Cool Power Technologies

30W Isolated DC/DC Converter

Features

RoHS COMPLIANT

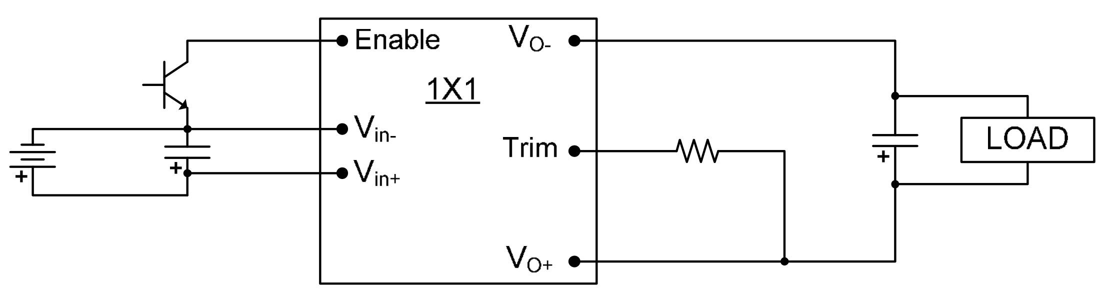
- Wide input voltage range: 4.5 – 9Vin
- High Efficiency – 88.5% typical @ Full Load
- Output: 5 V at 6 A, 30W max
- Tiny 0.94” X 0.94” x 0.35” max ht (Thru-hole)
- 0.94” X 0.94” x 0.396” Surface Mount
- 1” x 1” x 0.41” Encapsulated Product
- RoHS 3 Directive 2015/863/EU
- No minimum load/capacitance required
- Withstands 15V input transients
- Fixed-frequency operation
- Meets UL94, V-0 flammability rating
- Full protection (OTP, OCP, OVP, UVLO w/auto-restart)
- Remote ON/OFF - positive or negative enable logic options
- Output voltage trim range: ±10% (industry-standard trim equations)
- Weight: 0.266 oz [7.54 g] (open frame), 0.67 oz [19g] (encapsulated)
- 2250VDC isolation (open frame), 1600VDC (encapsulated)
- Complies with UL/CSA60950-1, TUV per IEC/EN60950-1, 2nd edition
- Compliant to REACH (EC) No 1907/2006, 205 SVHC update
- Designed to meet Class B conducted emissions per FCC and EN55032 when used with external filter (see EMC Compliance section below.)

Description

The “Cool Power Technologies” CP30_1160005 DC-DC converter is an open frame isolated 1” X 1” DC-DC module that conforms to industry standard pinout and trim equations. The converter operates over an input voltage range of 4.5 to 9 VDC, and provides a tightly regulated output voltage with an output current rating of 6 A. The standard feature set includes remote On/Off (positive or negative enable), input undervoltage lockout, output overvoltage protection, overcurrent and short circuit protections, output voltage trim and overtemperature shutdown with hysteresis. The high efficiency of the CP30_1160005 allows operation over a wide ambient temperature range with minimal derating.

TABLE OF CONTENTS

APPLICATION DIAGRAM



ELECTRICAL SPECIFICATIONS 4.5–9Vin, 5V/6Aout

Conditions: T_A = 25 °C, Airflow = 300 LFM, Vin = 5 VDC, Cin = 220 μF, unless otherwise specified.

Input Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Operating Input Voltage Range		4.5	5	9	VDC
Input Under-Voltage Lock-out Turn-on Threshold Turn-off Threshold		 4.3 3.3	 4.4 3.5	 4.5 3.7	VDC
Input Voltage Transient	100ms			15	VDC
Maximum Input Current	V_{IN} = 4.5VDC; I_{out} = 6A			8	A
Input Standby Current	Converter Disabled		5	20	mA
Input No-Load Current	Converter Enabled		160	240	mA
Short Circuit Input Current	RMS		100	200	mA
Input Reflected Ripple Current	5Hz to 50MHz See Fig 14 for setup		50	100	mA_{PK-PK}
Input Voltage Ripple Rejection	120Hz		50		dB
Inrush Current	All	-	0.1	1	A^2/s

Output Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Output Voltage Set point		4.925	5.00	5.075	VDC
Output Current		0		6	A
Output Current Limit Inception		6.5	8	10	A
Peak Short-Circuit Current	10mΩ Short		11	18	A
RMS Short-Circuit Current	10mΩ Short		1.1	1.5	A_{RMS}
External Load Capacitance		0		4700	uF
Output Ripple and Noise 20 MHz bandwidth	1 uF Ceramic + 10uF Tantalum See Fig 15 for setup		40	75	mV_{PK-PK}
Output Regulation Line: Load: Overall Output Regulation:	 Over line, load & temp.	 4.85	 ±0.02 ±0.04 	 ±0.1 ±0.1 5.15	 %Vo %Vo V

ELECTRICAL SPECIFICATIONS (continued) 4.5–9Vin, 5V/6Aout

Conditions: T_A = 25 °C, Airflow = 300 LFM, Vin = 5 VDC, Cin = 220 μF, unless otherwise specified.

Absolute Maximum Ratings

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage	Continuous Operation	0		9	VDC
Operating Temperature T_{ref}, see Thermal Derating section	Open Frame	-40		+123	
	Encapsulated Module	-40		+105	°C
Storage Temperature		-55		+125	°C

Feature Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Switching Frequency			410		kHz
Output Voltage Trim Range		-10		+10	%
Output Over-voltage Protection	Non-latching	115	130	140	%
Over-temperature Protection	Avg. PCB temp, non-latching		135		°C
Peak Backdrive Output Current during startup into prebiased output	Sinking current from external voltage source equal to V_{OUT} – 0.6V and connected to the output via 1Ω resistor. C_{OUT}=220μF, Aluminum		350	500	mA
Backdrive Output Current in OFF state	Converter disabled		0	5	mA
Power On to Output Turn-ON Time	$V_{OUT} = 0.9*V_{OUT\_NOM}$		10	20	mS
Enable to Output Turn-ON Time	$V_{OUT} = 0.9*V_{OUT\_NOM}$		10	20	mS
Output Enable ON/OFF	All voltages are WRT –Vin. Converter has internal pull-up voltage, thus positive enable is normally on, negative normally off.				
Negative Enable					
Converter ON		-0.7		0.8	VDC
Converter OFF		2.4		15	VDC
Positive Enable					
Converter ON		2.4		20	VDC
Converter OFF		-0.7		1.2	VDC
Enable Pin Current Source/Sink			0.25	1	mA
Output Voltage Overshoot @ Startup			0	2	%Vo
Auto-Restart Period	(OVP, OCP)		100		ms

ELECTRICAL SPECIFICATIONS (continued)

4.5–9Vin, 5V/6Aout

Conditions: Ta = 25 °C, Airflow = 300 LFM, Vin = 5 VDC, Cin = 220 μF, unless otherwise specified.

Efficiency

Parameter	Conditions	Min	Typ	Max	Unit
Full Load	Vin = 5Vin	87.5	88.5		%
50% Load		88	90		%

Dynamic Response

Parameter	Conditions	Min	Typ	Max	Unit
Load Change 25%-50% or 50%–75% of Iout Max, di/dt = 0.1 A/μs	Cout = 1 μF ceramic + 10 μF tantalum See Fig 15		40	100	mV
Settling Time to 1% of Vout			50		μS
Load Change 25%-75% or 75%–25% of Iout Max, di/dt = 0.2 A/μs	Cout = 1 μF ceramic + 2000 μF Oscon		30	50	mV
Settling Time to 1% of Vout			50		μS

Isolation Specifications

Parameter	Conditions	Min	Typ	Max	Unit
Isolation Capacitance			1000		pF
Isolation Resistance		10			MΩ
Isolation Voltage – Input to Output	Open Frame	2250			V_{DC}
	Encapsulated	1600			V_{DC}

Reliability

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)	MTFB	4,399,181	Hours
	FITs (failures in 10^9 hours)	227	/10^9 Hours

Notes:

CHARACTERISTIC CURVES:

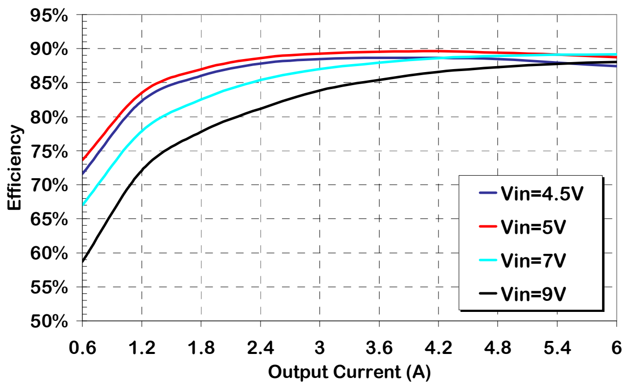


Figure 1. Efficiency vs Output Current, 300lfm airflow, 25°C ambient.

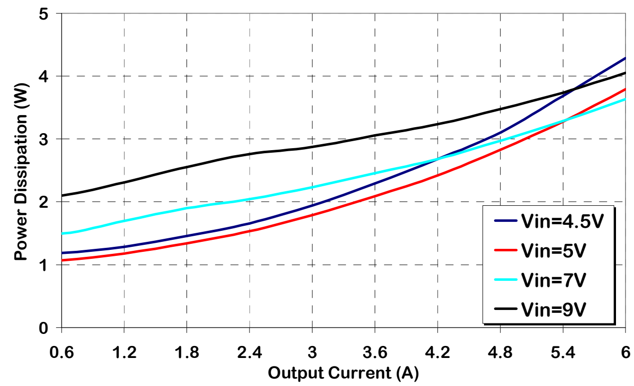


Figure 2. Power Dissipation vs. Load Current, 300lfm airflow, 25°C ambient.

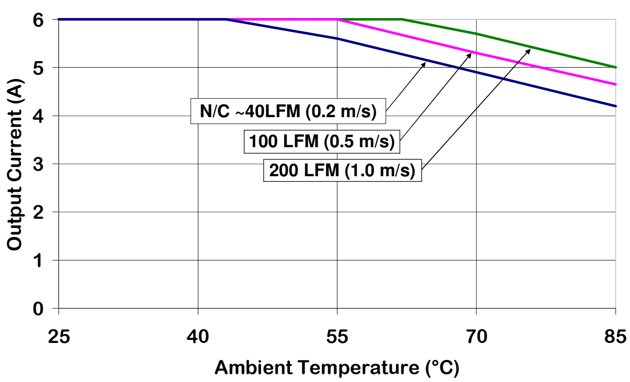


Figure 3. Output Current Derating vs Ambient Temperature & Airflow (converter mounted vertically with air flowing from Vin to Vout, Vin = 5 V.)

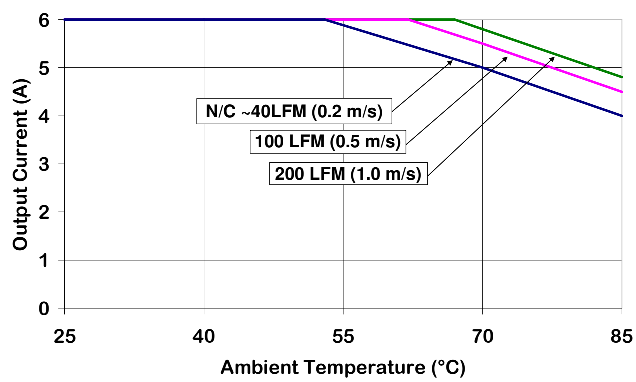


Figure 4. Output Current Derating vs Ambient Temperature & Airflow (converter mounted vertically Vin = 5 V - Encapsulated module)

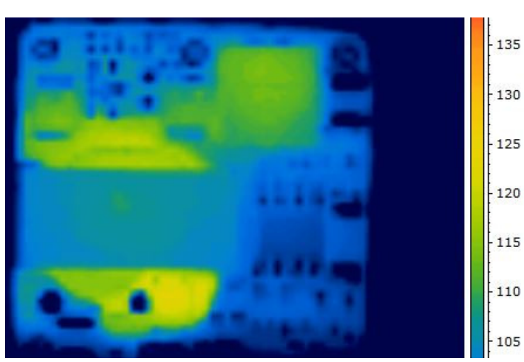


Figure 5. Thermal Image of CP30B1160005
Full load, 55C Ambient, 100LFM airflow
Tmax = 123C

CHARACTERISTIC WAVEFORMS:

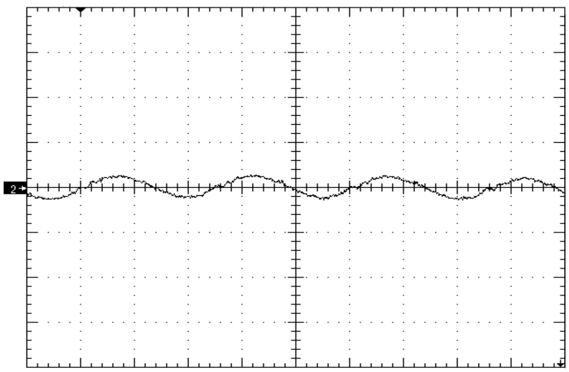


Figure 6. Input Reflected Ripple Current (100mA/div), time scale – 1uS/div. Vin=Vin_nom, full load (see Fig 14)

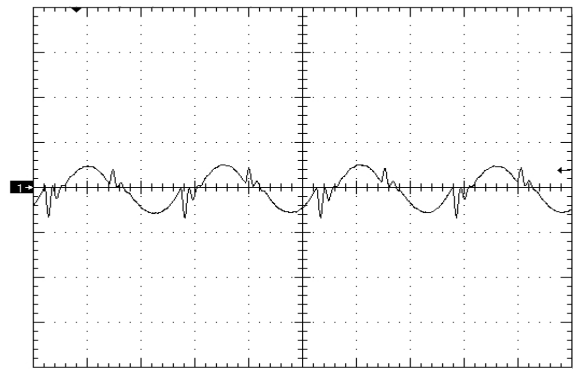


Figure 7. Output Voltage Ripple (20mV/div), time scale – 1uS/div. Vin=Vin_nom, full load Cout=1.0uF ceramic + 10uF Tantalum (see Fig 15)

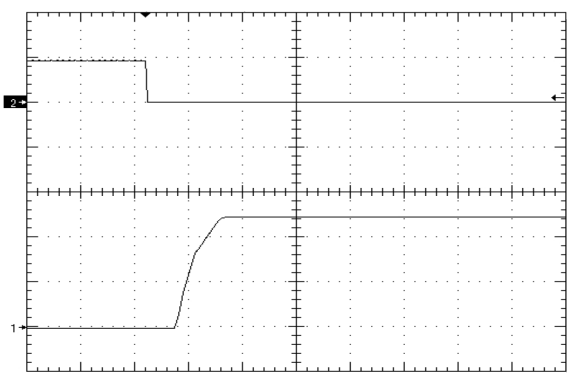


Figure 8. Startup Waveform via Enable (Neg ENBL), time scale 10mS/div. Vin=Vin_nom, Iout=no load Cout=0, Ch1=Vout (2V/div), Ch2=enable (10V/div)

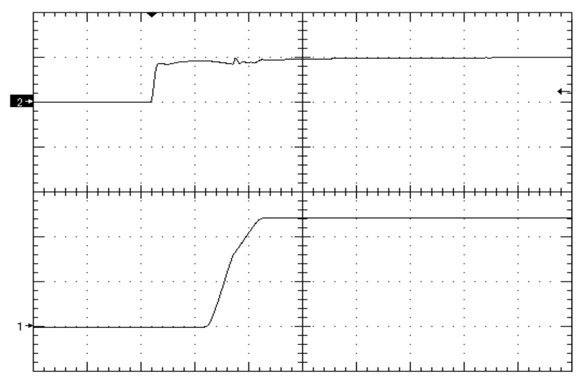


Figure 9. Startup Waveform via Input Voltage, time scale 10mS/div. Vin=Vin_nom, Iout=full load Cout=2200uF, Ch1=Vout (2V/div), Ch2=Vin (5V/div)

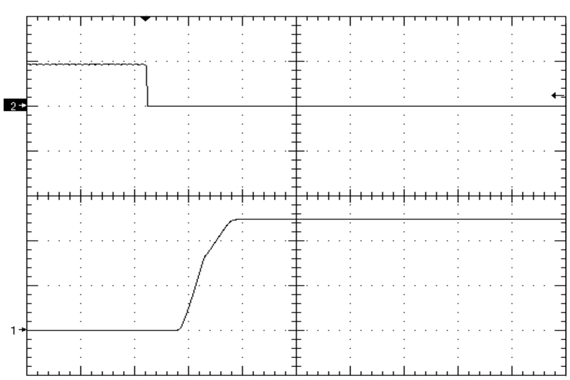


Figure 10. Startup Waveform via Enable (Neg ENBL), time scale 4mS/div. Vin=Vin_nom, Iout=no load Cout=2200uF, Ch1=Vout (2V/div), Ch2=enable (10V/div)

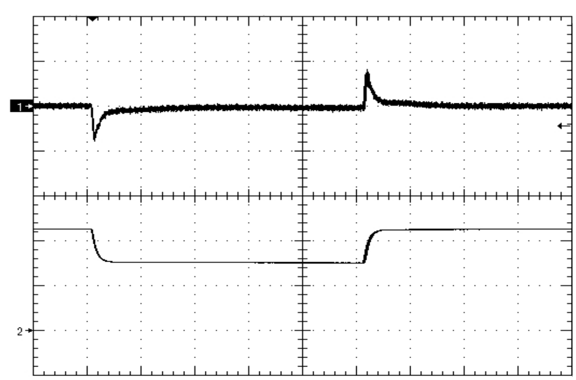


Figure 11. Load Transient Response (50mV/div), di/dt=0.1A/uS, 50%-75%-50% of full load, Cout=Fig15 time scale: 200uS/div. Ch1=Vout, Ch2=Iout (2A/div)

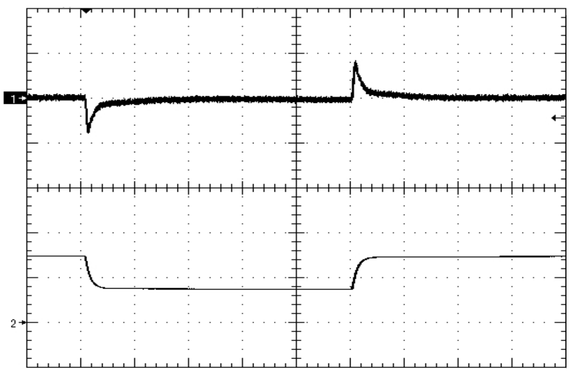


Figure 12. Load Transient Response (50mV/div), di/dt=0.1A/uS, 25% - 50% - 25% of full load, Cout=Fig15 time scale: 200uS/div. Ch1=Vout, Ch2=Iout (2A/div)

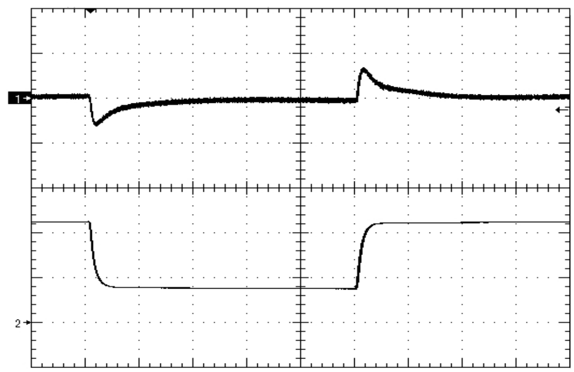
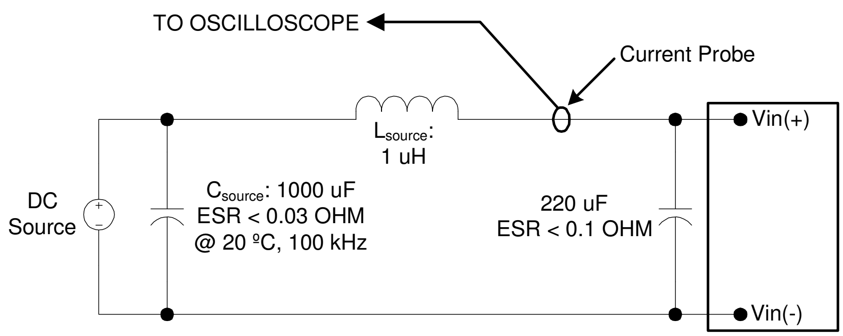


Figure 13. Load Load Transient Response 50mV/div), di/dt=0.2A/uS, 25% - 75% - 25% of full load +2200uF time scale: 200uS/div. Ch1=Vout, Ch2=Iout (2A/div)

Application Notes

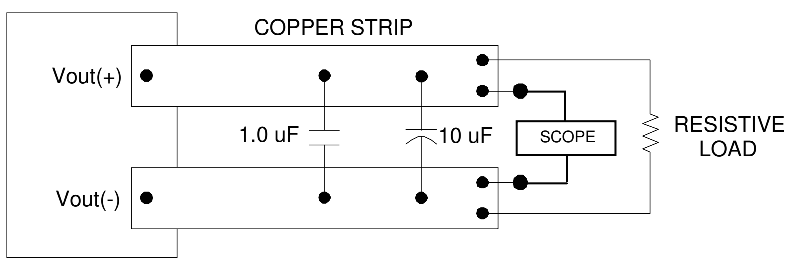
INPUT REFLECTED RIPPLE TEST SETUP:



Note: Measure input reflected-ripple current with a simulated source inductance (L_{SOURCE}) of 1 uH. Capacitor C_{SOURCE} offsets possible source impedance.

Figure 14. Input Reflected-ripple Current Test Setup.

OUTPUT RIPPLE TEST SETUP:



Use a 1.0µF X7R ceramic capacitor and 10µF @35V low ESR tantalum capacitor. Scope measurement made using a BNC socket. Position the load 3 in. [76mm] from module.

Figure 15. Peak-to-Peak Output Noise Measurement Test Setup.

Application Notes (cont)

OUTPUT VOLTAGE TRIM:

Output voltage adjustment is accomplished by connecting an external resistor between the Trim Pin and either the +Vout or –Vout pins.

- **TRIM UP EQUATION:**

$$R_{TRIM\_UP}(\Omega) = \frac{12750}{V_{DES} - 5} - 2050$$

Where R_{TRIM_UP} is the resistance value in ohms and V_{DES} is the desired output voltage.

E.g. to trim the output up 10%, $R_{TRIM\_UP} = \frac{12750}{5.5 - 5} - 2050 \cdot \Omega$ **or R_{TRIM_UP} = 23.45 kOhm.**

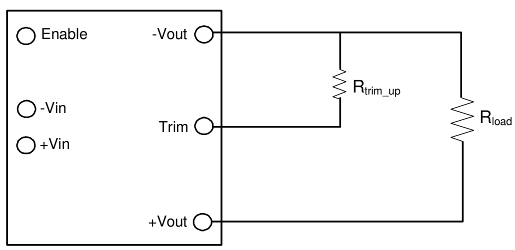


Figure 16. Trim UP circuit configuration

- **TRIM-DOWN EQUATION:**

$$R_{TRIM\_DOWN}(\Omega) = \frac{5100 \cdot (V_{DES} - 2.5)}{5 - V_{DES}} - 2050$$

Where R_{TRIM_DOWN} is the resistance value in ohms and V_{DES} is the desired output voltage.

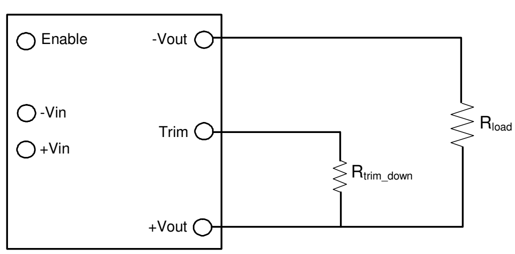
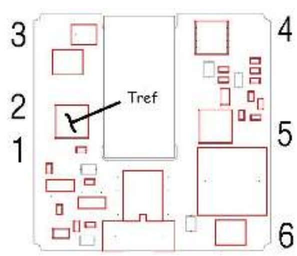


Figure 17. Trim DOWN circuit configuration

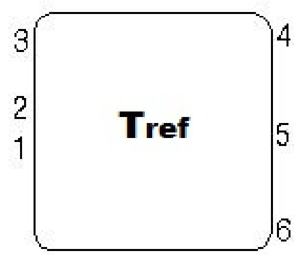
Application Notes (cont)

Thermal Derating

- It is preferable that the DC-DC module have an unobstructed flow of air across it for best thermal performance. Components taller than ~ 2mm in front of the module can deflect airflow and possibly create hotspots.
- Significant cooling is achieved through conductive flow from the modules I/O pins to the host PCB. Sufficiently large traces connecting the dc-dc converter to the source and load will help ensure thermal derating performance will meet or exceed the derating curves published in this datasheet.
- If the module is expected to be operated near the load limits defined in the derating curves, in-system verification of module derating performance should be performed to ensure long-term system reliability. Peak temperatures are to be measured using infrared thermography or by gluing a fine gauge (AWG #40) thermocouple at the T_{ref} location(s) shown below. Temperature at the specified location(s) should be kept below 123ºC for open frame units, 105ºC for encapsulated modules in order to maintain optimum converter reliability.



Open Frame



Encapsulated

Input Undervoltage Lockout

- The converter is disabled until the input voltage has exceeded the UVLO turn-on threshold. Once the input voltage exceeds this level (see Input Under-Voltage Lock-out in Electrical Specifications table) the module will commence soft-start. Hysteresis of (typically) 1-3 volts minimizes the likelihood of pulling the input voltage below the turn-off threshold during startup which could create an undesirable on/off cycling condition. The converter will continue to operate until the input voltage subsequently falls below the UVLO turn-off threshold.

Enable Pin Function

- The module has a remote enable function that allows it to be turned on or off remotely. The Enable pin is referenced to the negative input pin (-Vin) of the converter. Modules can be ordered with either negative or positive enable.
- The negative enable option the module will not turn on unless the enable pin is connected to –Vin. The positive enable option allows the converter to turn on as soon as voltage sufficient to exceed the UVLO of the converter has been applied to the input terminals. In this case the module is turned off by connecting the Enable pin to –Vin. On/off thresholds are located in the Electrical Specifications table.

Application Notes (cont)

Output Overvoltage Protection

- The module has an independent feedback loop that will disable the output of the converter if a voltage greater than about 125% of the nominal set point is detected. When this threshold is reached, the converter will shut down and remain off for the amount of time specified by the Auto-Restart Period. The converter will attempt a restart once this period of time has elapsed.

Output Overtemperature Protection

- To provide protection under certain fault conditions, the unit is equipped with a thermal shutdown circuit. The unit will shutdown if the average PCB temperature exceeds approx. 135ºC, but the thermal shutdown is not intended as a guarantee that the unit will survive temperatures beyond its rating. The module will automatically restart once it has cooled below the shutdown temperature minus hysteresis (typically 20 deg C.)

SMT Version Layout Considerations (if applicable)

- Copper traces with sufficient cross-section must be provided for all output & input pins. SMT pads tied to internal power/ground planes must have multiple vias around each SMT pad to couple expected current loads from module pins into internal traces/planes. One 0.024" (0.6mm) diameter via for each 4A of expected source or load current must be provided as close to the termination as possible, preferably in the direction of current flow from SMT pad to load. Vias must be at least 0.024" (0.6 mm) away from the SMT pad to prevent solder from flowing into the vias.

- SMT pads on the host card are to be 0.075" (1.9mm) diameter. Solder paste screen opening should be 0.070" diameter and the screen should be 0.006" (0.15 mm) thick (other thicknesses are possible; 0.006" provides a good compromise between solder volume and coplanarity compensation.)

Paralleling Converters

- Modules may be paralleled but it is recommended that the total power draw not exceed the output power rating of a single module. External sharing controllers are recommended for reliability and to ensure equal distribution of the load to the converters.

Application Notes (cont)

EMC Compliance

To meet Class B compliance for EN55032 (CISPR 32) or FCC part 15 sub part j, the following input filter is required:

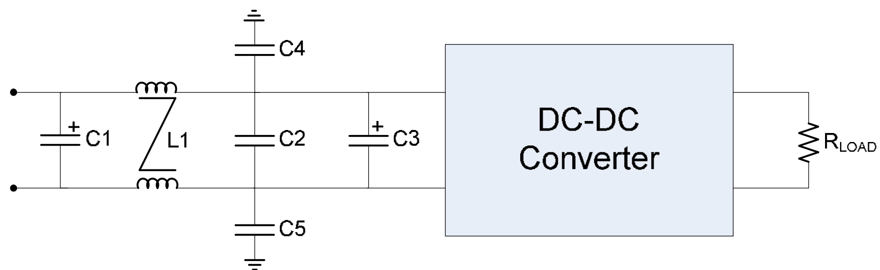


Figure 18. EMI Filter

L1 =	**0.63 mH Common Mode Inductor (Pulse P0469)**
C1 =	**1000uF <0.030 Ohm ESR Oscon**
C2 =	**Not Used**
C3 =	**220uF, 0.1 Ohm ESR electrolytic**
C4,C5 =	**3300pf ceramic**

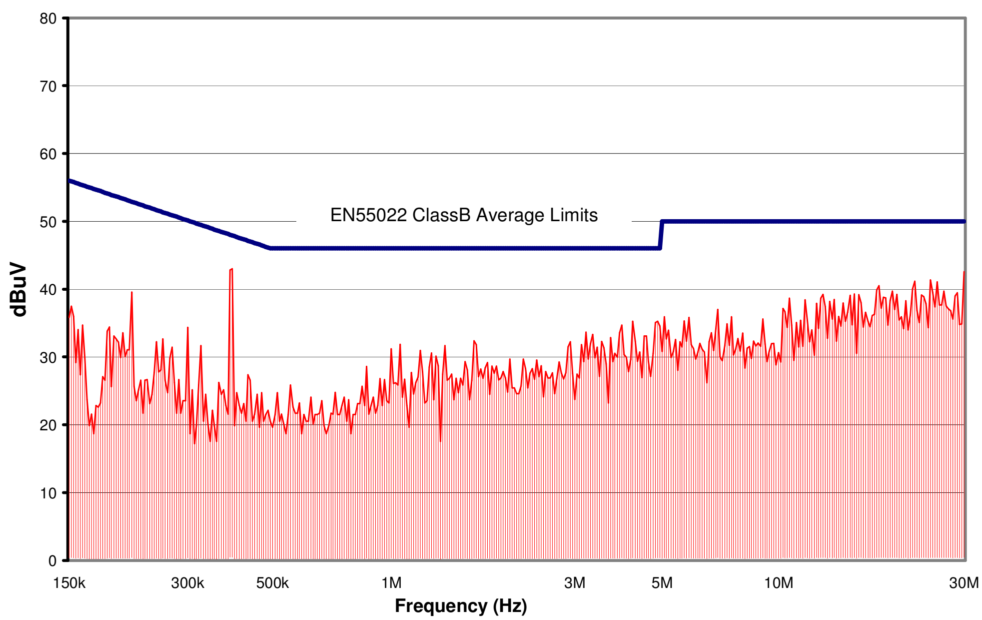


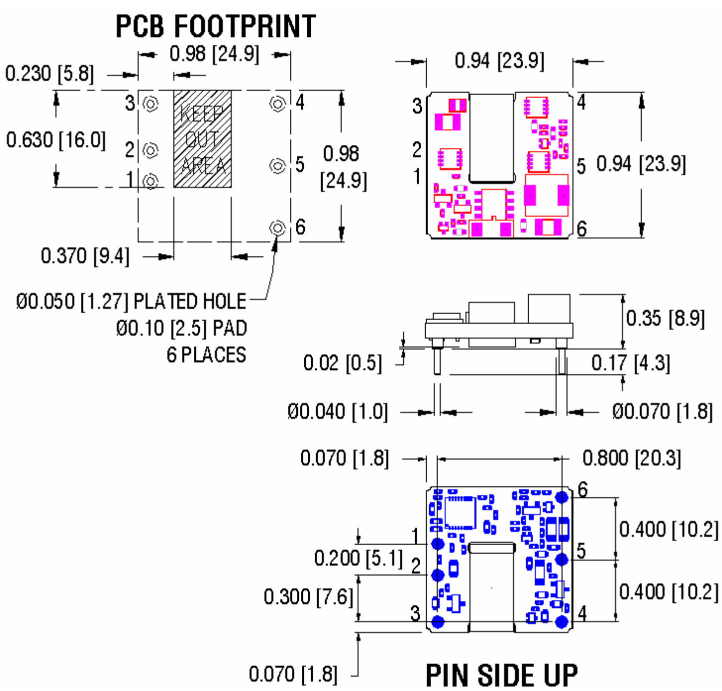
Figure 19. CP30_1160005 Conducted Emissions using above specified input filter.
Vin = 5V, Full Resistive Load

MODULE PIN ASSIGNMENT:

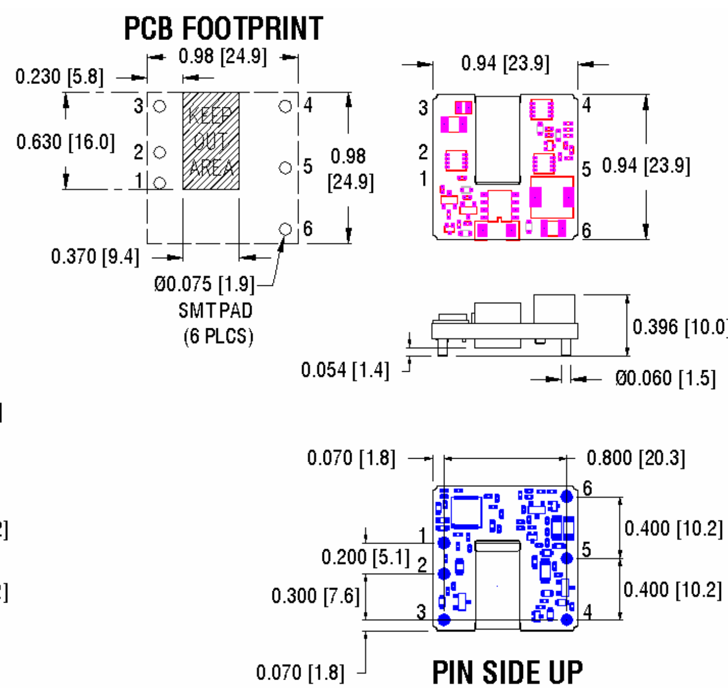
PIN #	DESIGNATION	NOTES
1	V_{IN} (+)	1) All dimensions in inches [mm] Tolerances: .xx ± 0.02 [.x ± .5] .xxx ± 0.010 [.xx ± .25] 2) TH pins Ø 0.040” [1.02] with Ø 0.070” [1.77] standoff shoulders. 3) SMT pins are Ø 0.060” 4) Keep Out Area – no copper traces or vias should be placed in this area. 5) All pins are gold plated with nickel under plating (ROHS). 6) Weight: 7.54 g (0.266 oz.) open frame, 19g (0.67 oz.) encapsulated 7) Workmanship: Meets or exceeds IPC-A-610 Class II
2	V_{IN} (-)	
3	On/Off	
4	V_{OUT} (-)	
5	Trim	
6	V_{OUT} (+)	

MECHANICAL OUTLINE - Open Frame:

Through-hole

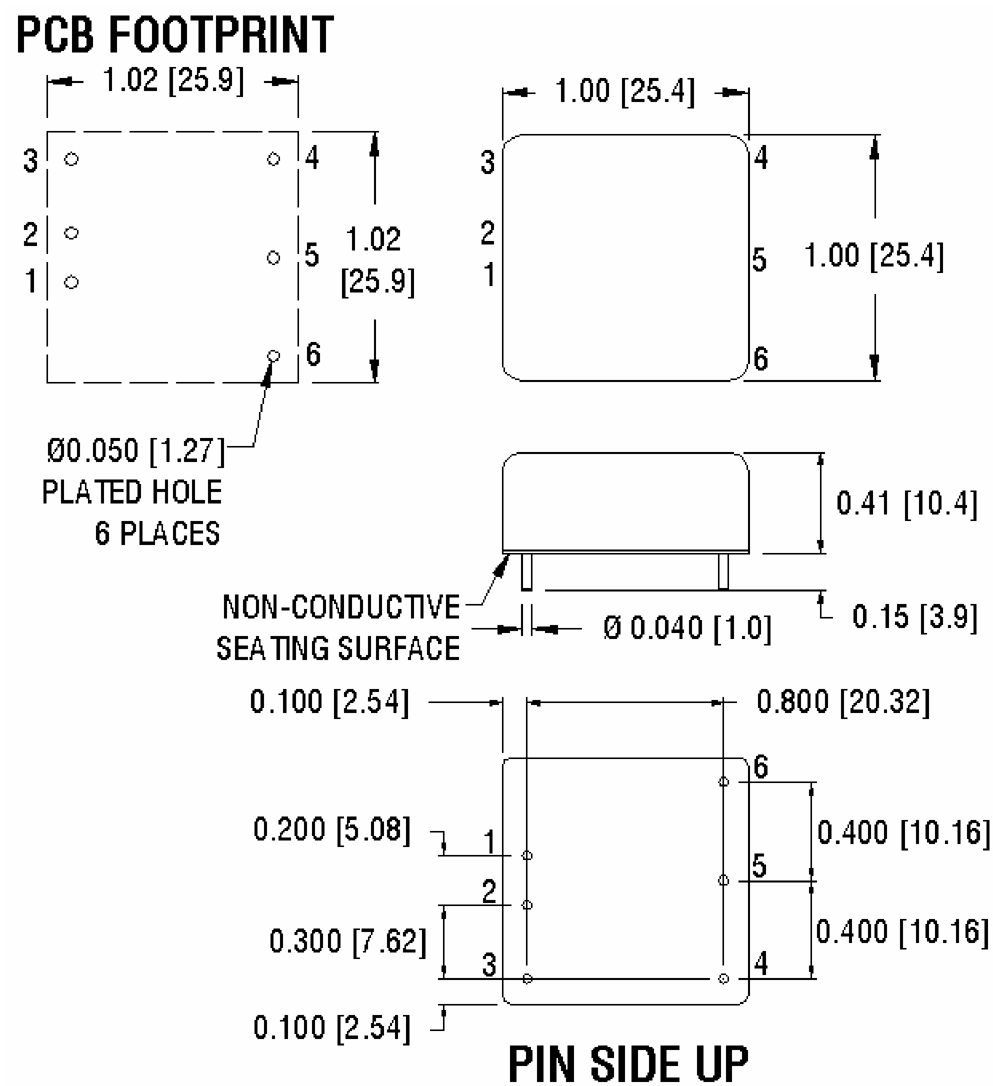


Surface Mount



Note: keep out area should be free of copper traces

MECHANICAL OUTLINE – Encapsulated Module:



Ordering Information:							
Product Series	Package Configuration	No. of Outputs	Output Voltage	Output Current	Input Voltage	Enable logic option	SMT Option
CP30	B or C	1	1	600	05	N or P	S*
30W 1x1	B = Open Frame C = Encapsulated	1 output	5V	6A	4.5 – 9V	N = Negative P = Positive Blank = No Enable or Trim Pin	Surface Mount

*Option not available on encapsulated version.