COOL POWER TECHNOLOGIES

SERIES OVERVIEW

The CPR30 series offer 30 watts of output power in standard 2.0 x 1.0 x 0.4 inch package and is designed for railway applications. These DC-DC modules offer high efficiency and 3000 Volts of input to output isolation. The CPR30 series provides a 4:1 wide input voltage range of 9 to 36 or 18 to 75VDC, and delivers a precisely regulated output. These modules operate over the ambient operating temperature range of –40°C to +85°C. All devices offer input Under Voltage Lockout (UVLO), output over-current, and over-voltage protected. The module withstands continuous short circuit conditions and has over-temperature shutdown with hysteresis. Standard control functions of the series include optional Remote On/Off and adjustable output voltage.

FEATURES

- Industry standard 2 inch X 1 inch DIP package.
- 3kV I-O isolation
- Fully encapsulated
- 89 % Efficiency Typical @ Full Load
- -40°C to +85°C EN 50155/60068 “TX” temperature range
- Negative and positive On/Off logic control, Trim option
- Continuous Short Circuit Protection
- ULVO, over-current and output over-temperature protection.
- UL/cUL/EN 62368-1 compliant
- Fire protection EN45545-2
- Railway EMC EN50121 -3 -2

APPLICATIONS:

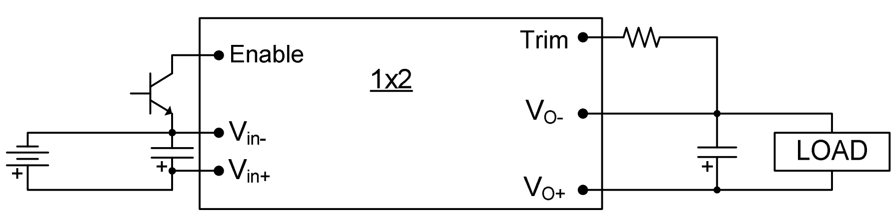
- Railway rolling stock
- Mobile telecommunication
- Industrial applications
- Battery operated equipment

AVAILABLE OPTIONS

- Customizable output voltages – contact factory.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT	MAX POWER	RIPPLE (mV P-P MAX)	EFFICIENCY @ Full Load	LOAD REGULATION	OPTION
CPR301760018	24 (9 – 36)	3.3VDC @ 6A	19.8W	50	88	± 0.1 %	N
CPR301160018		5.0 VDC @ 6A	30W	50	89	± 0.1 %	N
CPR301225018		12 VDC @ 2.5A	30W	100	89	± 0.1 %	N
CPR301320018		15 VDC @ 2A	30W	100	89	± 0.1 %	N
CPR301412518		24 VDC @ 1.25A	30W	150	89	± 0.1 %	N
CPR301606218		48 VDC @ 0.625A	30W	150	89	± 0.1 %	N
CPR301760036	48 (18 – 75)	3.3VDC @ 6A	19.8W	50	88	± 0.1 %	N
CPR301160036		5.0 VDC @ 6A	30W	50	89	± 0.1 %	N
CPR301225036		12 VDC @ 2.5A	30W	100	89	± 0.1 %	N
CPR301320036		15 VDC @ 2A	30W	100	89	± 0.1 %	N
CPR301412536		24 VDC @ 1.25A	30W	150	89	± 0.1 %	N
CPR301606236		48 VDC @ 0.625A	30W	150	89	± 0.1 %	N

APPLICATION DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	24V_{in} 48V_{in}	-0.3 -0.3		36 75	Volts
Transient	100ms	24V_{in} 48V_{in}			50 100	Volts
Operating Ambient Temperature	Derate Above 70°C	All	-40		+85	°C
Case Temperature		All			+105	°C
Storage Temperature		All	-55		+115	°C
Input / Output Isolation Voltage	1 minute	All	3000			VDC

INPUT CHARACTERISTICS

Note: All specifications are typical at nominal input, full load at 25℃ unless otherwise noted

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Operating Input Voltage		24V_{in} 48V_{in}	9 18	24 48	36 75	Volts
Input Under Voltage Lockout						
Turn-On Voltage Threshold		24V_{in} 48V_{in}	8.5 17.3	8.7 17.6	8.9 17.9	Volts
Turn-Off Voltage Threshold		24V_{in} 48V_{in}	7.7 15.7	8.0 16.2	8.2 16.7	Volts
Lockout Hysteresis Voltage		24V_{in} 48V_{in}		0.7 1.4		Volts
Maximum Input Current	100% Load, V_{in} = 9V	24V_{in}			3800	mA
	100% Load, V_{in} = 18V	48V_{in}			1900	mA
No-Load Input Current	V_{in} =Nominal input	CPR301760018 CPR301160018 CPR301225018 CPR301320018 CPR301412518 CPR301606218 CPR301760036 CPR301160036 CPR301225036 CPR301320036 CPR301412536 CPR301606236		50 60 60 60 60 60 40 40 50 50 50 50		mA
Off Converter Input Current	Shutdown input idle current	All		4	10	mA
Inrush Current (I^2t)	As per ETS300 132-2	All			0.1	A^2s
Input Reflected-Ripple Current	P-P thru 10uH inductor, 5Hz to 20MHz	All			30	mA

OUTPUT CHARACTERISTICS

Parameters	Conditions	Model	Min	Typ	Max	Units
Output Voltage Set Point	V_{in} =Nominal V_{in} , I_o = I_{o_max}, Tc=25℃	Vo=3.3 Vo=5.0 Vo=12 Vo=15 Vo=24 Vo=48	3.250 4.925 11.82 14.77 23.64 47.33	3.3 5 12 15 24 48	3.350 5.075 12.18 15.23 24.36 48.67	Volts
Output Voltage Regulation						
Line Regulation	V_{in} =High line to Low line Full Load	All			±0.1	% %
Load Regulation	I_o = Full Load to min. Load	All			±0.1	% %
Temperature Coefficient	TC=-40℃ to 85℃				±0.03	%/℃
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, 20MHz bandwidth 10uF tantalum and 1uF ceramic capacitor	Vo=3.3V Vo=5V			50	mV
		Vo=12V Vo=15V			100	
		Vo=24V Vo=48V			200	
Operating Output Current Range		Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=24V Vo=48V	0 0 0 0 0 0		6000 6000 2500 2000 1250 625	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{O,\ nominal}$		110	140	170	%
Maximum Output Capacitance	Full resistive load	Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=24V Vo=48V			6000 6000 2500 2000 1250 620	μF

DYNAMIC CHARACTERISTICS

Parameters	Conditions	Model	Min	Typ	Max	Units
Output Voltage Current Transient						
Step Change in Output Voltage	75% to 100% of I_{o_max} di/dt=0.1A/us	All			±5	%
Setting Time (within 1% $Vo_{nominal}$)		All			250	μs
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off Control	$V_{on/off}$ to 90%V_{o_set}	All		15		ms
Turn-On Delay Time, From Input	V_{in_min} to 90%V_{o_set}	All		15		ms
Output Voltage Rise Time	10% V_{o_set} to 90% V_{o_set}	All		15		ms

FEATURE CHARACTERISTICS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
100% Load	V_{in} =12 V_{dc}, I_o = I_{o_max}, Tc=25℃	CPR301760018		88		%
		CPR301160018		90		
		CPR301225018		90		
		CPR301320018		90		
		CPR301412518		89		
		CPR301606218		89		
	V_{in} =24 V_{dc}, I_o = I_{o_max}, Tc=25℃	CPR301760018		88		%
		CPR301160018		89		
		CPR301225018		89		
		CPR301320018		89		
		CPR301412518		88		
		CPR301606218		88		
100% Load	V_{in} =24 Vdc, I_o = I_{o_max}, Tc=25℃	CPR301760036		88		%
		CPR301160036		90		
		CPR301225036		90		
		CPR301320036		90		
		CPR301412536		89		
		CPR301606236		89		
	V_{in} =48 Vdc, I_o = I_{o_max}, Tc=25℃	CPR301760036		88		%
		CPR301160036		90		
		CPR301225036		89		
		CPR301320036		89		
		CPR301412536		89		
		CPR301606236		89		
ISOLATION CHARACTERISTICS						
Input to Output	1 minutes	All	3000			Volts
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		1000		pF
Switching Frequency		All		410		KHz
On/Off Control, Positive Enable On/Off logic						
Logic High (Module On)	$V_{on/off}$ at $I_{on/off}$=0.1uA	All	2.4		20	Volts
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	-0.5		0.8	Volts
On/Off Control, Negative Enable On/Off logic						
Logic High (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	2.4		20	Volts
Logic Low (Module On)	$V_{on/off}$ at $I_{on/off}$=0.1uA	All	-0.5		0.8	Volts
On/Off Current (for remote on/off logic)	$I_{on/off}$ at $V_{on/off}$=0V			0.3	1	mA
Leakage Current (for remote on/off logic)	Logic High, $V_{on/off}$=15V				30	uA
Output Over Voltage Protection	Non-latching	All		125		%V_{o_nom}
MTBF	Per Telcordia SR-332, Issue 2: Method I, Case 3 (I_O=80% of I_O_max, T_A=40°C, airflow = 200 lfm, 90% confidence)	All		3.8		M hours
Weight		All		20		grams

Operating Temperature Range

The CPR30 series converters operate over a wide ambient temperature ranging from -40°C to +85°C and derating starts above +70°C. The modules operate normally up to +105°C case temperature.

Remote On/Off`

The CPR30 series offers a Remote On/Off feature in order for the user to switch the module on and off electronically. All standard models are available as "positive logic" versions. The converter turns on if the Remote On/Off pin is high (above 2.4VDC to 20VDC or open circuit). When the Remote On/Off pin is low (below 0.8VDC) the converter will turn off. The signal level of the Remote On/Off input is defined with respect to ground. If not using the Remote On/Off pin, leave the pin open and the converter will be on. Models with part number suffix option "N" are the "negative logic" Remote On/Off version. For the N model, the converter turns off if the remote on/off pin is high (greater than 2.4VDC to 20VDC or open circuit). The converter is off by default. The converter turns on if the Remote On/Off pin input is low (less than 0.8VDC).

UVLO (Under Voltage Lock Out)

The input Under Voltage Lock Out feature is standard for the CPR30 series. The converter will shut down when the input voltage drops below the threshold and it operates in normal condition when the input voltage goes above the upper threshold.

Over Current and Short Circuit Protection

All CPR30 models have internal Over Current and Continuous Short Circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into hiccup mode protection.

Over Voltage Protection

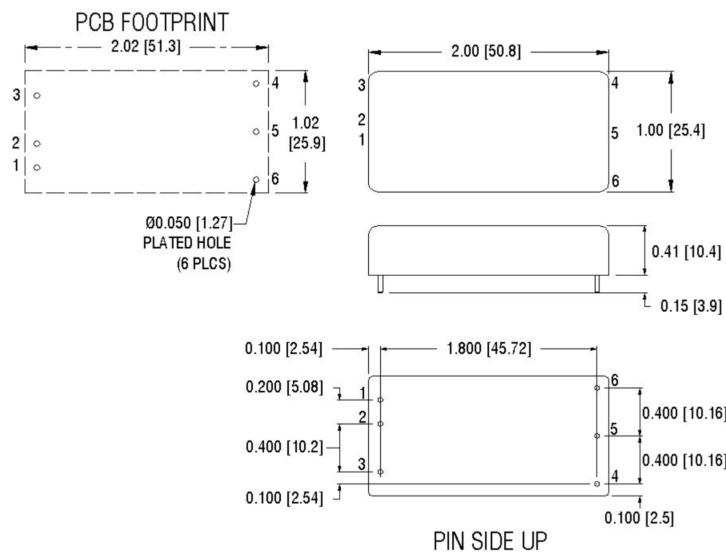
The Over Voltage protection feature consists of an independent feedback loop to limit the output voltage. When the OVP threshold is reached, the converter will shutdown and attempt a restart (hiccup mode.)

Over-Temperature Protection (OTP)

The CPR30 series of converters are equipped with non-latching Over Temperature protection. If the case temperature exceeds a threshold of +115°C (typical) the converter will shut down, disabling the output. When the temperature decreases the converter will automatically restart. The over-temperature condition can be induced by a variety of reasons such as external overload condition, a system fan failure or others.

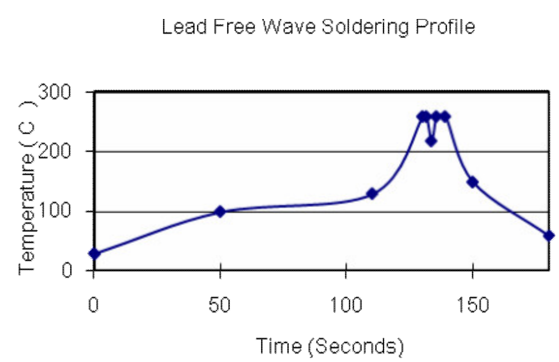
Recommended Layout PCB Footprints and Soldering Information

The end user of the converter must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces should be used where possible. Careful consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown in the next figures.



Recommended PCB Layout Footprint

Dimensions are in inches (mm)



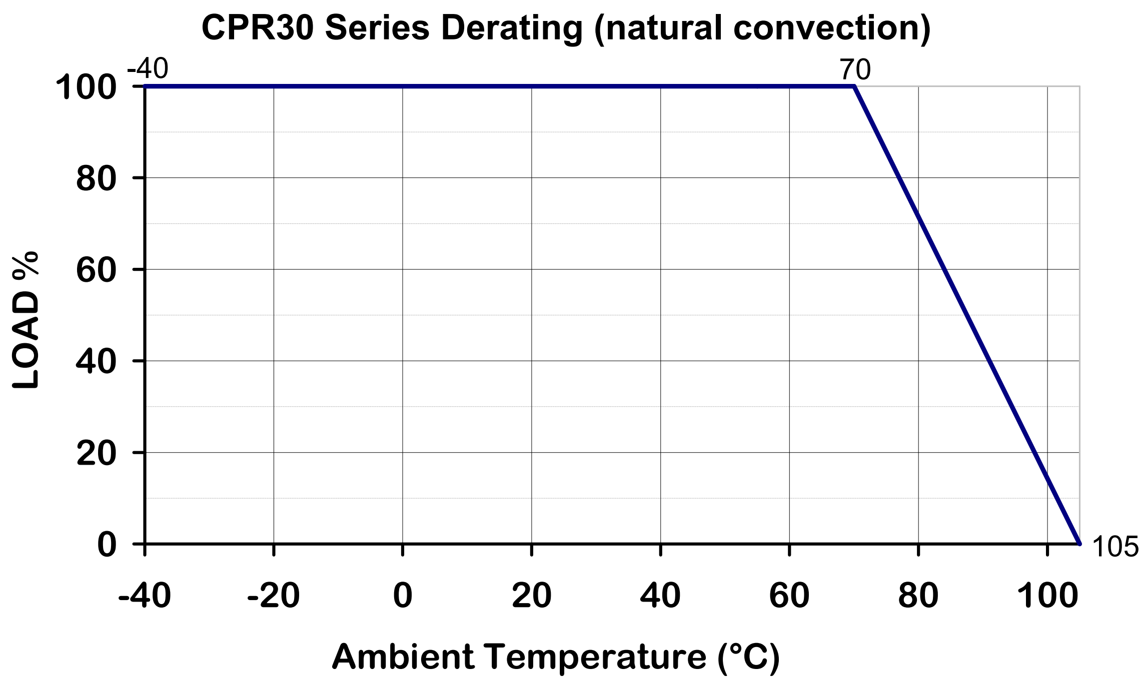
Wave Soldering Profiles

Note：

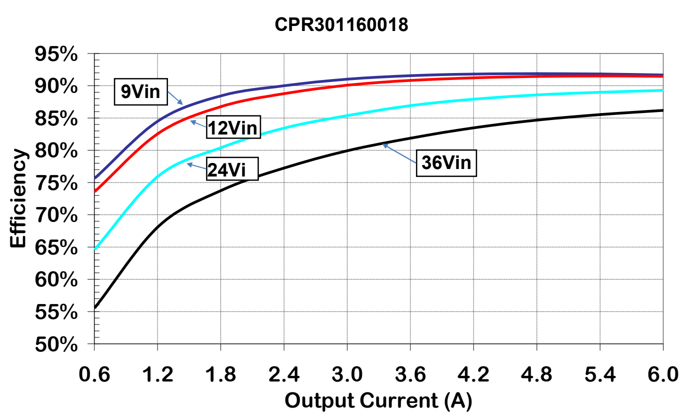
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 ℃/Sec (From 50℃ to 100℃)
3. Soaking temperature: 0.5 ℃/Sec (From 100℃ to 130℃), 60±20 seconds
4. Peak temperature: 260℃, above 250℃ 3~6 Seconds
5. Ramp up rate during cooling: -10.0 ℃/Sec (From 260℃ to 150℃)

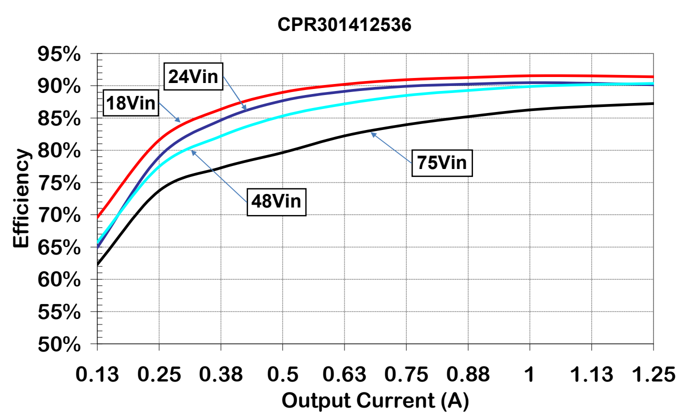
CPR30 Series power derating curves

Note that the converter operating ambient temperature range is -40°C to + 85°C with derating above +70°C. Also, maximum case temperature under any operating condition should not exceed +105°C.



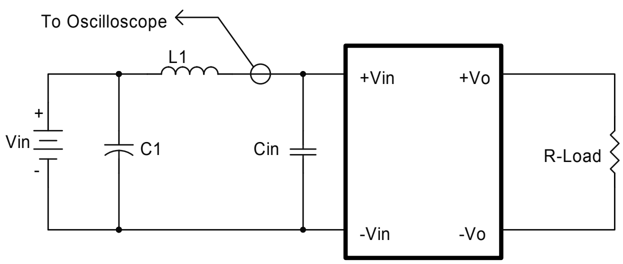
Efficiency vs. Load Curves – typical examples:





Input Capacitance at the Converter

In order to avoid problems with loop stability, the converter must be connected to a low impedance AC source and a low inductance source. The input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. The external input capacitors should have low ESR in order to quiet any ripple. Circuit as shown in the figure below represents typical measurement methods for reflected ripple current. The capacitor C1 and inductor L1 simulate the typical DC source impedance. The input reflected-ripple current is measured by a current probe oscilloscope with a simulated source Inductance (L1).



L1: 10uH
C1: 220uF ESR < 0.1ohm @100KHz
Cin: 33µF ESR < 0.7ohm @100KHz

Input Reflected-Ripple Test Setup

Test Set-Up

The basic test set-up to measure efficiency, load regulation, line regulation and other parameters is shown in the next figure. When testing the converter under any transient conditions, the user should ensure that the transient response of the source is sufficient to power the equipment under test. Below is the calculation of :

1- Efficiency
2- Load regulation
3- Line regulation

The value of efficiency is defined as:

$$\eta = \frac{V_O \times I_O}{V_{IN} \times I_{IN}} \times 100\%$$

Where

V_O is output voltage,
I_O is output current,
V_{IN} is input voltage,
I_{IN} is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where

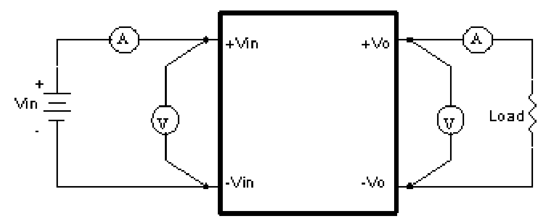
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load

The value of line regulation is defined as:

$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where

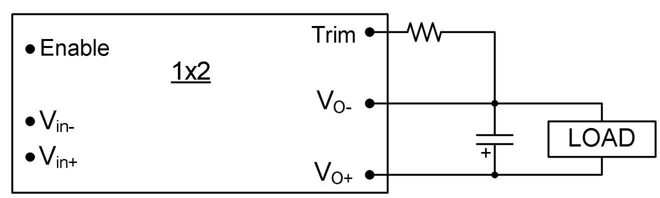
V_{HL} is the output voltage of the maximum input voltage at full load.
V_{LL} is the output voltage of the minimum input voltage at full load.



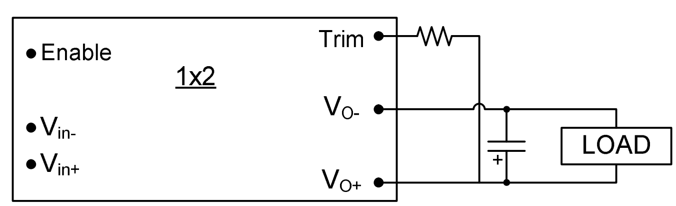
CPR30 Series Test Setup

Output Voltage Adjustment

In order to trim the voltage up or down, the user needs to connect the trim resistor either between the trim pin and -Vo for trim-up and between trim pin and +Vo for trim-down. The output voltage trim range is ±10%. This is shown in the next two figures:



Trim-up circuit configuration



Trim-down Voltage Setup

Trim Up and Trim Down Resistor Values

- **The value of R_{TRIM_UP} is defined as:**

$$R_{TRIM\_UP} = \frac{Rl \times V_R}{V_{DES} - V_{O\_NOM}} - R_T$$

Where

R_{TRIM_UP} is the external resistor in Kohm.
V_{O_NOM} is the nominal output voltage.
V_{DES} is the desired output voltage.

R1, Rt, and Vr are internal to the unit and are defined in the table below:

Model Number	Output Voltage(V)	R1 (kΩ)	Rt (kΩ)	Vr (V)
CPR3017600xx	3.3	5.1	2.05	1.24
CPR3011600xx	5.0	5.1	2.05	2.5
CPR3012250xx	12.0	10	5.1	2.5
CPR3013200xx	15.0	10	5.1	2.5
CPR3014125xx	24.0	23.7	5.1	2.5
CPR3016062xx	48.0	44.2	5.1	2.5

For example, to trim-up the output voltage of the 5.0 Votls module (CPR3011600xx) by 10% to 5.5V, R_{TRIM_UP} is calculated as follows:

R1 = 5.10 kΩ
Rt = 2.05 kΩ
Vr= 2.5 V

$$R_{trim\_up}(k\Omega) = \frac{2.5 \times 5.1}{5.5 - 5.0} - 2.05 \quad = 23.45\text{kOhm}$$

- **The value of R_{TRIM_DOWN} is defined as:**

$$R_{TRIM\_DOWN} = \frac{Rl(V_{DES} - V_R)}{V_{O\_NOM} - V_{DES}} - R_T$$

Where

R_{TRIM_DOWN} is the external resistor in kOhm.
V_{O_NOM} is the nominal output voltage.
V_{DES} is the desired output voltage.

R1, Rt, and Vr are internal to the unit and are defined in the table above.

For example, to trim-down the output voltage of 5.0V module (CPR3011600xx) by 10% to 4.5V, R_{TRIM_DOWN} is calculated as follows:

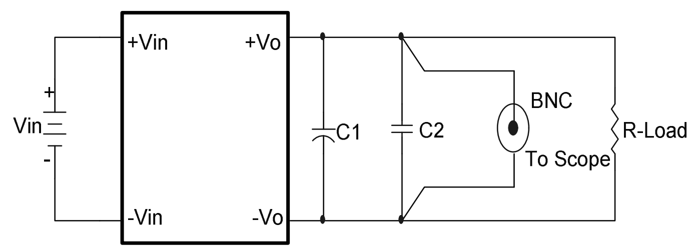
V_{O_NOM} – Vo = 5.0 – 4.5 = 0.5V

R1 = 5.1 kΩ
Rt = 2.05 kΩ
Vr= 2.5 V

$$R_{trim\_down}(k\Omega) = \frac{5.1(4.5 - 2.5)}{5.0 - 4.5} - 2.05 \quad = 18.35\text{kOhm}$$

Noise Measurement and Output Ripple

The test set-up for noise and ripple measurements is shown in the figure below. A coaxial cable was used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements are taken with the output appropriately loaded and all ripple/noise specifications are from D.C. to 20MHz Bandwidth.



Note: C1: 10µF tantalum capacitor
C2: 1µF ceramic capacitor

Output Voltage Ripple and Noise Measurement Set-Up

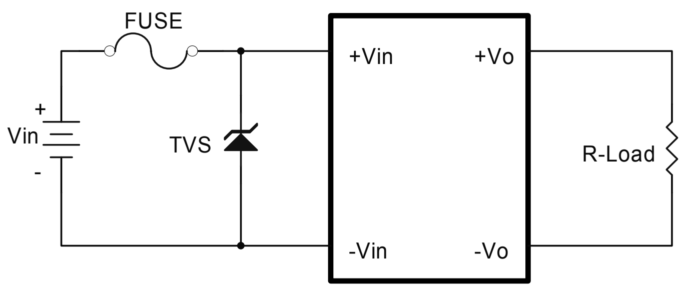
Output Capacitance

The CPR30 series converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitor(s) should be located close to the point of load.

SAFETY and EMC

Input Fusing and Safety Considerations

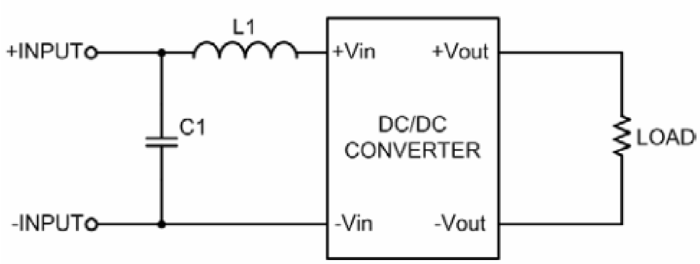
The CPR30 series of converters do not have an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. Semiconductor Circuits recommended a time delay fuse of 6A for 24Vin models and 3A for 48Vin modules. The circuit in the figure below is recommended. Use a transient voltage suppressor diode across the input terminal to protect the unit against a surge or spike voltage and input reverse voltage.



Input Protection Circuit

EMC Considerations

EMI Test standard: EN55022 Class A Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load

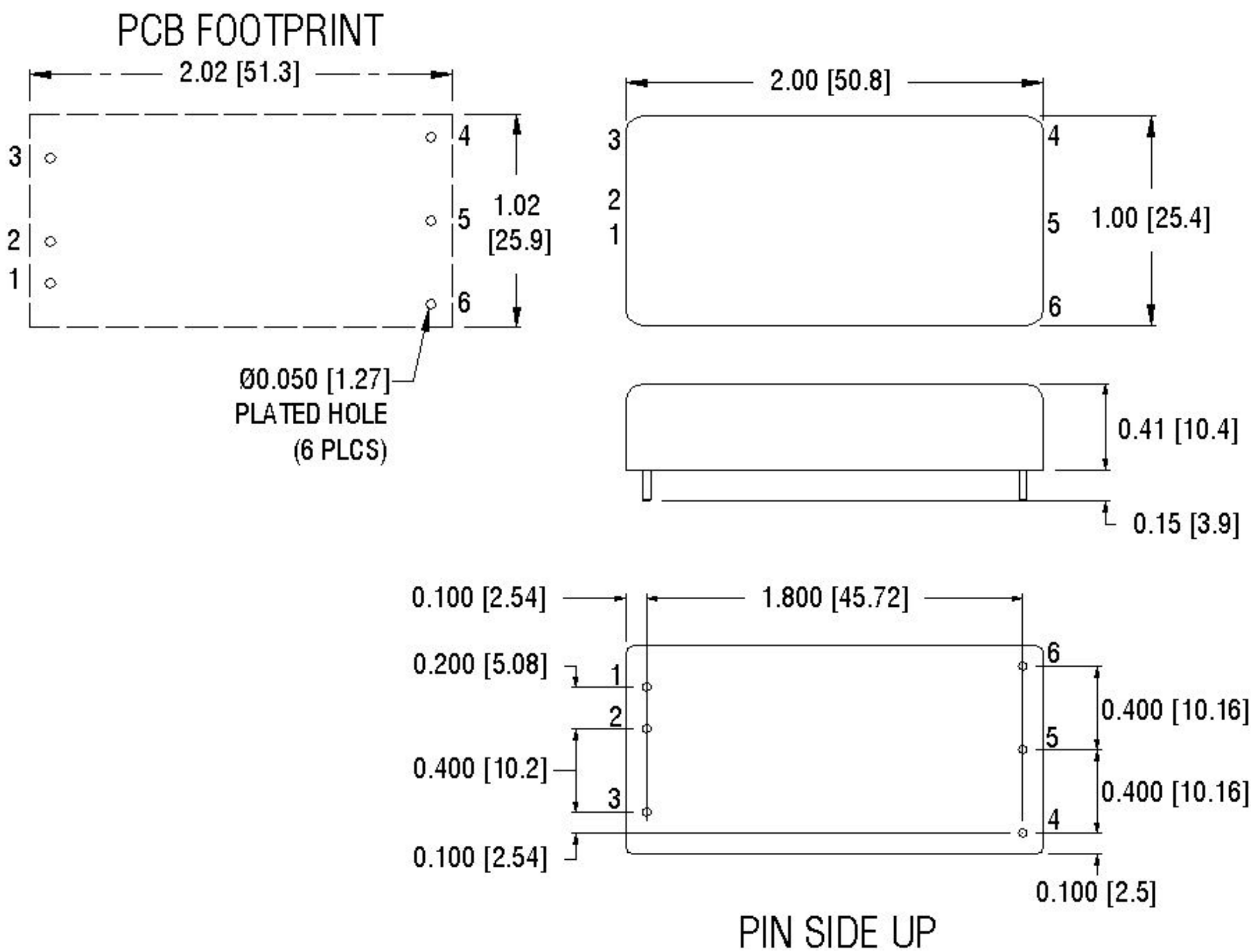


Connection circuit for conducted EMI testing

EN55022 class A					
Model No.	C1	L1	Model No.	C1	L1
CPR301760018	100µF/50V	0.47µH	CPR301760036	47µF/100V	2.2µH
CPR301160018	100µF/50V	0.47µH	CPR301160036	47µF/100V	2.2µH
CPR301225018	100µF/50V	0.47µH	CPR301225036	47µF/100V	2.2µH
CPR301320018	100µF/50V	0.47µH	CPR301320036	47µF/100V	2.2µH
CPR301412518	100µF/50V	0.47µH	CPR301412536	47µF/100V	2.2µH
CPR301606218	100µF/50V	0.47µH	CPR301606236	47µF/100V	2.2µH

Note: All of capacitors are low ESR aluminum electrolytic capacitors.

MECHANICAL DIMENSIONS Inches (mm)



Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.02 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

PIN	FUNCTION
1	+ V Input
2	- V Input
3	Remote On/Off
4	Trim
5	- V Output
6	+ V Output

PART NUMBER AND ORDERING INFORMATION

Family, Power Rating	Number of Outputs	Output Voltage	Output Current (A)	Nominal Input Voltage	Option
CPR30	1	1	600	18	N
	1 - Single 2 - Dual	1 = 5 Volts 2 = 12 Volts 3 = 15 Volts 4 = 24 Volts 6 = 48 Volts 7 = 3.3 Volts	600 = 6.00A 250 = 2.50A 125 = 1.25A 062 = 0.625A	(9-36) 18 Volts (18-75) 48 Volts	N - Negative On/Off control No option suffix = Positive On/Off Ctrl.

For proper part ordering, enter option suffixes in order listed in table above