Technical Data Sheet

RPA20-FR Series ◊ DC-DC Converter

20W ◊ 4:1 Input: 36V-160VDC

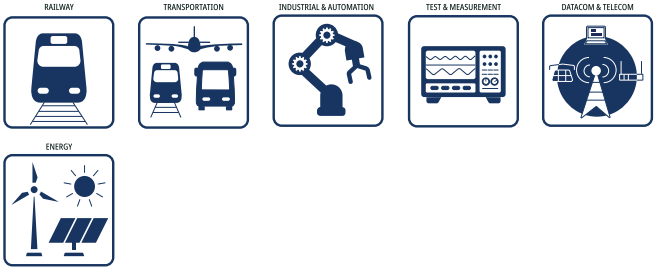
RECOM DC/DC Converter

FEATURES

- Internal EN55032 Class A filter
- 4:1 wide input voltage range
- 3kVAC/1 minute reinforced insulation
- High efficiency over entire input voltage range
- -40°C to +105°C operating temperature range
- ON/OFF CTRL
- Output voltage trimming +20%/-10%
- UL, CE marked
- 3 year warranty

Dimensions (LxWxH): 40.6 x 25.4 x 10.2mm (1.60 x 1.00 x 0.40 inch)
24g (0.053 lbs)

APPLICATIONS



SAFETY & EMC

RoHS² compliant 10 from 10 | Reach compliant | CE | cULus E196683

DESCRIPTION

The RPA20-FR series wide range input DC/DC converters have been especially designed for railway applications and are EN45545-2, EN50155, and UL/EN/IEC 62368-1 certified. With an input voltage range from 36V to 160VDC and a reinforced isolation barrier rated up to 3kVAC/1min, these high power density converters in a 1.6“ x 1“ case are particularly suited for rolling stock rail applications. Despite their small size, the RPA20-FR converters are fully specified devices with output currents up to 4 amps, up to 90.5% typical efficiency, no minimum load, UVLO, tight regulation, and low ripple/noise figures. The trimmable outputs are also fully protected against over-temperature, short circuits, over-current, and over-voltage.

SELECTION GUIDE

Part Number	Input Voltage Range [VDC]	nom. Output Voltage [VDC]	Output Current max. [mA]	Efficiency typ. (1) [%]	Max. Capacitive Load (2) [µF]
RPA20-11005SFR (3)	36-160	5	4000	90.5	5000
RPA20-1105.1SFR (3)	36-160	5.1	4000	90.5	5000
RPA20-11012SFR (3)	36-160	12	1670	88.5	850
RPA20-11015SFR (3)	36-160	15	1330	89.5	700
RPA20-11024SFR (3)	36-160	24	833	88.5	220
RPA20-11005DFR (3)	36-160	±5	±2000	86	±2500
RPA20-11012DFR (3)	36-160	±12	±833	88.5	±500
RPA20-11015DFR (3)	36-160	±15	±667	89.5	±350

Note1: Efficiency is tested at 110Vin and full load at +25°C ambient
Note2: Max. Cap Load is tested at nominal input and full resistive load

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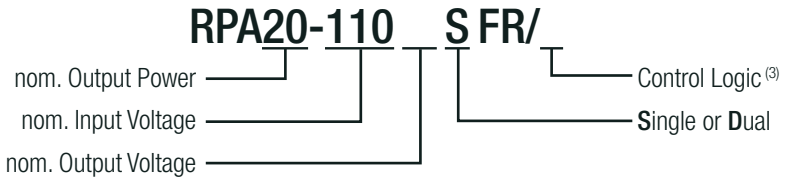
20W ◊ 4:1 Input: 36V-160VDC

RECOM DC/DC Converter

MODEL NUMBERING



Note3: standard part is without suffix for positive logic (1=ON, 0=OFF)
or add suffix "/N" for negative logic (0=ON, 1=OFF), for more details refer to **„ON/OFF CTRL“**

ACCESSIBLE PART

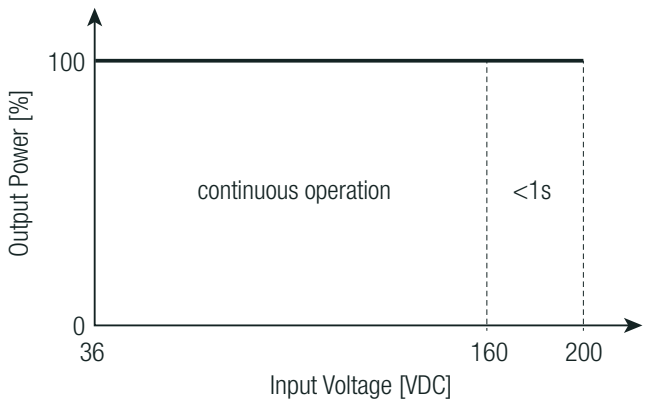
Part Number	Description	Datasheet Link
RSP20-168	Surge protector (voltage clamp) for RIA12 and NF F01-510 transients	RSP20-168.pdf

BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Condition			Min.	Typ.	Max.
Internal Input Filter						Pi-Type
Input Voltage Range				36VDC	110VDC	160VDC
Input Surge Voltage	nom. Vin= 110VDC	1 second max.				200VDC
Under Voltage Lockout (UVLO)	DC-DC OFF			32VDC	34VDC	35.8VDC
Input Current	nom. V_{IN}= 36VDC				650mA	
	nom. V_{IN}= 110VDC				200mA	
	nom. V_{IN}= 160VDC				150mA	
Quiescent current	nom. Vin= 110VDC				10mA	
Output Voltage Trimming	refer to **„Output Voltage Trimming“** Single output only		15, 24Vout	-10%		+20%
			others	-10%		+10%
Minimum Load				0%		
Start-up Time	constant resistive load				30ms	60ms
ON/OFF CTRL (4)	refer to **„ON/OFF CTRL“**	Positive Logic	DC/DC ON	Open or 3VDC < V_{CTRL} < 12VDC		
			DC/DC OFF	Short or 0VDC < V_{CTRL} < 1.2VDC		
		Negative Logic	DC/DC ON	Short or 0VDC < V_{CTRL} < 1.2VDC		
			DC/DC OFF	Open or 3VDC < V_{CTRL} < 12VDC		
Input Current of CTRL pin	DC-DC ON			-0.5mA		+0.5mA
Standby Current	DC-DC OFF				3mA	
Internal Operating Frequency				250kHz	270kHz	310kHz
Output Ripple and Noise	measured at 20MHz BW and 1µF/50V X7R MLCC	5, 5.1Vout			75mVp-p	
		12, 15Vout			100mVp-p	
		24Vout			150mVp-p	

Note4: The ON/OFF control function can be positive or negative logic. The pin voltage is referenced to -Vin

Input Voltage Range



Continuous full power operation is rated between 36V and 160VDC, including full load start-up.
Once running, the converter will operate for short periods of time over an extended input voltage range up to 200V, thus covering all EN50155 under-voltage and over-voltage transient conditions.

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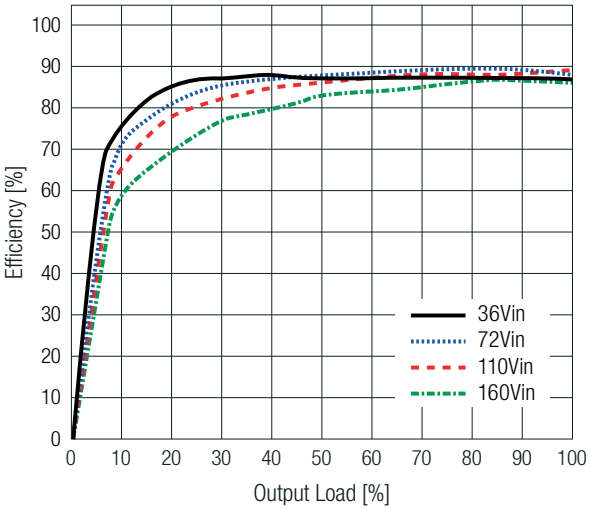
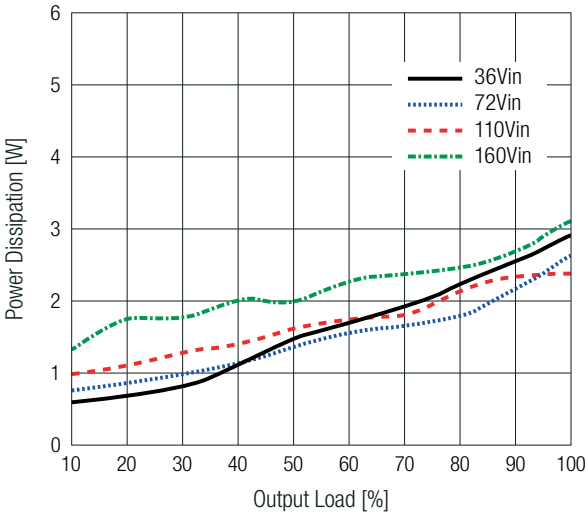
BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

RPA20-11005SFR, RPA20-1105.1SFR

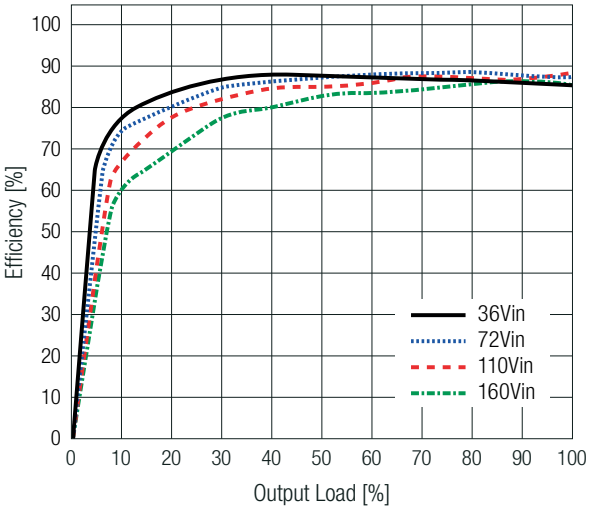
Efficiency vs. Output Load

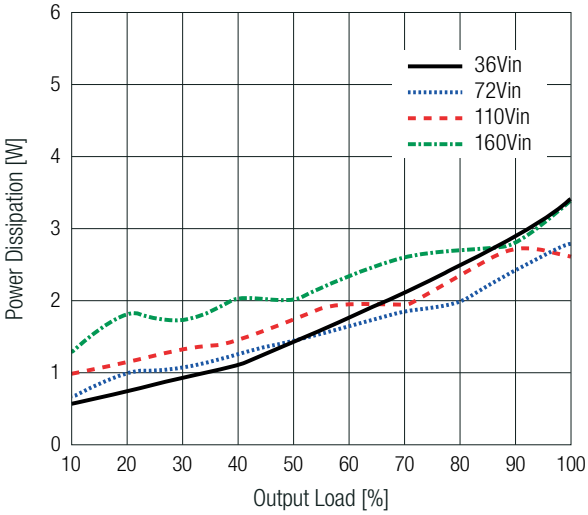


Power Dissipation vs. Output Current



RPA20-11012SFR





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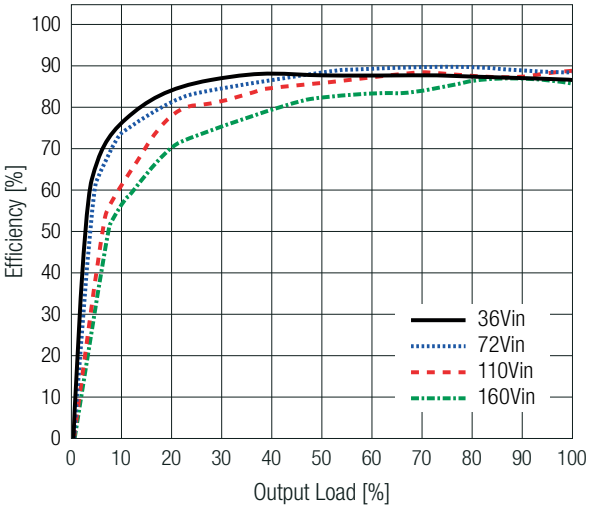

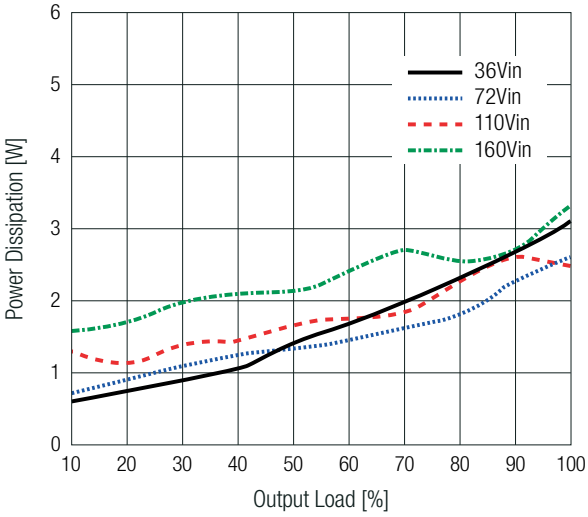

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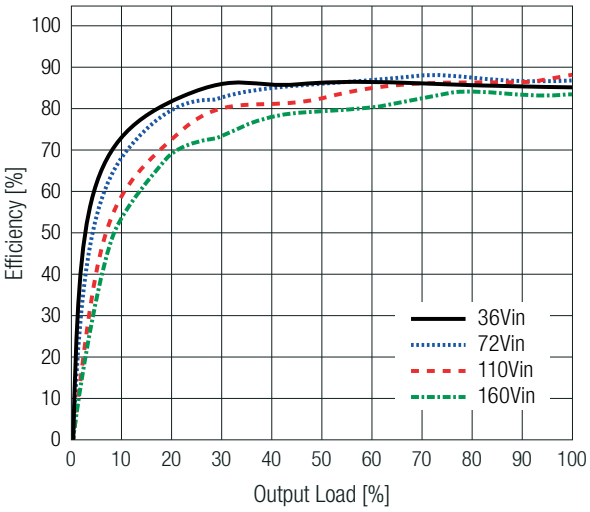
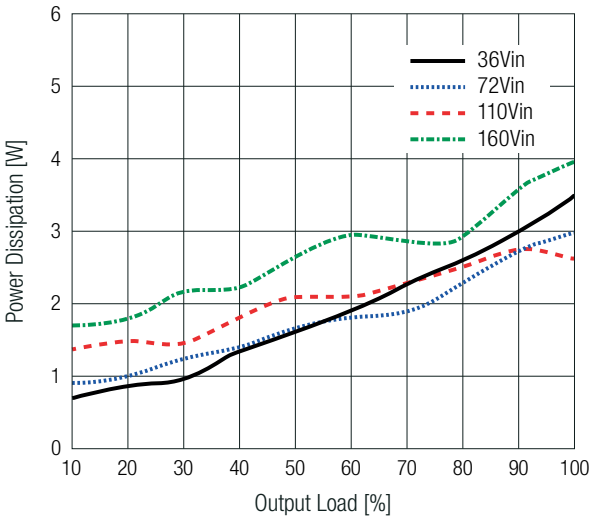
BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

RPA20-11024SFR

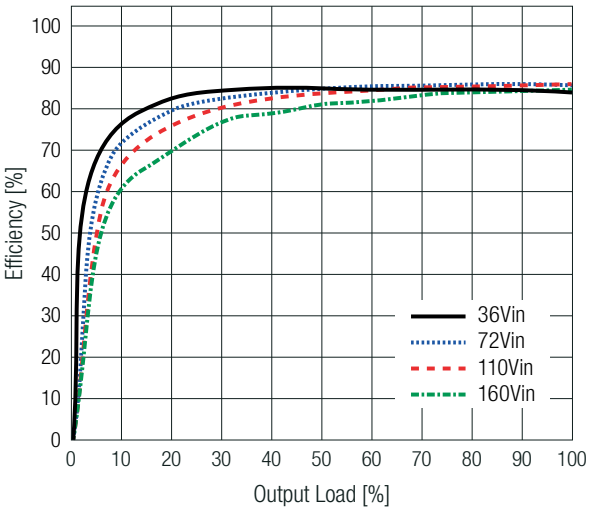
Efficiency vs. Output Load

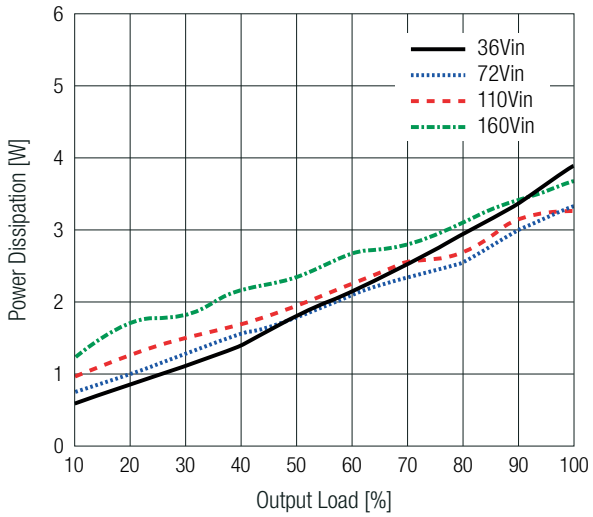


Power Dissipation vs. Output Current



RPA20-11005DFR





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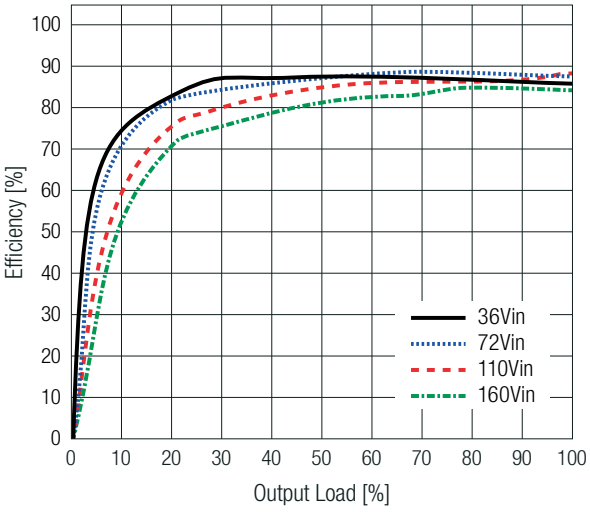

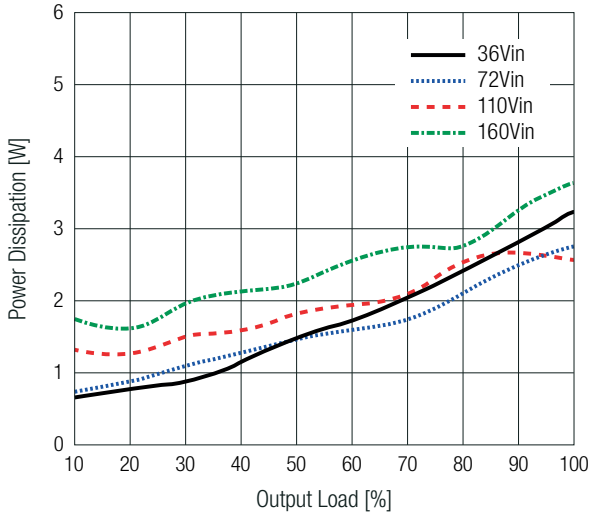

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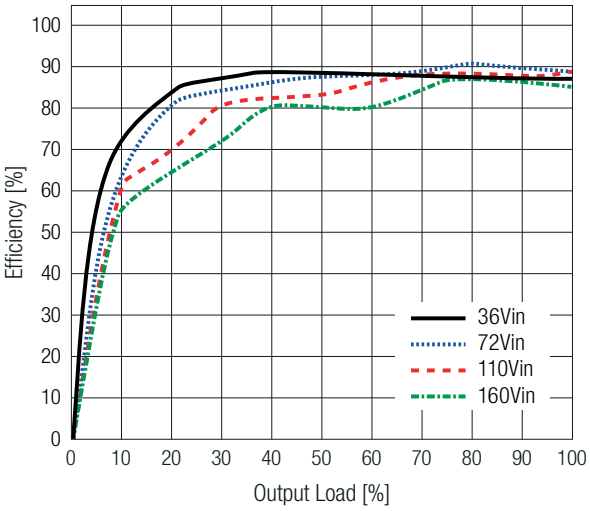
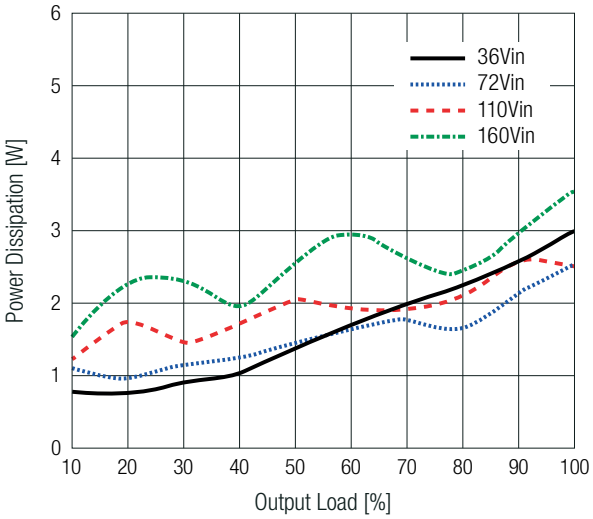
BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

RPA20-11015DFR

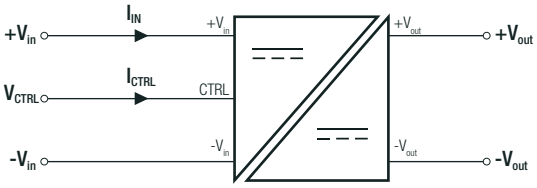
Efficiency vs. Output Load



Power Dissipation vs. Output Current



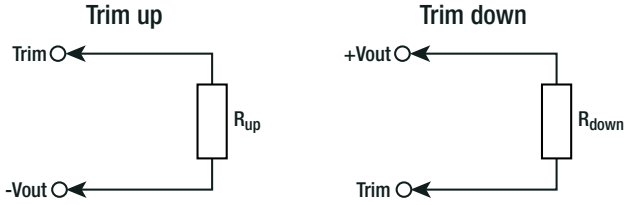
ON/OFF CTRL



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

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 +Vout or -Vout pins. With an external resistor between the Trim and -Vout pin, the output voltage increases. With an external resistor between the Trim and +Vout 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.



RPA20-11005SFR

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	5.05	5.1	5.15	5.2	5.25	5.3	5.35	5.4	5.45	5.5	[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	4.9	4.85	4.8	4.75	4.7	4.65	4.6	4.55	4.5	[VDC]
R_{up} (E96) ≈	249k	121k	78k7	56k2	44k2	35k7	29k4	24k9	21k	18k2	[Ω]

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OUTPUT VOLTAGE TRIMMING

RPA20-1105.1SFR

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	5.151	5.202	5.253	5.304	5.355	5.406	5.457	5.508	5.559	5.61	[VDC]
R_{up} (E96) ≈	249k	124k	80k6	60k4	47k5	39k2	34k	29k4	25k5	23k2	[Ω]

Trim down	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	[%]
$Vout_{set}$ =	5.049	4.998	4.947	4.869	4.845	4.794	4.743	4.692	4.641	4.59	[VDC]
R_{up} (E96) ≈	255k	124k	80k6	57k6	45k3	36k5	30k1	25k5	21k5	18k7	[Ω]

RPA20-11012SFR

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	13.2	[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	11.4	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]

RPA20-11015SFR

Trim up	1	2	3	4	5	6	7	8	9	10	[%]
$Vout_{set}$ =	15.15	15.3	15.45	15.6	15.75	15.9	16.05	16.2	16.35	16.5	[VDC]
R_{up} (E96) ≈	162k	78k7	49k9	36k5	28k	22k6	18k7	15k8	13k3	11k5	[Ω]

Trim up	11	12	13	14	15	16	17	18	19	20	[%]
$Vout_{set}$ =	16.65	16.8	16.95	17.1	17.25	17.4	17.55	17.7	17.85	18	[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	14.7	14.55	14.4	14.25	14.1	13.95	13.8	13.65	13.5	[VDC]
R_{up} (E96) ≈	825k	402k	261k	191k	150k	124k	105k	88k7	76k8	68k1	[Ω]

RPA20-11024SFR

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

Trim up	11	12	13	14	15	16	17	18	19	20	[%]
$Vout_{set}$ =	26.64	26.88	27.12	27.36	27.6	27.84	28.08	28.32	28.56	28.8	[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	[%]
$Vout_{set}$ =	23.76	23.52	23.28	23.04	22.8	22.56	22.32	22.08	21.84	21.6	[VDC]
R_{up} (E96) ≈	4M99	2M43	1M62	1M18	931k	768k	649k	562k	487k	732k	[Ω]

REGULATIONS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Condition		Value
Output Accuracy			±1.0% max.
Line Regulation	low line to high line, full load		±0.2% max.
Load Regulation	0% to 100% load	single output	±0.5% max.
		dual output	±1.0% max.
Cross Regulation	asymmetrical load 25%/100% load	dual output only	±5.0% max.
Transient Response	25% load step change		250µs typ.

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PROTECTIONS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Condition		Value
Short Circuit Protection (SCP)	below 100mΩ		continuous, automatic recovery
Over Voltage Protection (OVP)	zener diode clamp	5, 5.1Vout	6.2VDC typ.
		12Vout	15VDC typ.
		15Vout	20VDC typ.
		24Vout	30VDC typ.
Over Current Protection (OCP)			150% of rated I_{OUT}, hiccup mode
Over Temperature Protection (OTP)	internal temperature sensor		115°C 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

Note5: For repeat Hi-Pot testing, reduce the time and/or the test voltage
Note6: Refer to local safety regulations if input over-current protection is also required. Recommended fuse: T1A slow blow type

ENVIRONMENTAL (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Condition		Value
Operating Temperature Range	refer to **„Derating Graph“**		-40°C to +105°C
Maximum Case Temperature			+105°C
Temperature Coefficient			±0.02%/K
Thermal Impedance	vertical direction by natural convection (0.1m/s)		11.48K/W
Operating Altitude			5000m
Operating Humidity			5%-95% RH
Pollution Degree			PD2
Thermal Shock			according to MIL-STD-810F
Vibration			according to EN61373 and MIL-STD-810F
Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behavior of materials and components			EN45545-2:2013+A1:2015
Environmental testing Part 2-1: Tests – Test A: Cold	Temperature: -40°C to +70°C, Class OT4		EN60068-2-1:2007
Environmental testing Part 2-2: Tests – Test B: Dry heat	Temperature: -40°C to +70°C, Test cycle B, Class OT4 and ST1		EN60068-2-2:2007
Environmental testing Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	Temperature: +21°C ±2°C Humidity: 53% ±6% Test Duration: 48 hours		EN60068-2-30:2005
Railway applications – Rolling stock equipment – Shock and vibration tests	Functional Random vibration test Category 1 Class B Body mounted 5Hz to 2000Hz, Transverse 0.45m/s², Longitudinal 0.70m/s², Vertical 1.01m/s² Simulated long-life testing at Increased vibration test Category 1 Class B Body mounted 5Hz to 2000Hz, Transverse 2.55m/s², Longitudinal 3.96m/s², Vertical 5.72 Shock Test Category 1 Class A and B Body mounted Transverse 30m/s² (Peak), 30ms, Longitudinal 50m/s² (Peak), 30ms, Vertical 30m/s² (Peak), 30ms		EN61373:2010
MTBF	according to MIL-HDBK-217F, G.B.	T_{AMB}= +25°C	1558 x 10^3 hours

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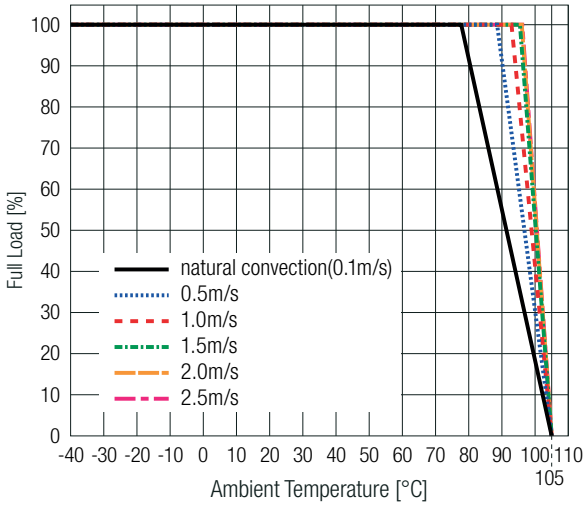
ENVIRONMENTAL (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

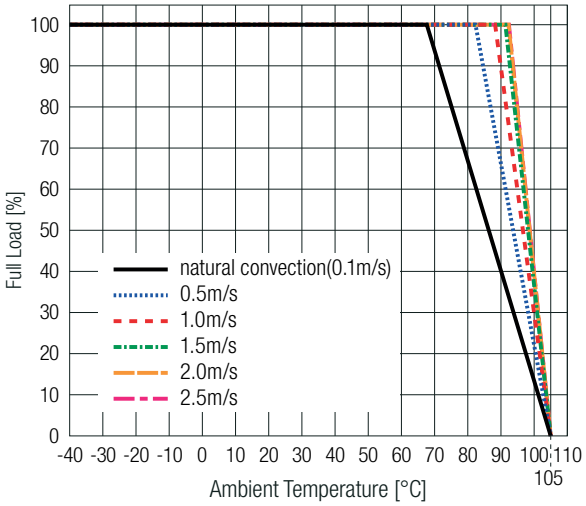
Derating Graph

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

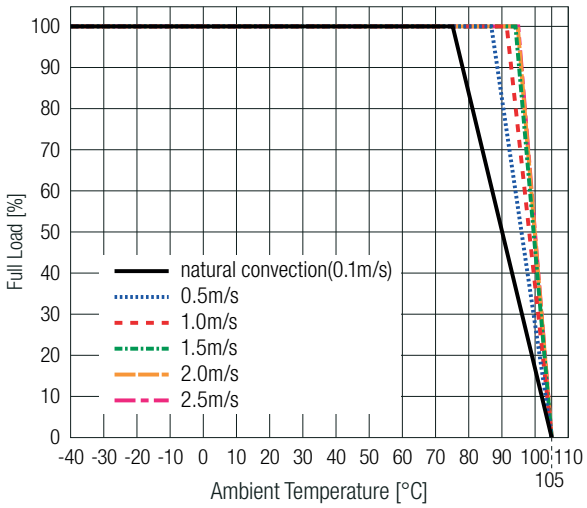
RPA20-11005SFR, RPA20-1105.1SFR



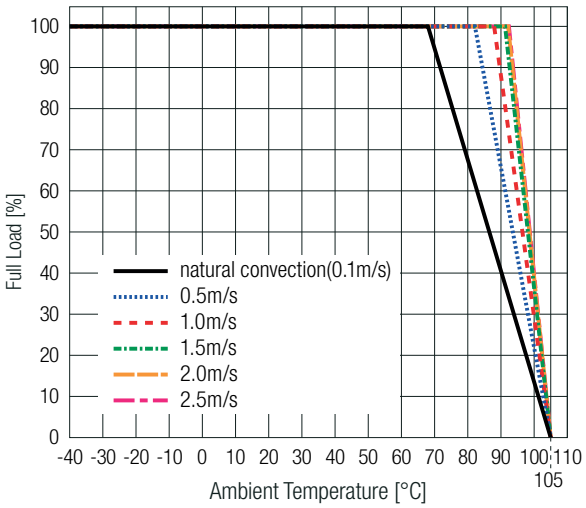
RPA20-11005DFR



RPA20-11012SFR, RPA20-11024SFR, RPA20-11012DFR



RPA20-11015SFR, RPA20-11015DFR



SAFETY AND CERTIFICATION

Certificate Type (Safety)	Report / File Number	Standard
Audio/video, information and communication technology equipment. Safety requirements	240701301	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-Part1: Safety requirements	E196683	UL62368-1:2014, 2nd Edition
		CAN/CSA-C22.2 No. 62368-1:2014
Railway applications - Electrical equipment used on rolling stock		EN50155:2017
RoHS2		RoHS 2011/65/EU + AM2015/863

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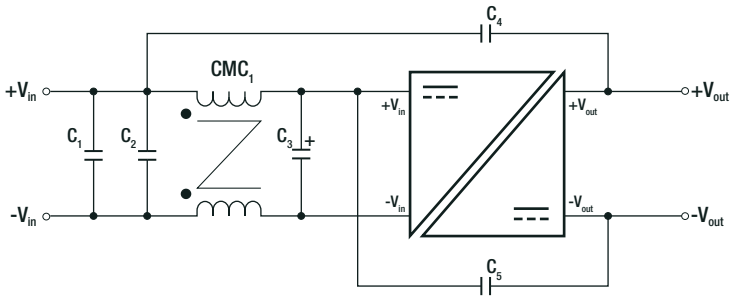
SAFETY AND CERTIFICATION

EMC Compliance (EN50121-3-2)	Condition	Standard / Criterion
Railway applications - Electromagnetic compatibility		EN50121-3-2:2016 + A1:2019
ESD Electrostatic discharge immunity test	Air: ±4, 8kV, Contact: ±4, 6kV	EN61000-4-2, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	20V/m (80-1000MHz)	EN61000-4-3, Criteria A
Fast Transient and Burst Immunity (7)	DC Power Port: ±2kV	EN61000-4-4, Criteria A
Surge Immunity (7)	DC Power Port: ±0.5, 1kV, 2kV	EN61000-4-5, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	DC Power Port: 10Vrms (0.15-80MHz)	EN61000-4-6, Criteria A
Power Magnetic Field Immunity	50Hz, 100A/m 60 seconds 1000A/m 1 second	EN61000-4-8, Criteria A

EMC Compliance (EN55032)	Condition	Standard / Criterion
Electromagnetic compatibility of multimedia equipment – Emission Requirements	without external filter	EN55032:2015 + AC:2016, Class A
	refer to **„EMC Filtering“**	EN55032:2015 + AC:2016, Class B
Electromagnetic compatibility of multimedia equipment – Immunity requirements		EN55032:2017
Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments		IEC61000-6-4

Note7: An external input filter capacitor is required if the module has to meet EN61000-4-4 and EN61000-4-5
Recom suggests: 2 pcs. 220µF/200V (in parallel) and a TVS 170V/3000W peak in parallel

EMC Filtering suggestion for EN55032 Class B



Component List Class B

C_1, C_2	CMC_1	C_3	C_4	C_5
1µF	570µH	47µF	680pF	330pF

DIMENSION & PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Material	case, baseplate	non-conductive black plastic, UL94 V-0
	potting	silicone, UL94 V-0
	PCB	FR4, UL94 V-1
Dimension (LxWxH)		40.6 x 25.4 x 10.2mm 1.60 x 1.00 x 0.40 inch
Weight		24g typ. 0.053 lbs

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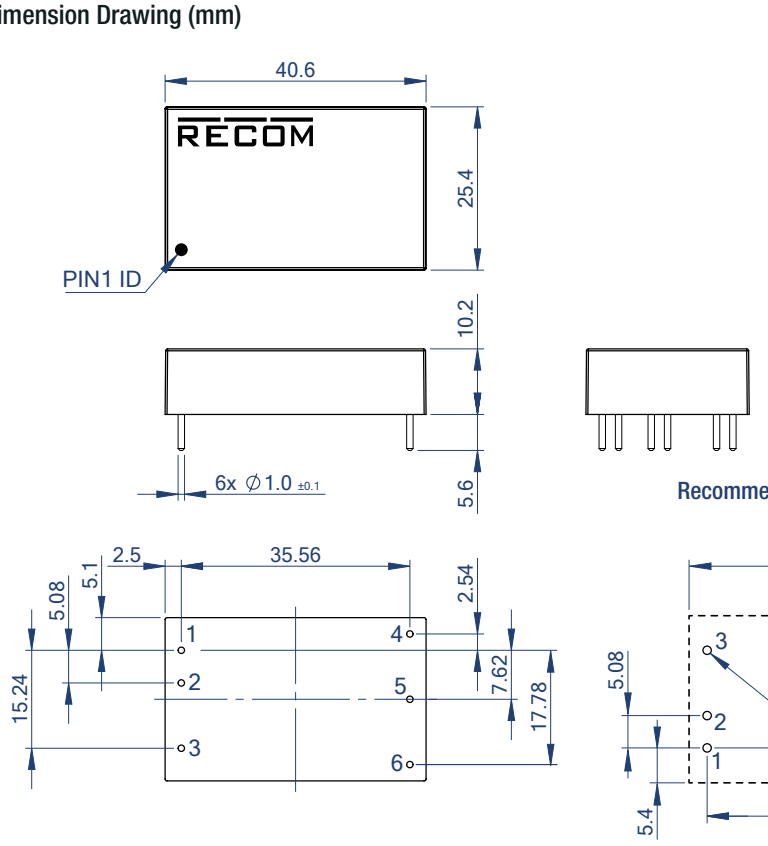
DIMENSION & PHYSICAL CHARACTERISTICS

Dimension Drawing (mm)

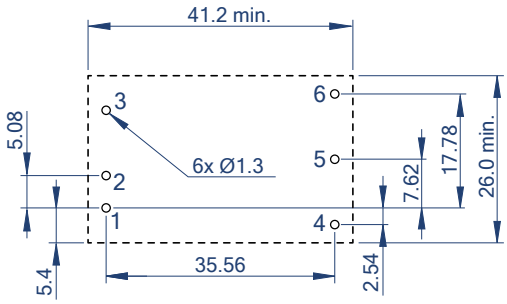


Pinning Information

Pin #	Single	Dual
1	+Vin	+Vin
2	-Vin	-Vin
3	CTRL	CTRL
4	+Vout	+Vout
5	-Vout	COM
6	TRIM	-Vout

Recommended Footprint Detail

Top View



Tolerances:
x.x= ±0.5mm
x.xx= ±0.25mm

PACKAGING INFORMATION

Parameter	Type	Value
Packaging Dimension (LxWxH)	tube	290 x 43.5 x 19.7mm
Packaging Quantity		10pcs
Storage Temperature Range		-55°C to +125°C
Storage Humidity	non-condensing	5% - 95% RH

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