Features

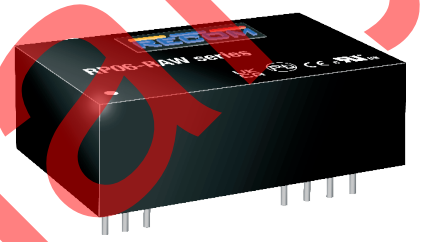
Regulated Converter

- Ultra wide 4:1 input range (36-160VDC)
- Certified for Railway applications (EN50155)
- -40°C to +105°C operating temperature with derating
- Input under voltage lockout
- Output OVLO, short circuit and OLP
- 3kVAC/1min. reinforced isolation
- Remote On/Off

RECOM
DC/DC Converter

RP06-RAW

6 Watt DIP24 Single and Dual Output



UL62368-1 certified
CAN/CSA-C22.2 No. 62368-1-14 certified
IEC/EN62368-1-1 pending
EN50155 compliant
EN50121-3-2 compliant
EN55032 compliant

Description

The RP06-RAW series DC/DC converters are designed for railway rolling stock applications with an extra wide continuous input voltage range of 36-160VDC (200VDC for 1s), making them suitable for 72V, 96V and 110VDC railway systems, but they are also suitable for non-railway high voltage battery applications. They offer single or dual outputs from 3.3V up to ±15V. The high efficiency permits an ambient temperature range from -40°C to more than 85°C without derating, forced cooling, or the need for heatsinks. The RP06-RAW series features UVLO, OVP, SCP, and OLP making them ideal for any harsh railway and industrial applications such as powering IoT sensors, battery management systems, or electric fork-lift trucks. The RP06-RAW is available in an industry standard, compact DIP24 package and comes with a 3 year warranty.

Selection Guide

Part Number	Input Voltage Range [VDC]	nom. Output Voltage [VDC]	Output Current [mA]	Efficiency typ. (1) [%]	max. Capacitive Load (2) [µF]
RP06-1103.3SRAW	36-160	3.3	1800	80	1050
RP06-11005SRAW	36-160	5	1200	81.5	750
RP06-11012SRAW	36-160	12	500	84.5	130
RP06-11015SRAW	36-160	15	400	84	100
RP06-11024SRAW	36-160	24	250	85	39
RP06-11005DRAW	36-160	±5	±600	81	±430
RP06-11012DRAW	36-160	±12	±250	85	±75
RP06-11015DRAW	36-160	±15	±200	85	±56

Notes:

Note1: Efficiency is tested at nominal V_{IN}, full load and 25°C

Note2: Max. Cap load is tested at minimum input and constant resistive load

Model Numbering

RP06-110 RAW

- 110: nom. Input Voltage
- 110: nom. Output Voltage
- RAW: Single or Dual

Ordering Examples

RP06-1103.3SRAW	nom. V_{IN}= 110VDC	nom. V_{OUT}= 3.3VDC	single output
RP06-11012DRAW	nom. V_{IN}= 110VDC	nom. V_{OUT}= ±12VDC	dual output

Preliminary

Specifications (measured @ Ta= 25°C, nom. V_{IN}, full load unless otherwise stated)

BASIC CHARACTERISTICS					
Parameter	**Condition**		**Min.**	**Typ.**	**Max.**
Internal Input Filter					Pi-Type
Input Voltage Range	nom. V_{IN}= 110VDC		36VDC	110VDC	160VDC
Input Surge Voltage	1s max.				200VDC
Under Voltage Lockout (UVLO)	DC-DC ON				36VDC
	DC-DC OFF		32VDC	34VDC	35.8VDC
Quiescent Current				4mA	
Output Voltage Trimming	refer to ***"OUTPUT VOLTAGE TRIMMING"***	others	-10%		+10%
		nom. V_{OUT}= 15/24VDC	-10%		+20%
Minimum Load			0%		
Start-up Time	constant resistive load	Power up		30ms	60ms
		CTRL ON/OFF		30ms	60ms
ON/OFF CTRL [3] refer to ***"ON/OFF CTRL"***	DC-DC ON			Open or 3VDC < V_{CTRL}< 12VDC	
	DC-DC OFF			Short or 0VDC < V_{CTRL}< 1.2VDC	
Input Current of CTRL pin			-0.5mA		+0.5mA
Standby Current	DC-DC OFF			2.5mA	
Internal Operating Frequency			270kHz	300kHz	330kHz
Output Ripple and Noise [4]	20MHz BW	nom. V_{OUT}= 3.3/5VDC		50mVp-p	
		nom. V_{OUT}= 12/15VDC		75mVp-p	
		nom. V_{OUT}= 24VDC		75mVp-p	

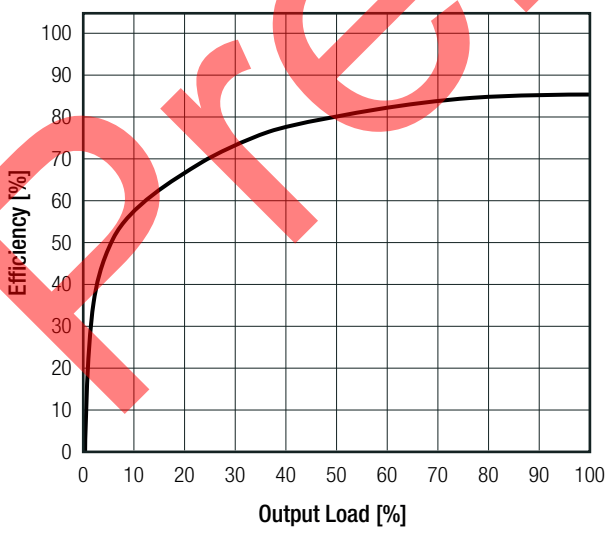
Notes:

Note3: The ON/OFF control function is positive logic. The pin voltage is referenced to -Vin pin

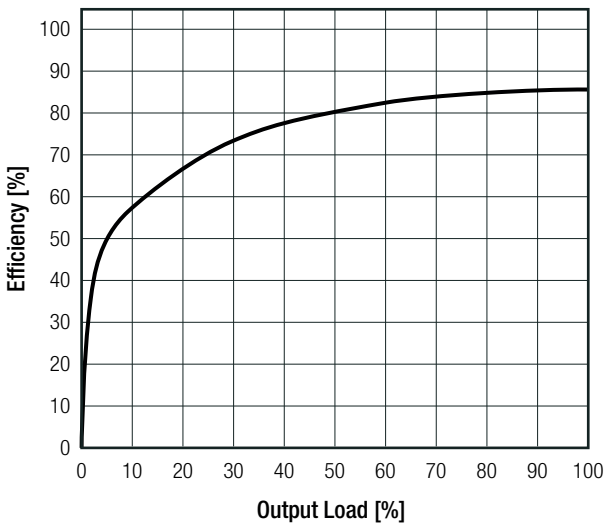
Note4: Measured with: nom. V_{OUT}= 3.3/5/12/15VDC = 10µF/25V X7R MLCC
nom. V_{OUT}= 24VDC = 4.7µF/50V X7R MLCC

Efficiency vs. Load
(@ nom. V_{IN}= 110VDC)

RP06-1103.3SRAW



RP06-11005SRAW



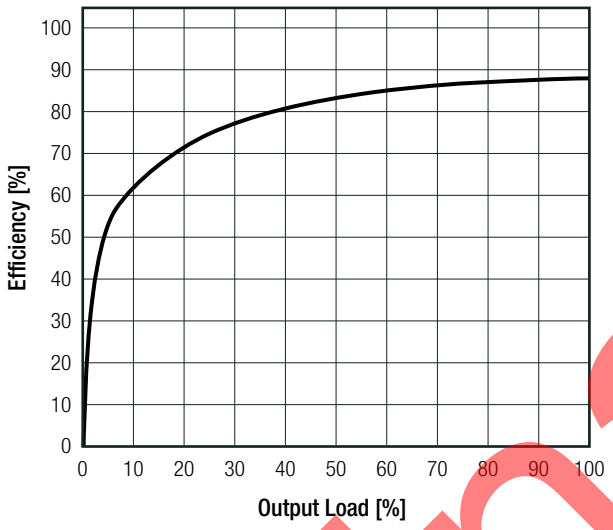
continued on next page

Preliminary

Specifications (measured @ T_{amb}= 25°C, nom. V_{IN}, full load unless otherwise stated)

Efficiency vs. Load
(@ nom. V_{IN}= 110VDC)

RP06-11012SRAW

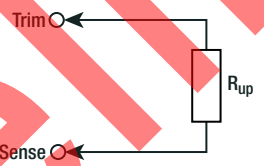


Preliminary

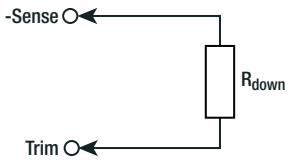
OUTPUT VOLTAGE TRIMMING

RP06-RAW converter 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.

Trim up



Trim down



$Vout_{nom}$ = nominal output voltage [VDC]
$Vout_{set}$ = output voltage change [VDC]
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]

Calculation:

$$R_{up} = \frac{(R_1 \times V_{ref})}{(Vout_{set} - V_{ref} - R_3)} - R_2$$

$$R_{down} = \frac{(Vout_{set} - V_{ref}) \times R_1}{(Vout_{nom} - Vout_{set})} - R_2$$

Single Output

$Vout_{nom}$	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	V_{ref} [VDC]
3.3VDC	5110	2050	0.8	2.5
5VDC			2.5	
12VDC	10000	5110	9.5	
15VDC			12.5	
24VDC	56000	13000	21.5	

Dual Output

$Vout_{nom}$	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	V_{ref} [VDC]
5VDC	3000	3000	7.5	2.5
12VDC	56000	13000	21.5	
15VDC	30000	13000	27.5	

continued on next page

Specifications (measured @ T_{amb}= 25°C, nom. V_{IN}, full load unless otherwise stated)

OUTPUT VOLTAGE TRIMMING

Practical Example RP06-1103.3SRAW trim up +1%

$Vout_{nom}$= 3.3V, $Vout_{set}$= +1% (3.333VDC)

$$R_{up} = \frac{(5110 \times 2.5)}{(3.333 - 2.5 - 0.8)} - 2050 = \mathbf{385071\Omega}$$

R_{up} according to E96 ≈ **383kΩ**

Practical Example RP06-11015SRAW trim down -8%

$Vout_{nom}$= 15V, $Vout_{set}$= -8% (13.8VDC)

$$R_{down} = \frac{(13.8 - 2.5) \times 10000}{(15 - 13.8)} - 5110 = \mathbf{89057\Omega}$$

R_{down} according to E96 ≈ **88k7Ω**

RP06-1103.3SRAW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	3.333	3.366	3.399	3.432	3.465	3.498	3.531	3.564	3.597	3.63	[VDC]
R_{up} (E96) ≈	383k	191k	127k	95k3	75k	61k9	53k6	46k4	41k2	36k5	[Ω]

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	3.267	3.234	3.201	3.168	3.135	3.102	3.069	3.036	3.003	2.97	[VDC]
R_{up} (E96) ≈	118k	54k9	34k	23k7	17k4	13k3	10k5	8k25	6k65	5k23	[Ω]

RP06-11005SRAW

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) ≈	255k	127k	82k5	61k9	48k7	40k2	34k8	30k1	26k1	23k7	[Ω]

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	4.95	4.90	4.85	4.80	4.75	4.70	4.65	4.60	4.55	4.50	[VDC]
R_{up} (E96) ≈	249k	121k	78k7	56k2	44k2	35k7	29k4	24k9	21k	18k2	[Ω]

RP06-11012SRAW

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) ≈	205k	100k	64k9	47k5	36k5	29k4	24k9	21k	17k9	15k8	[Ω]

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	11.88	11.76	11.64	11.52	11.40	11.28	11.16	11.04	10.92	10.8	[VDC]
R_{up} (E96) ≈	768k	383k	249k	182k	143k	118k	97k6	84k5	73k2	63k4	[Ω]

RP06-11015SRAW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	15.15	15.3	15.45	15.60	15.75	15.90	16.05	16.20	16.35	16.50	[VDC]
R_{up} (E96) ≈	162k	78k7	49k9	36k5	28k	22k6	1k87	15k8	13k3	11k5	[Ω]

Trim up	11	12	13	14	15	16	17	18	19	20	[%]
$Vout_{set}$ =	16.650	16.800	16.950	17.100	17.250	17.400	17.550	17.700	17.850	18.000	[VDC]
R_{up} (E96) ≈	10k	8k87	7k68	6k81	6k04	5k36	4k64	4k12	3k65	3k24	[Ω]

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	14.85	14.70	14.55	14.40	14.25	14.1	13.95	13.8	13.65	13.5	[VDC]
R_{up} (E96) ≈	825k	402k	261k	191k	150k	124k	105	88k7	76k8	68k1	[Ω]

continued on next page

Preliminary

Specifications (measured @ T_{amb}= 25°C, nom. V_{IN}, full load unless otherwise stated)

OUTPUT VOLTAGE TRIMMING

RP06-11024SRAW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	24.240	24.480	24.720	24.960	25.200	25.440	25.680	25.920	26.160	26.400	[VDC]
R_{up} (E96) ≈	576k	280k	182k	133k	105k	84k5	69k8	60k4	52k3	45k3	[Ω]

Trim up	11	12	13	14	15	16	17	18	19	20	[%]
$Vout_{set}$ =	26.640	26.880	27.120	27.360	27.600	27.840	28.080	28.320	28.560	28.800	[VDC]
R_{up} (E96) ≈	40k2	35k7	31k6	28k7	26k1	23k7	21k5	19k6	17k9	16k2	[Ω]

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	23.760	23.520	23.280	23.040	22.800	22.560	22.320	22.080	21.840	21.600	[VDC]
R_{up} (E96) ≈	4990k	2430k	1620k	1180k	931k	768k	649k	562k	487k	432k	[Ω]

RP06-11005DRAW

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) ≈	71k5	34k8	22k1	15k8	12k1	95k3	7k68	6k34	5k36	4k53	[Ω]

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	±4.95	±4.90	±4.85	±4.80	±4.75	±4.70	±4.65	±4.60	±4.55	±4.50	[VDC]
R_{up} (E96) ≈	221k	107k	69k8	49k9	39k2	31k6	26k1	22k1	19k1	16k5	[Ω]

RP06-11012DRAW

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) ≈	576k	280k	182k	133k	105k	84k5	69k8	60k4	52k3	45k3	[Ω]

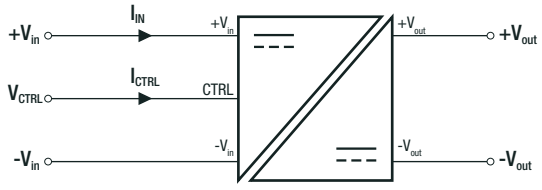
Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	±11.88	±11.76	±11.64	±11.52	±11.40	±11.28	±11.16	±11.04	±10.92	±10.8	[VDC]
R_{up} (E96) ≈	4990k	2430k	1620k	1180k	931k	768k	649k	562k	487k	432k	[Ω]

RP06-11015DRAW

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	±15.15	±15.3	±15.45	±15.60	±15.75	±15.90	±16.05	±16.20	±16.35	±16.50	[VDC]
R_{up} (E96) ≈	237k	113k	69k8	49k9	37k4	28k7	22k6	18k2	14k7	12k1	[Ω]

Trim down	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	±14.85	±14.70	±14.55	±14.40	±14.25	±14.1	±13.95	±13.8	±13.65	±13.5	[VDC]
R_{up} (E96) ≈	2740k	1330k	866k	649k	511k	412k	348k	301k	261k	232k	[Ω]

ON/OFF CTRL



Positive Logic	DC-DC ON	Open or 3VDC<VCTRL<12VDC
	DC-DC OFF	Open or 0VDC<VCTRL<1.2VDC

Preliminary

Specifications (measured @ T_{amb}= 25°C, nom. V_{IN}, full load unless otherwise stated)

REGULATIONS

Parameter	Condition		Value
Output Accuracy			±1.0%
Line Regulation	low line to high line, full load	Single	±0.2%
		Dual	±0.5%
Load Regulation	0% to 100% load	Single	±0.2%
		Dual	±1.0%
Cross Regulation	asymmetrical 25%-100% load		±5.0%
Transient Response Recovery Time	25% load step change		250µs typ.

PROTECTIONS

Parameter	Condition			Value
Short Circuit Protection (SCP)				continuous, automatic recovery
Over Voltage Protection (OVP)	zener diode clamp	Single	nom. V_{OUT}= 3.3VDC	3.7-5VDC
			nom. V_{OUT}= 5VDC	5.6-7VDC
			nom. V_{OUT}= 12VDC	13.5-16VDC
			nom. V_{OUT}= 15VDC	18.3-22VDC
			nom. V_{OUT}= 24VDC	29.1-34.5VDC
		Dual	nom. V_{OUT}= ±5VDC	5.6-7VDC
			nom. V_{OUT}= ±12VDC	13.5-18.2VDC
			nom. V_{OUT}= ±15VDC	17-22VDC
Over Load Protection (OLP)	% of Iout rated; Hiccup mode			150% typ.
Isolation Voltage (5)	I/P to O/P	1 minute		3kVAC
Isolation Resistance	V_{ISO}= 500VDC			1GΩ min.
Isolation Capacitance				1000pF max.
Insulation Grade				reinforced

Notes:

Note4: This power module is not internally fused. An input line fuse must always be used. Recom suggests: nom. V_{IN}= 110VDC = T0.5A slow blow

Note5: For repeat Hi-Pot testing, reduce the time and/or the test voltage

ENVIRONMENTAL

Parameter	Condition	Value
Operating Temperature Range	with derating (refer to ***"Derating Graph"***)	-40°C to +105°C
Maximum Case Temperature	no load	+105°C
Temperature Coefficient		±0.02%/K
Thermal Impedance	@ natural convection 0.1m/s	18.91K/W typ.
Operating Humidity		5% - 95% RH max.
Pollution Degree (PD)		PD2
Shock		according to MIL-STD-810F
Thermal Shock		according to EN61373, MIL-STD-810F
Vibration		according to EN61373, MIL-STD-810F
Environmental testing Part 2-1: Tests – Test A: Cold	Low temperature start-up test Class OT4: -40°C to +70°C	according to EN60068-2-1:2007
Environmental testing Part 2-2: Tests – Test B: Dry heat	Dry Heat Test Class OT4: -40°C to +70°C Class ST1: Test cycle B	according to EN60068-2-2:2007

continued on next page

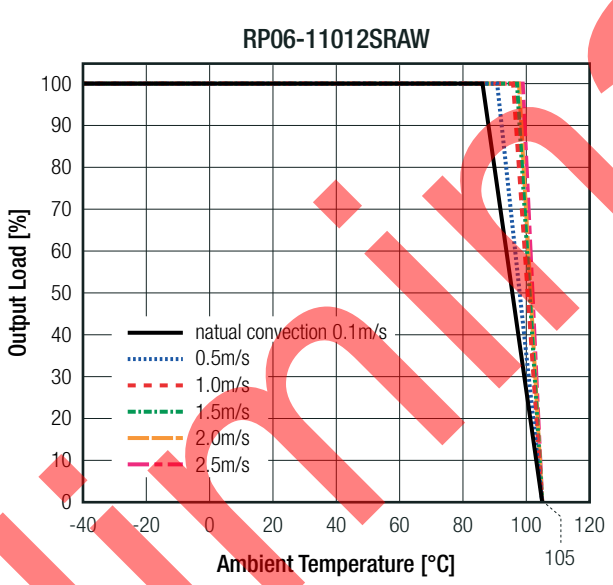
Preliminary

Specifications (measured @ T_{amb}= 25°C, nom. V_{IN}, full load unless otherwise stated)

ENVIRONMENTAL

Parameter	Condition	Value
Environmental testing Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	Damp Heat Test Temperature: +25 to +55°C Humidity: 95% ±5% RH Test Duration: 48 hours	according to EN60068-2-30:2005
Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behavior of materials and components		EN45545-2
Railway applications – Rolling stock equipment – Shock and vibration tests		EN61373:2010
MTBF	according to MIL-HDBK-217F, G.B	3036 x 10^3 hours

Derating Graph
(@ Chamber and natural convection 0.1m/s)



SAFETY AND CERTIFICATIONS

Certificate Type (Safety)	Condition	Standard
Audio/video, information, and communication technology equipment. Safety requirements (CB)	pending	IEC62368-1:2014 2nd Edition
Audio/video, information, and communication technology equipment. Safety requirements (LVD)		EN62368-1:2014+A11:2017
Audio/video, information, and communication technology equipment. Safety requirements	E196683	UL62368-1:2014 2nd Edition
		CAN/CSA-C22.2 No. 62368-1-14 2nd Edition
Railway applications - Electronic equipment used on rolling stock		EN50155:2017
RoHS2		RoHS 2011/65/EU + AM2015/863

EMC Compliance according to EN50121-3-2	Condition	Standard / Criterion
Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus	without external components	EN50121-3-2
ESD Electrostatic discharge immunity test	Air: ± 8kV; Contact ±6kV	EN61000-4-2, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	20V/m	EN61000-4-3, Criteria A
Fast Transient and Burst Immunity (6)	±2kV	EN61000-4-4, Criteria A
Surge Immunity (6)	±2kV	EN61000-4-5, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	10Vrms	EN61000-4-6, Criteria A
Power frequency magnetic field	100A/m cont.; 1000A/m 1sec	EN61000-4-8, Criteria A

continued on next page

Preliminary

Specifications (measured @ T_{amb}= 25°C, nom. V_{IN}, full load unless otherwise stated)

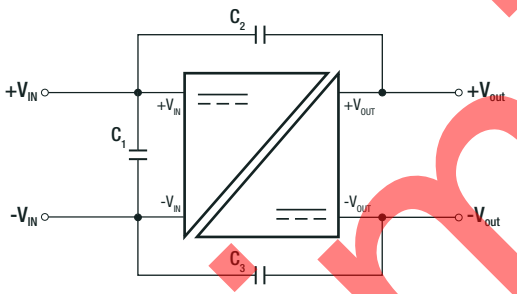
SAFETY AND CERTIFICATIONS

EMC Compliance according to EN55032/35	Condition	Standard / Criterion
Electromagnetic Compatibility of Multimedia Equipment - Emission Requirements	without external components	EN55032, Class A
	refer to ***"EMC Filtering"***	EN55032, Class B
Electromagnetic compatibility of multimedia equipment – Immunity requirements		EN55035:2017
ESD Electrostatic discharge immunity test	Air: ± 8kV; Contact ±6kV	EN61000-4-2, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	20V/m	EN61000-4-3, Criteria A
Fast Transient and Burst Immunity (6)	±2kV	EN61000-4-4, Criteria A
Surge Immunity (6)	±2kV	EN61000-4-5, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	10Vrms	EN61000-4-6, Criteria A
Power frequency magnetic field	100A/m cont.; 1000A/m 1sec	EN61000-4-8, Criteria A

Notes:

Note6: An external input filter capacitor + TVS diode is required if the module has to meet EN61000-4-4 and EN61000-4-5.
2pcs of aluminum E-cap to connect in parallel (220µF/200V), Recom suggest: Nippon Chemi-con KXJ series and TVS: 220V/600W

EMC Filtering Suggestions according to EN55032/35



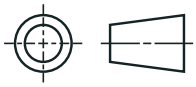
Component List Class B

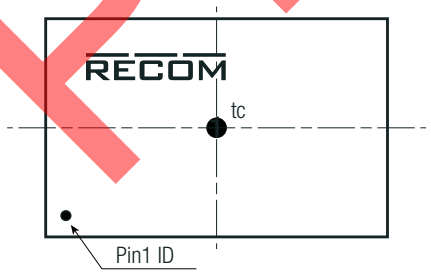
C1	C2	C3
1µF	330pF	680pF

DIMENSIONS AND PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Material	case/baseplate	non-conductive black plastic
	potting	silicone, (UL94 V-0)
Dimensions (LxWxH)		31.8 x 20.3 x 10.6mm
Weight		14g typ.

Dimension Drawing (mm)





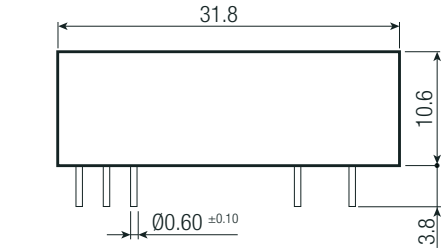
Tolerance: xx.x ±0.5mm
xx.xx ±0.25mm

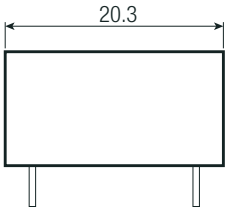
continued on next page

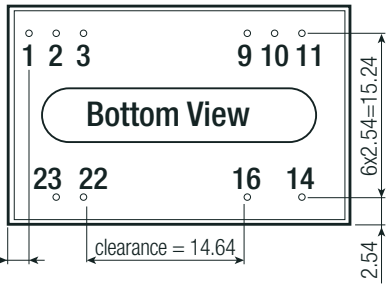
Preliminary

Specifications (measured @ T_{amb}= 25°C, nom. V_{IN}, full load unless otherwise stated)

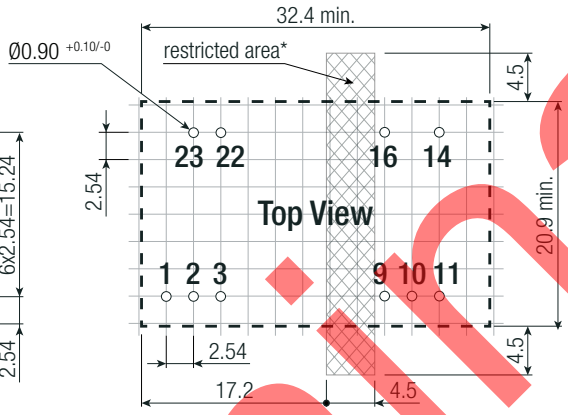
Dimension Drawing (mm)







Recommended Footprint Details



Pinning Information

Pin #	Single	Dual
1	CTRL (3)	CTRL (3)
2	-Vin	-Vin
3	-Vin	-Vin
9	NC	Com
10	Trim	Trim
11	NC	-Vout
14	+Vout	+Vout
16	-Vout	Com
22	+Vin	+Vin
23	+Vin	+Vin

NC= No Connection
Tolerance: xx.x ±0.5mm
xx.xx ±0.25mm

*A minimum of 4.5mm clearance and creepage is required between primary and secondary circuit to meet 2MOPP under IEC60601-1. No copper traces and/or components are allowed in this area if 2MOPP is required.

PACKAGING INFORMATION		
Parameter	**Type**	**Value**
Packaging Dimension (LxWxH)	tube	255.0 x 21.8 x 16.5mm
Packaging Quantity		7pcs
Storage Temperature Range		-55°C to +125°C
Storage Humidity	non-condensing	5% - 95% RH

Preliminary

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.