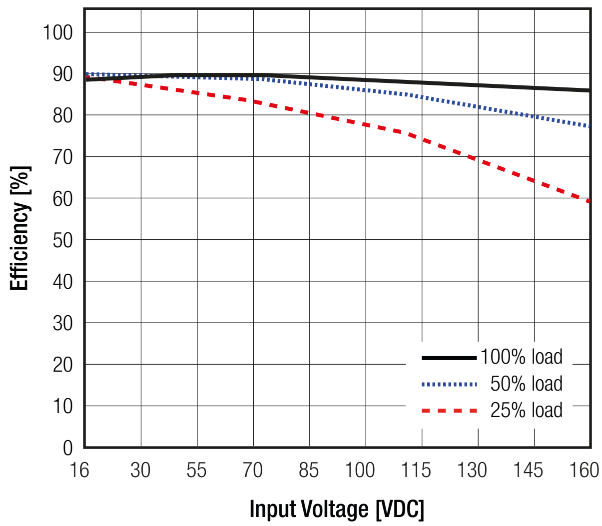
Note7: Refer to page PB-5 Remote Sense. If not used connect Remote Sense pins to corresponding output pins

RP60Q-11005SRW

Efficiency vs. Output Load



Efficiency vs. Input Voltage



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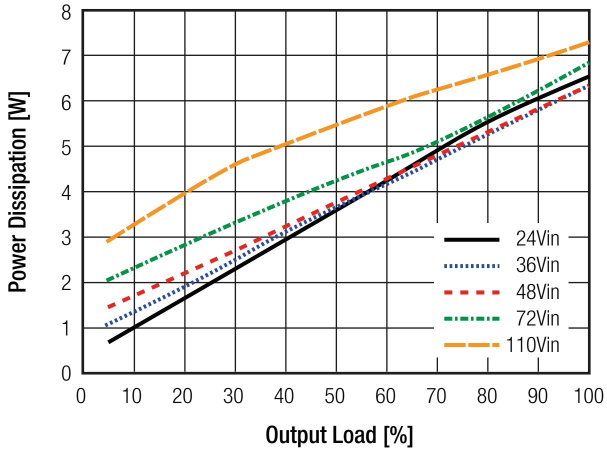
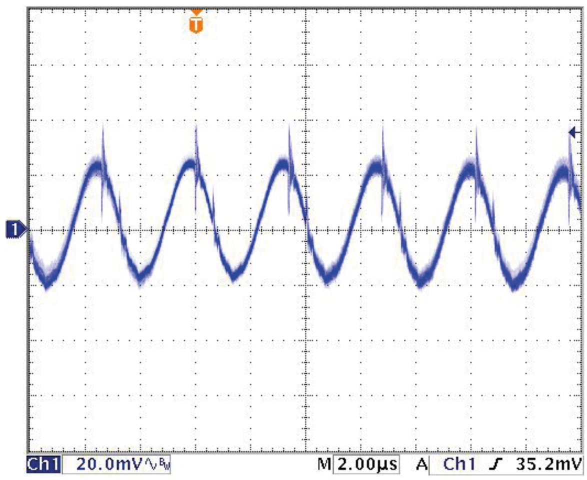
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

RP60Q-11005SRW

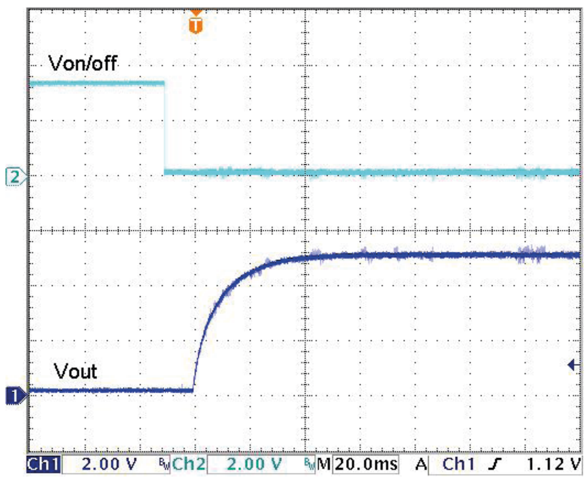
Power Dissipation vs. Output Current



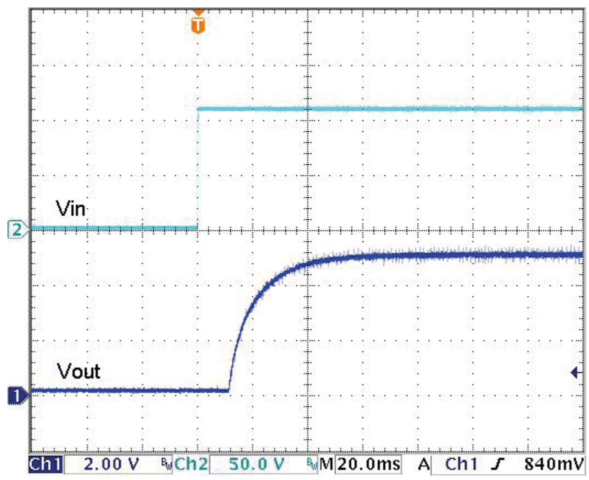
Typical Output Ripple and Noise/full load



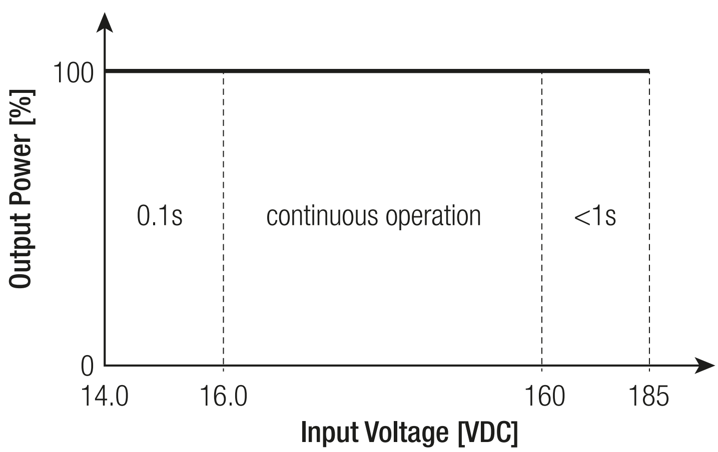
ON/OFF Control Start up Rise Characteristic



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.

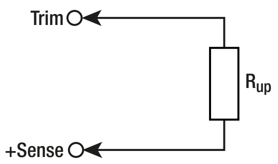
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

OUTPUT VOLTAGE TRIMMING

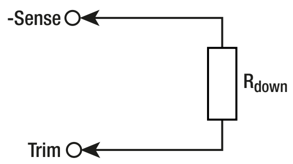
Output Voltage Trimming

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.

Trim up



Trim down



$Vout_{nom}$	= nominal output voltage	[VDC]
$\Delta Vout$	= 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				

Calculation:

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

$$R_{down} = \left[\frac{R_2}{\Delta Vout}\right] - R_1$$

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

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

R_{up} according to E96 ≈ **169kΩ**

$$R_{down} = \left[\frac{511k}{10}\right] - 10k2 = \mathbf{40k9\Omega}$$

R_{down} according to E96 ≈ **41k2Ω**

RP60Q-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]

RP60Q-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]

RP60Q-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]

continued on next page

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

OUTPUT VOLTAGE TRIMMING

RP60Q-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]

RP60Q-xx48SRW

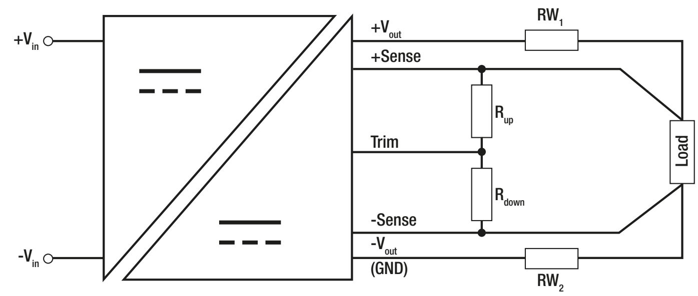
Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	48.48	48.96	49.44	49.92	50.40	50.88	51.36	51.84	52.32	52.80	[VDC]
R_{up} (E96) ≈	19M6	9M94	6M65	5M11	4M12	3M4	3M01	2M61	2M37	2M15	[Ω]

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]

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.

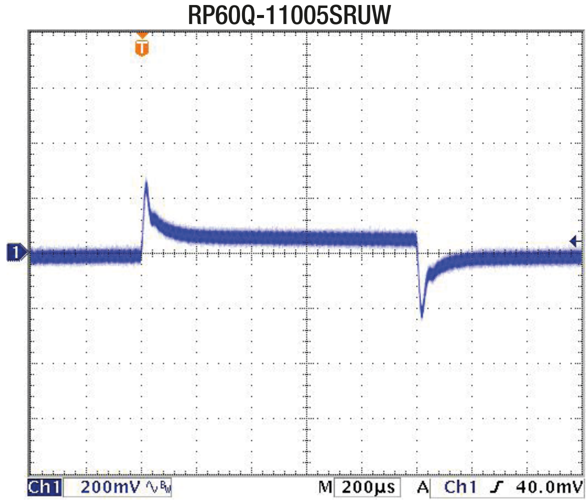
RW_1 ... wire losses +
RW_2 ... wire losses -
R_{up} ... trim up resistor
R_{down}... trim down resistor

REGULATION

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

RP60Q-11005SRUW



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

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	nom. Vin = 110Vin			reinforced

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: T8A slow blow type

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	800 x 10^3 hours 120 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 [%]

continued on next page

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

Practical Example:

Take the **RP60Q-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
$P_{out\ nom.}$ = 60W
$P_{out\ set}$ = 60 x 0.5 = 30W
R_{th} = 6.3K/W (vertical)
η = 90% (Graph)

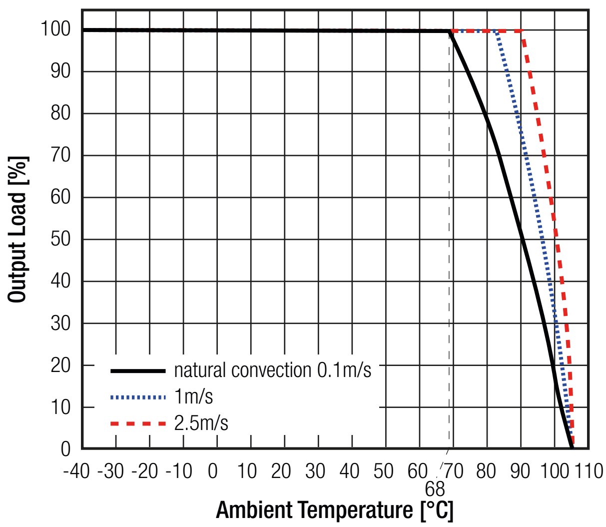
$$P_{diss} = \left[\frac{30}{0.90}\right] - 30 = 3.33W$$

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

$$6.3 = \frac{110 - T_{amb}}{3.33}$$

$$T_{amb} = \underline{89.0°C}$$

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



Take the **RP60Q-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_{case} = 110°C
$P_{out\ nom.}$ = 60W
$P_{out\ set}$ = 60 x 0.5 = 30W
R_{th} = 5.0K/W (vertical)
η = 90% (Graph)

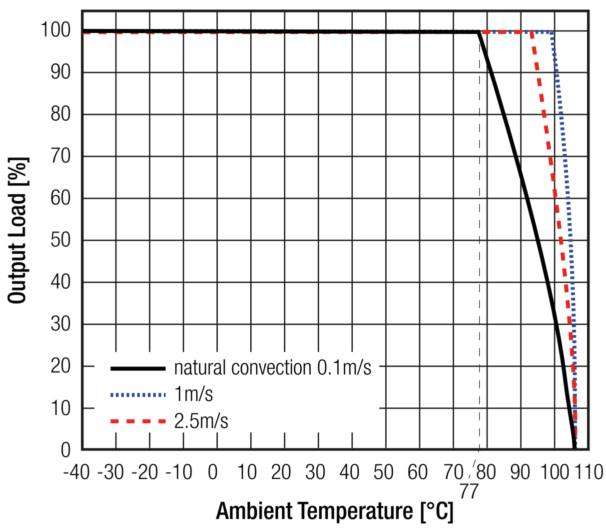
$$P_{diss} = \left[\frac{30}{0.90}\right] - 30 = 3.33W$$

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

$$5.0 = \frac{110 - T_{amb}}{3.33}$$

$$T_{amb} = \underline{93.3°C}$$

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	pending	EN62368-1:2014 + A11:2017 IEC62368-1:2014 2nd Edition
Information technology equipment - General requirements for safety	pending	EN60950-1:2006 + A2:2013
Railway applications - Electrical equipment used on rolling stock	pending	EN50155, 1st Edition, 2007
RoHS 2+		RoHS 2011/65/EU + AM2015/863

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RECOM

DC/DC Converter

RP60Q-RUW
Series

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

EMC Compliance	Condition	Standard / Criterion
Electromagnetic compatibility of multimedia equipment - Emission requirements	with external filter	EN55032:2015
Information technology equipment - Immunity characteristics - Limits and methods of measurement		EN55024:2010 + A1:2015
ESD Electrostatic discharge immunity test		EN61000-4-2:2008
Radiated, radio-frequency, electromagnetic field immunity test		EN61000-4-3:2006 + A2:2010
Fast transient and burst immunity		EN61000-4-4:2012
Surge immunity		EN61000-4-5:2014
Immunity to conducted disturbances, induced by radio-frequency fields		EN61000-4-6:2013
Power magnetic field immunity		EN61000-4-8:2009+F19

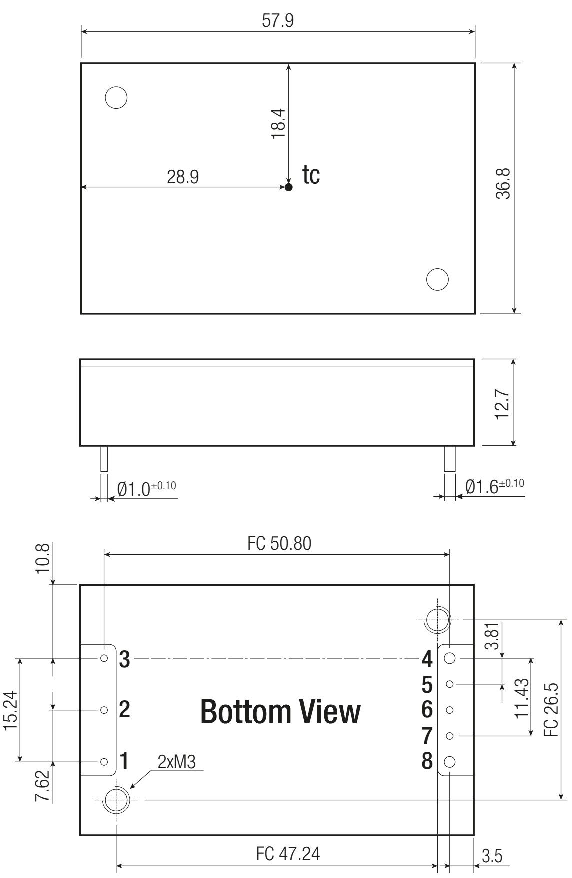
Notes:

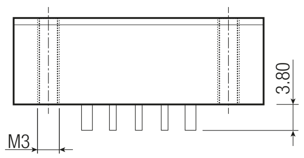
Note10: An external input filter capacitor is required if the module has to meet EN61000-4-4 and EN61000-4-5
Recom suggests: 2 pcs. 150µF/250V connected in parallel

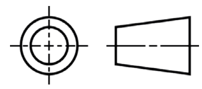
DIMENSIONS and PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Material	baseplate case potting	aluminum plastic (UL94V-0) low smoke silicone (UL94V-0)
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.

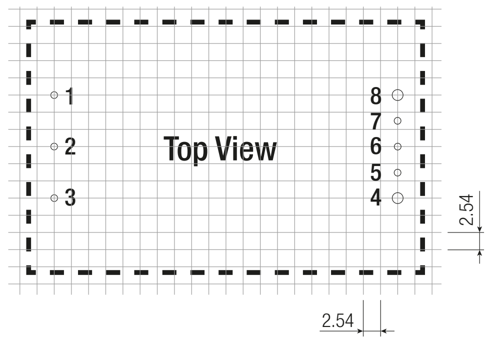
Dimension Drawing (mm)







Recommend Footprint Details



Pin Connections

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

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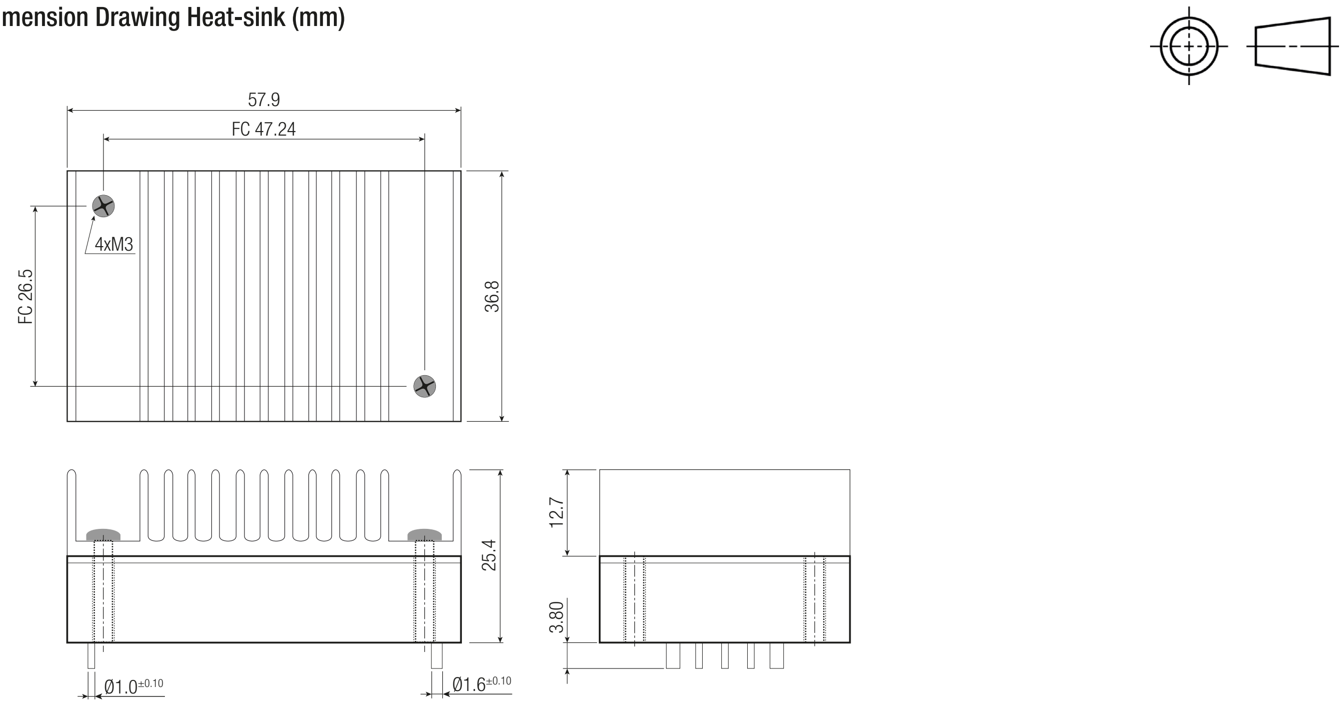
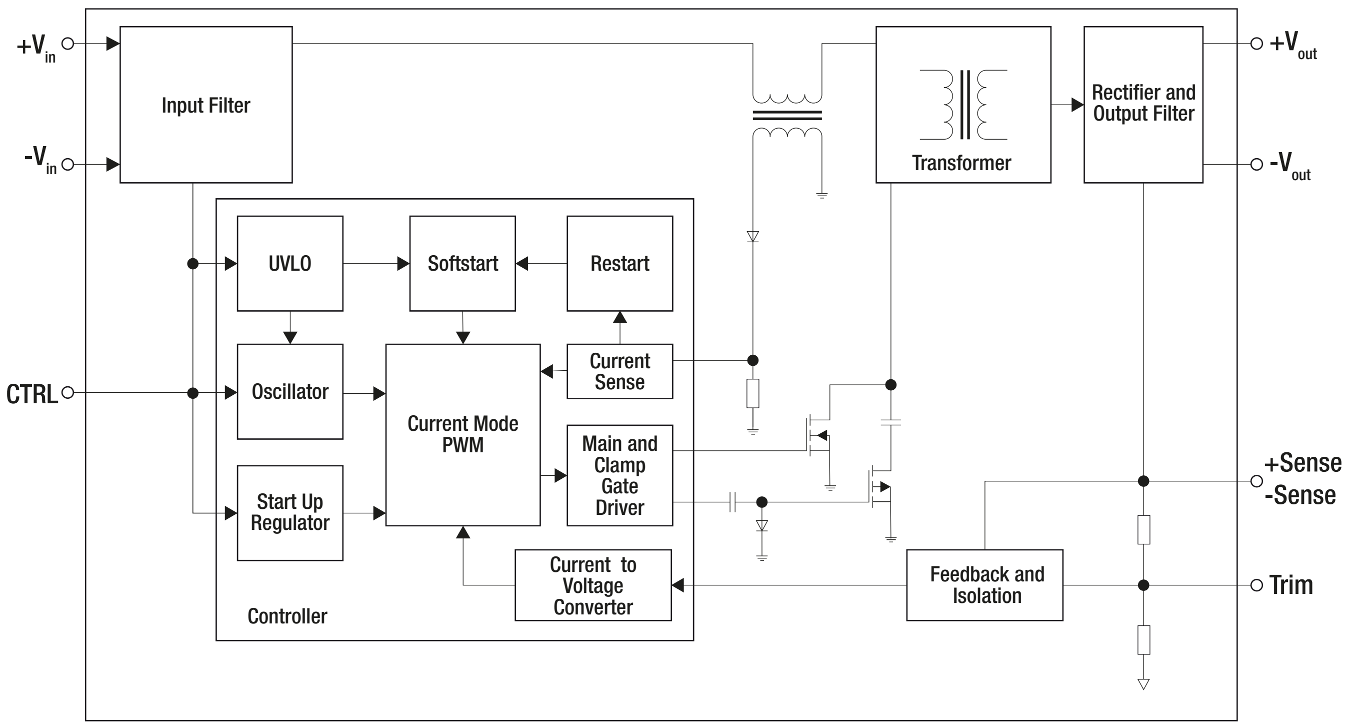
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

Dimension Drawing Heat-sink (mm)



BLOCK DIAGRAMM



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

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