

COOL POWER TECHNOLOGIES

Sixteenth-Brick Isolated DC/DC Converter

Features

- Ultra-wide input voltage range: 9 – 36V_{in}
- Output: 5 V at 8 A, 40W max.
- High Efficiency – 89% typical @ FL
- No minimum load/capacitance required
- RoHS 3 Directive 2015/863/EU
- Low height - 0.374" (9.5mm) max.
- 2250V Isolation
- Withstands 100 V input transients
- Fixed-frequency operation
- Industry standard 1/16th brick footprint
- Full protection (OTP, OCP, OVP, UVLO – auto-restart)
- Remote ON/OFF - positive or negative enable logic options
- Remote sense
- Output voltage trim range: +10/-20% (industry-standard trim equations)
- Weight: 0.44 oz (12.5 g) open frame, 0.72 oz (20.5 g) baseplate model
- On-board input differential LC-filter
- Meets UL94, V-0 flammability rating
- Compliant to REACH (EC) No 1907/2006, 205 SVHC update
- Complies with UL/CSA60950-1, TUV per IEC/EN60950-1, 2nd edition
- Designed to meet Class B conducted emissions per FCC and EN55032 when used with external filter (see EMC Compliance page.)



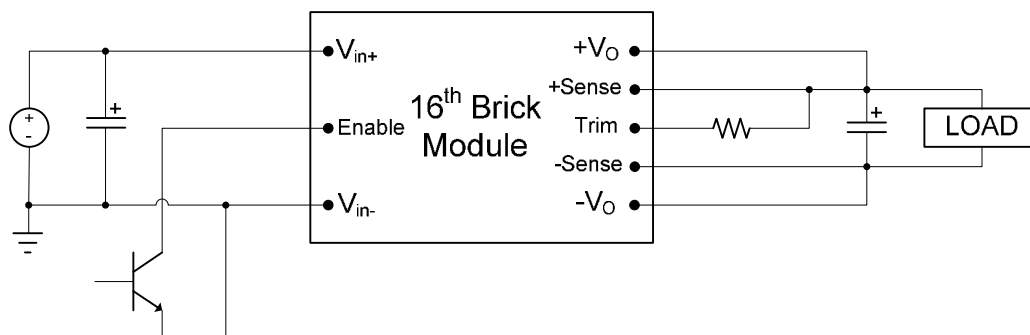
Description

The CPT8A18 “Cool Power Technologies” DC-DC converter is an open frame sixteenth-brick DC-DC converter that conforms to industry standard specifications. The converter operates over an input voltage range of 9 to 36 VDC, and provides a tightly regulated output voltage with an output current rating of 8 A. The output is fully isolated from the input and the converter meets Basic Insulation requirements. The standard feature set includes remote On/Off (positive or negative enable), input undervoltage lockout, output overvoltage protection, overcurrent/short circuit protection, output voltage trim, remote sense and overtemperature shutdown with hysteresis. The high efficiency of the CPT8A18 allows operation over a wide ambient temperature range with minimal derating (see Characteristic Curves section below.)

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APPLICATION DIAGRAM



ELECTRICAL SPECIFICATIONS

9–36Vin, 5.0V/8Aout

Conditions: $T_A = 25\text{ }^{\circ}\text{C}$, Airflow = 300 LFM, $V_{in} = 24\text{ VDC}$, $C_{in} = 100\text{ }\mu\text{F}$, unless otherwise specified.

Input Characteristics					
Parameter	Conditions	Min	Typ	Max	Unit
Operating Input Voltage Range		9	24	36	VDC
Input Under-Voltage Lock-out					
Turn-on Threshold		9.2	9.6	10	VDC
Turn-off Threshold		8.1	8.5	8.9	
Input Voltage Transient	100ms			50	VDC
Maximum Input Current	$V_{IN} = 9\text{VDC}$; $I_{out} = 8\text{A}$			5.5	A
Input Standby Current	Converter Disabled		2	5	mA
Input No-Load Current	Converter Enabled		40	80	mA
Short Circuit Input Current	RMS		40		mA
Input Reflected Ripple Current	5Hz to 50MHz See Fig 13 for setup		20	30	$\text{mA}_{\text{PK-PK}}$
Input Voltage Ripple Rejection	120Hz		50		dB
Inrush Current	All	-	-	0.1	A^2/s
Output Characteristics					
Parameter	Conditions	Min	Typ	Max	Unit
Output Voltage Set point	Sense pins connected to output pins	4.925	5	5.075	VDC
Output Current		0		8	A
Output Current Limit Inception		9	11	14	A
Peak Short-Circuit Current	10m Ω Short			20	A
RMS Short-Circuit Current	10m Ω Short		1.2	2.0	A_{RMS}
External Load Capacitance				4700 ²	μF
Output Ripple and Noise	20MHz Bandwidth 1 μF Ceramic + 10 μF Tantalum See Fig 14 for setup		50	80	$\text{mV}_{\text{PK-PK}}$
	1 μF Ceramic + 47 μF Ceramic See Fig 15 for setup		35	50	$\text{mV}_{\text{PK-PK}}$
Output Regulation					
Line:			± 1	± 5	mV
Load:			± 1	± 5	mV
Overall Output Regulation:	Over line, load & temp.	4.85		5.15	V



ELECTRICAL SPECIFICATIONS (continued)

9–36Vin, 5.0V/8Aout

Conditions: $T_A = 25^\circ\text{C}$, Airflow = 300 LFM, $V_{in} = 24\text{ VDC}$, $C_{in} = 100\text{ }\mu\text{F}$, unless otherwise specified.

Absolute Maximum Ratings

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage	Continuous Operation	0		36	VDC
Operating Ambient Temperature	w/derating	-40		+85	$^\circ\text{C}$
Operating Temperature - T_{ref} (See Thermal Derating section)	Open Frame	-40		+123	$^\circ\text{C}$
	Baseplate Option	-40		+110	$^\circ\text{C}$
Storage Temperature		-55		+125	$^\circ\text{C}$

Feature Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Switching Frequency			430		kHz
Output Voltage Trim Range ¹		-10		+10	%
Remote Sense Compensation ¹				+10	%
Output Over-voltage Protection	Non-latching	115	125	140	%
Over-temperature Protection	Avg. PCB temp, non-latching		135		$^\circ\text{C}$
Peak Backdrive Output Current during startup into prebiased output	Sinking current from external voltage source equal to $V_{OUT} - 0.6\text{V}$ and connected to the output via 1Ω resistor. $C_{OUT}=220\mu\text{F}$, Aluminum		-	500	mA
Backdrive Output Current in OFF state	Converter disabled		0	5	mA
Enable to Output Turn-ON Time	$V_{OUT} = 0.9 \cdot V_{OUT_NOM}$		20		ms
Output Enable ON/OFF	All voltages are WRT $-V_{in}$. Converter has internal pull-up of approx. 5V	-0.5 2.4		0.8	VDC
Negative Enable				20	VDC
Positive Enable		2.4 -0.5		20	VDC
Converter ON				0.8	VDC
Enable Pin Current Source/Sink			0.25	1	mA
Output Voltage Overshoot @ Startup			0	2	%Vo
Auto-Restart Period	(all protection features)		100		ms



ELECTRICAL SPECIFICATIONS (continued)

9–36Vin, 5.0V/8Aout

Conditions: Ta = 25 °C, Airflow = 300 LFM, Vin = 24 VDC, Cin=100 µF, unless otherwise specified.

Efficiency					
Parameter	Conditions	Min	Typ	Max	Unit
Full Load	Vin = 12Vin	89.5	90		%
	Vin = 24Vin	87	89		%
60% Load	Vin = 12Vin	89	90		%
	Vin = 24Vin	87	88		%
Dynamic Response					
Parameter	Conditions	Min	Typ	Max	Unit
Load Change 50%-75% or 25% to 50% of Iout Max, di/dt = 0.1 A/μs	Co = 1 μF ceramic + 10 μF tantalum		60	100	mV
Settling Time to 1% of Vout			50		μs
Load Change 50%-75% or 25% to 50% of Iout Max, di/dt = 1.0 A/μs	Co = 1 μF ceramic + 100 μF Tantalum		60	100	mV
Settling Time to 1% of Vout			50		μs
Isolation Specifications					
Isolation Capacitance			1000		pF
Isolation Resistance		10			MΩ
Isolation Voltage	Input to Output	2250			V _{DC}
	Input to Baseplate	1500			V _{DC}
	Output to Baseplate	1000			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	3,237,658			Hours
	FITs (failures in 10 ⁹ hours)	309			/10 ⁹ Hours

Notes:

- 1) Combination of trim + remote sense cannot exceed 10% of V_{o_nom}
- 2) Consult factory if higher output capacitance capability is required

3) CHARACTERISTIC CURVES:

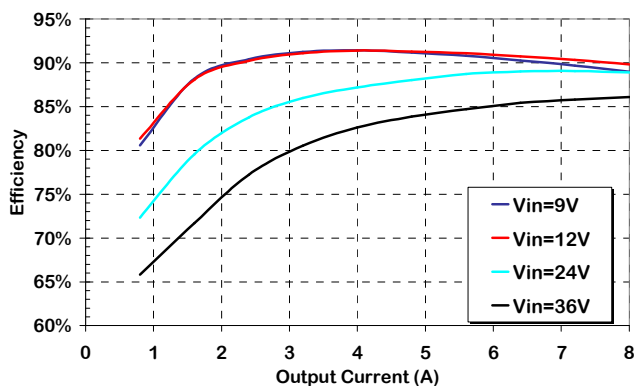


Figure 1. Efficiency vs Output Current, 300lfm airflow, 25°C ambient.

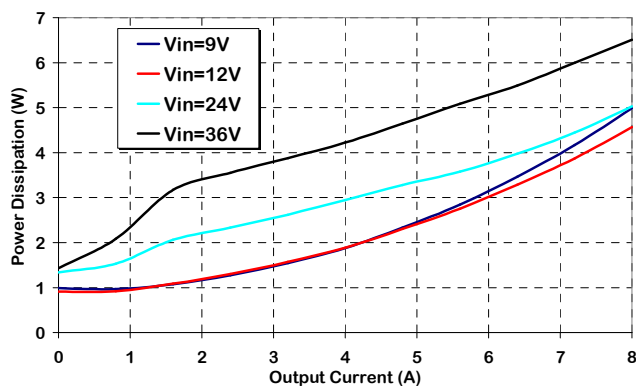


Figure 2. Power Dissipation vs. Load Current, 300lfm airflow, 25°C ambient.

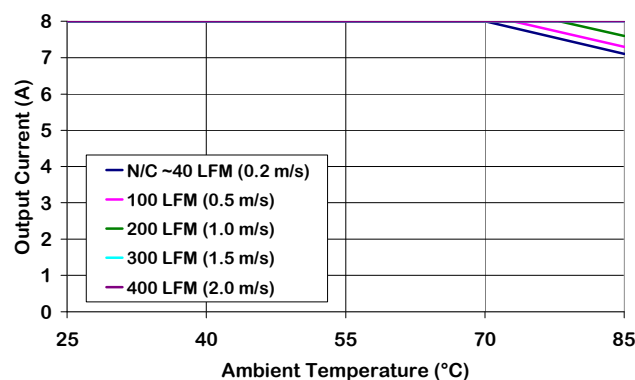


Figure 3. Output Current Derating vs Ambient Temperature & Airflow (converter mounted vertically with air flowing from pin 3 to pin 1, Vin = 18 V.)

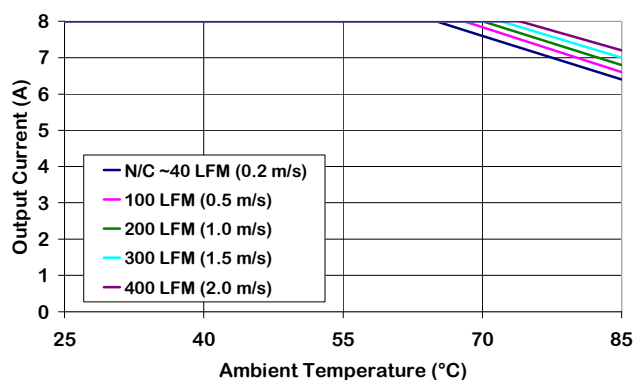


Figure 4. Output Current Derating vs Ambient Temperature & Airflow (converter mounted vertically with air flowing from pin 3 to pin 1, Vin = 12 V.)

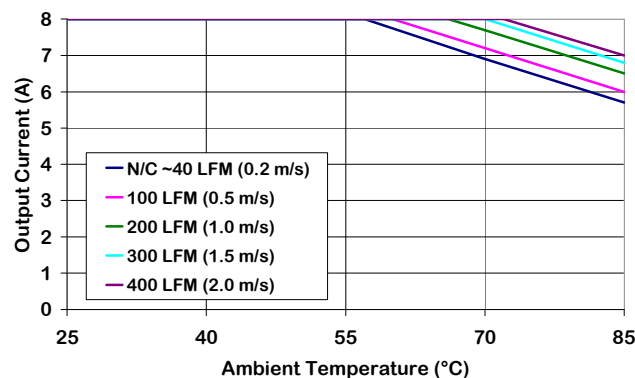


Figure 5. Output Current Derating vs Ambient Temperature & Airflow (converter mounted vertically with air flowing from pin 3 to pin 1, Vin = 24 V.)

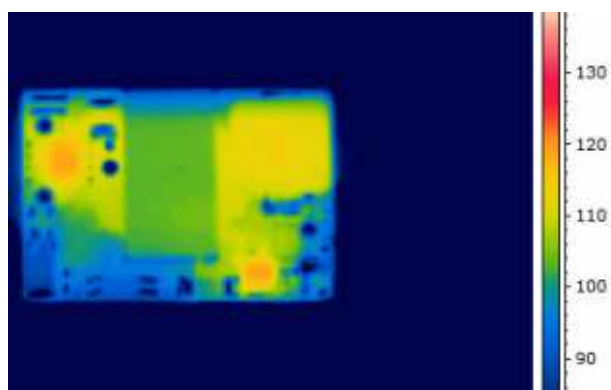


Figure 6. Thermal Image of CPT8A18 (8A output, 70°C Ambient, 200lfm airflow, Vin = 18V, airflow from pin 3 to pin 1, T_{max} = 117°C)



CHARACTERISTIC WAVEFORMS:

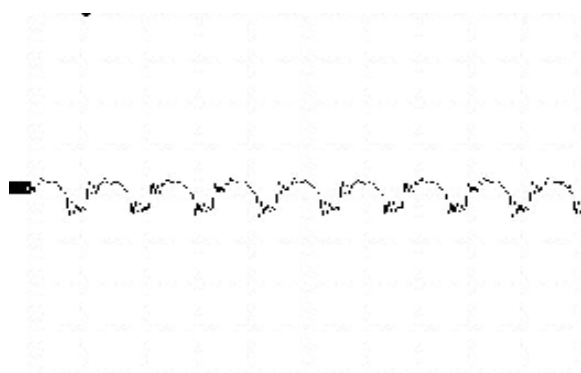


Figure 7. Output Voltage Ripple (50mV/div), time scale - 2uS/div. Vin=Vin_nom, full resistive Cout=1uF ceramic + 10uF Tantalum (see Fig 14)

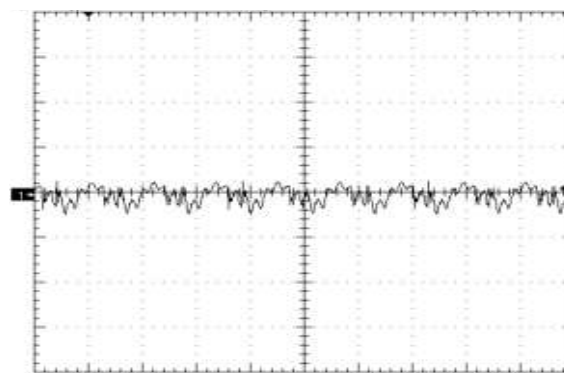


Figure 8. Output Voltage Ripple (50mV/div), time scale - 2uS/div. Vin=Vin_nom, full resistive Cout=1uF ceramic + 47uF Ceramic (see Fig 15)

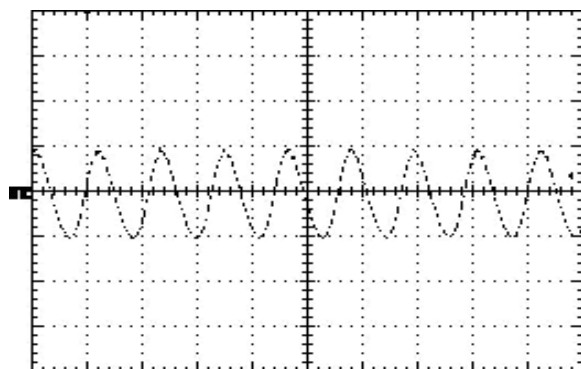


Figure 9. Input Reflected Ripple Current (10mA/div), time scale - 2uS/div. Vin=Vin_nom, full resistive

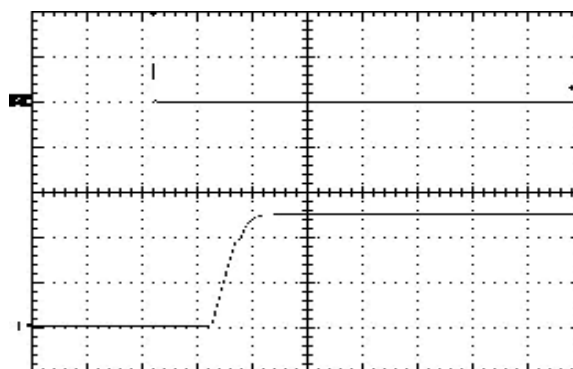


Figure 10. Startup Waveform (2V/div) via Enable Pin, time scale 10mS/div. Vin=Vin_nom, full resistive load + 4700uF (negative enable.) Ch2=5V/div

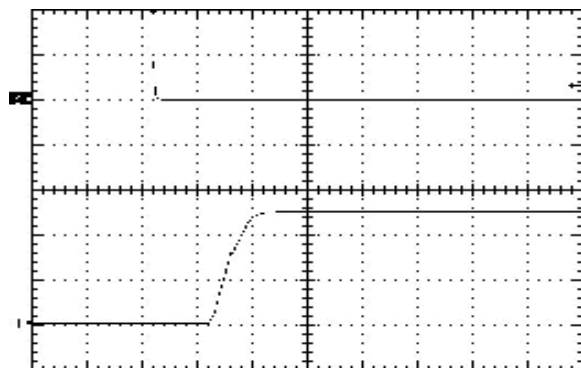


Figure 11. Startup Waveform (2V/div) via Enable Pin, time scale 10mS/div. Vin=Vin_nom, full resistive load (negative enable.) Ch2=5V/div

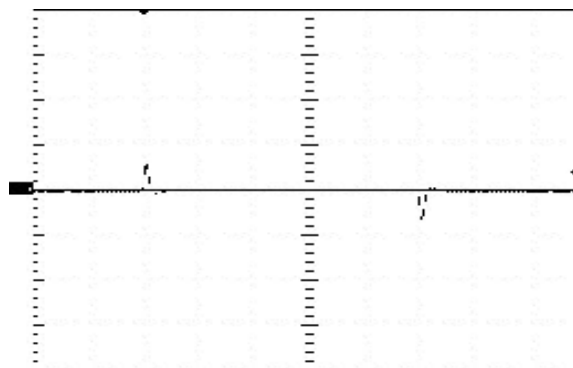
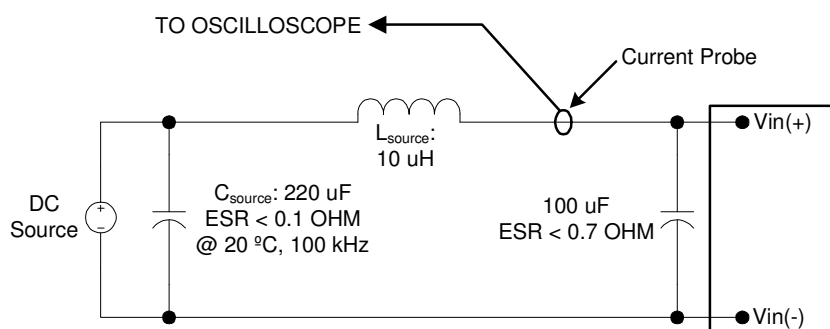


Figure 12. Load Transient Response (100mV/div), di/dt=0.1A/uS, 25% - 50% - 25% of full load, time scale: 200uS/div.



Application Notes

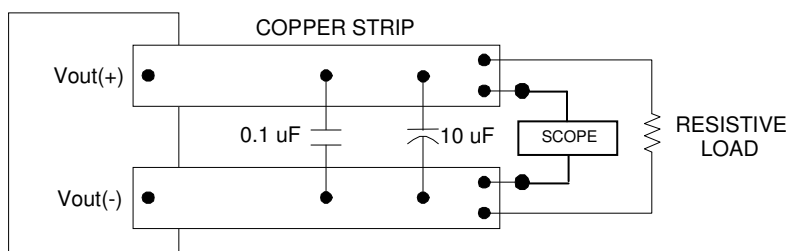
INPUT REFLECTED RIPPLE TEST SETUP:



Note: Measure input reflected-ripple current with a simulated source inductance (L_{test}) of 10 μH . Capacitor C_s offsets possible source impedance.

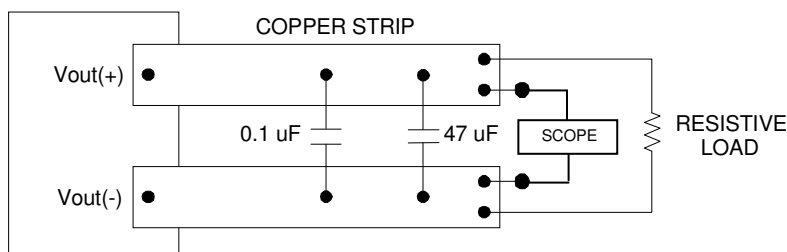
Figure 13. Input Reflected-ripple Current Test Setup.

OUTPUT RIPPLE TEST SETUP:



Note: Use a 0.1 μF X7R ceramic capacitor and a 10 μF @ 25V tantalum capacitor. Scope measurement should be made using a BNC socket. Position the load 3 in. [76mm] from module.

Figure 14. Peak-to-Peak Output Noise Measurement Test Setup.



Note: Use a 0.1 μF X7R ceramic capacitor and a 100 μF @ 6V3 ceramic capacitor. Scope measurement should be made using a BNC socket. Position the load 3 in. [76mm] from module.

Figure 15. Peak-to-Peak Output Noise Measurement Test Setup (alt).



Application Notes (cont)

Output Voltage Trim

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

- TRIM UP EQUATION:**

$$R_{\text{trim_up}} = \left[\frac{5.1 \times V_{O_nom} \times (100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{510}{\Delta\%} - 10.2 \right] \times k\Omega$$

Where $R_{\text{trim_up}}$ is the resistance value in k-ohms and $\Delta\%$ is the percent change in the output voltage. E.g. to

trim the output up 10%, $R_{\text{trim_up}} = \left[\frac{5.1 \times 5.0 \times (100 + 10)}{1.225 \times 10} - \frac{510}{10} - 10.2 \right] \times k\Omega$ or $R_{\text{trim_up}} = 168k\Omega$.

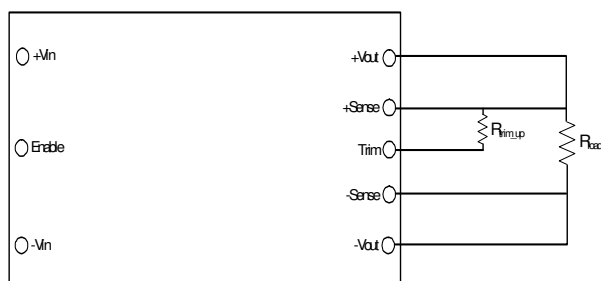


Figure 16. Trim UP circuit configuration

- TRIM-DOWN EQUATION:**

$$R_{\text{trim_down}} = \left(\frac{510}{\Delta\%} - 10.2 \right) \times k\Omega$$

Where $R_{\text{trim_down}}$ is the resistance value in k ohms and $\Delta\%$ is the percent change in the output voltage.

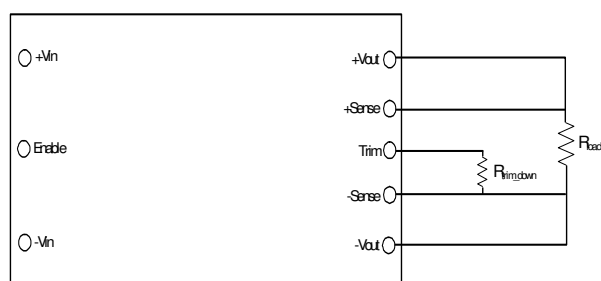


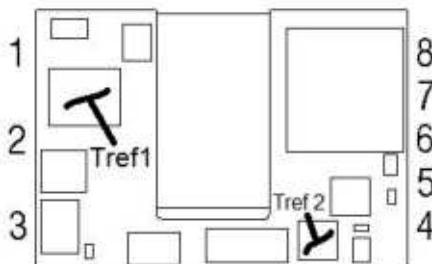
Figure 17. Trim DOWN circuit configuration



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. Thermal reliefs are not recommended on power pin connections.
- 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. T_{ref_1} should be monitored for input voltages below 18 Vin, T_{ref_2} for input voltages > 18 Vin. Temperature at the specified location is not to exceed 123°C in order to meet derating curves.



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 1-2 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. Once started, 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.
- With the negative enable option, the converter 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 threshold 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. 135°C, 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 0.080" (2.03 mm) diameter. Solder paste screen opening should be 0.075" (1.9 mm) 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. In lower current applications, ORing diodes can be used to prevent converter interactions and improve current sharing.



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:

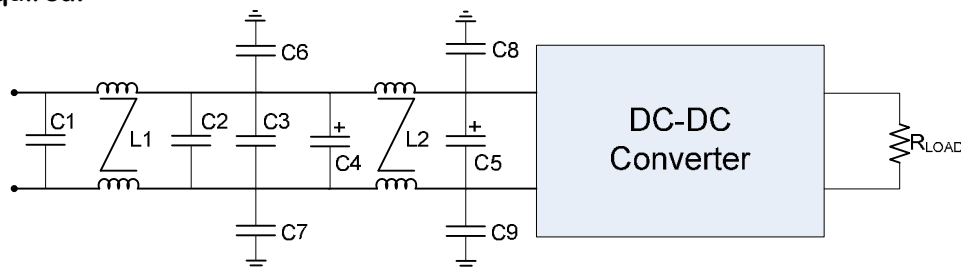


Figure 18. EMI Filter

L1, L2 =	0.59 mH Common Mode Inductor (Pulse P0353)
C1, C2, C3 =	4.7uF ceramic
C4 =	Not used
C5 =	100uF electrolytic
C6, C7 =	8.2nF (@2kV if output is ref. to gnd.)
C8, C9 =	8.2nF (@2kV if output is ref. to gnd.)

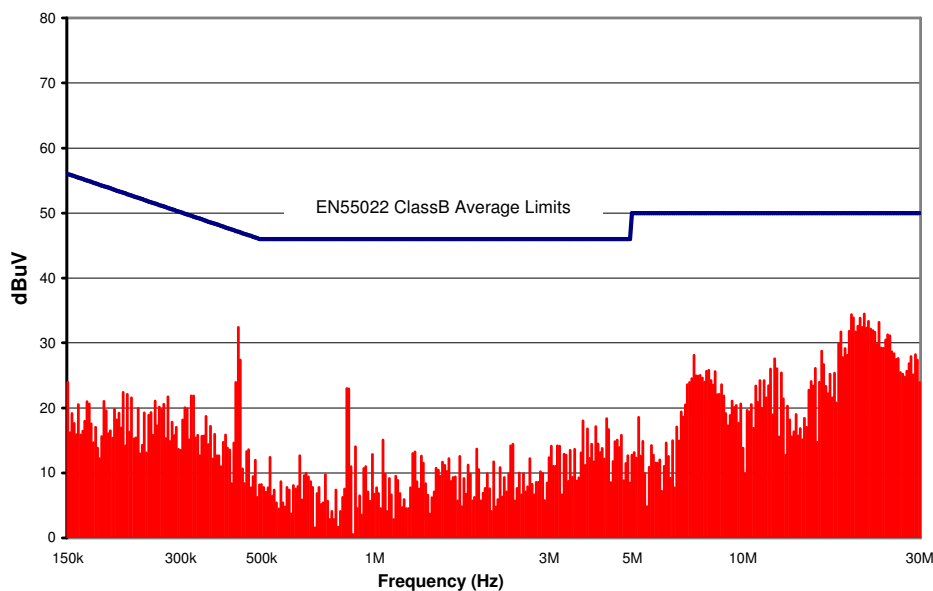


Figure 19. CPT8A18 Conducted Emissions using above specified input filter.
 $V_{in} = 24V$, Full Resistive Load ($12V_{in}$ - subtract 2dB from peaks)



PIN #	DESIGNATION	NOTES
1	V _{IN} (+)	1) All dimensions in inches [mm] Tolerances: .xx ± 0.02 [.x ± .5] .xxx ± 0.010 [.xx ± .25] 2) Input, on/off control and sense/trim pins are Ø 0.040" [1.02] with Ø 0.070" [1.77] standoff shoulders. 3) Output pins are Ø 1.57 mm (0.062") with Ø 0.093" [2.36] shoulders (note, shoulder sits .008" above mounting surface) 4) All pins are gold plated with nickel under plating. 5) Weight: 12.5 g (0.44 oz) open frame, 20.5g (0.72 oz) baseplated 6) Workmanship: Meet or exceeds IPC-A-610 Class II
2	On/Off	
3	V _{IN} (-)	
4	V _{OUT} (-)	
5	Sense (-)	
6	Trim	
7	Sense (+)	
8	V _{OUT} (+)	

THROUGH-HOLE PCB FOOTPRINT

MOUNTED (TOP) VIEW

SIDE VIEW W/BASEPLATE

SIDE VIEW

PINS UP VIEW

SMT PCB FOOTPRINT

TOP VIEW

Dimensions (mm [inches]):

- Overall width: 1.32 [33.4]
- Overall height: 0.92 [23.3]
- Pin 1 to Pin 8 pitch: 1.10 [28.0]
- Pin 1 to Pin 2 pitch: 0.11 [2.7]
- Pin 2 to Pin 3 pitch: 0.30 [7.6]
- Pin 3 to Pin 4 pitch: 0.30 [7.6]
- Pin 4 to Pin 5 pitch: 0.15 [3.8]
- Pin 5 to Pin 6 pitch: 0.15 [3.8]
- Pin 6 to Pin 7 pitch: 0.15 [3.8]
- Pin 7 to Pin 8 pitch: 0.15 [3.8]
- Pin 1 to Pin 8 pitch: 0.080 [2.03]
- SMT PAD (8 PLCS)

BOTTOM VIEW (PIN SIDE UP)

Dimensions (mm [inches]):

- Overall width: 1.30 [33.0]
- Overall height: 0.90 [22.9]
- Pin 1 to Pin 8 pitch: 1.10 [27.9]
- Pin 1 to Pin 2 pitch: 0.10 [2.5]
- Pin 2 to Pin 3 pitch: 0.15 [3.8]
- Pin 3 to Pin 4 pitch: 0.30 [7.6]
- Pin 4 to Pin 5 pitch: 0.15 [3.8]
- Pin 5 to Pin 6 pitch: 0.15 [3.8]
- Pin 6 to Pin 7 pitch: 0.30 [7.6]
- Pin 7 to Pin 8 pitch: 0.45 [11.4]
- Pin 8 to Pin 9 pitch: 0.60 [15.2]
- Pin 9 to Pin 10 pitch: 0.60 [15.2]
- Pin 10 to Pin 11 pitch: 0.60 [15.2]
- Pin 11 to Pin 12 pitch: 0.60 [15.2]
- Pin 12 to Pin 13 pitch: 0.60 [15.2]
- Pin 13 to Pin 14 pitch: 0.60 [15.2]
- Pin 14 to Pin 15 pitch: 0.60 [15.2]
- Pin 15 to Pin 16 pitch: 0.60 [15.2]
- Pin 16 to Pin 17 pitch: 0.60 [15.2]
- Pin 17 to Pin 18 pitch: 0.60 [15.2]
- Pin 18 to Pin 19 pitch: 0.60 [15.2]
- Pin 19 to Pin 20 pitch: 0.60 [15.2]
- Pin 20 to Pin 21 pitch: 0.60 [15.2]
- Pin 21 to Pin 22 pitch: 0.60 [15.2]
- Pin 22 to Pin 23 pitch: 0.60 [15.2]
- Pin 23 to Pin 24 pitch: 0.60 [15.2]
- Pin 24 to Pin 25 pitch: 0.60 [15.2]
- Pin 25 to Pin 26 pitch: 0.60 [15.2]
- Pin 26 to Pin 27 pitch: 0.60 [15.2]
- Pin 27 to Pin 28 pitch: 0.60 [15.2]
- Pin 28 to Pin 29 pitch: 0.60 [15.2]
- Pin 29 to Pin 30 pitch: 0.60 [15.2]
- Pin 30 to Pin 31 pitch: 0.60 [15.2]
- Pin 31 to Pin 32 pitch: 0.60 [15.2]
- Pin 32 to Pin 33 pitch: 0.60 [15.2]
- Pin 33 to Pin 34 pitch: 0.60 [15.2]
- Pin 34 to Pin 35 pitch: 0.60 [15.2]
- Pin 35 to Pin 36 pitch: 0.60 [15.2]
- Pin 36 to Pin 37 pitch: 0.60 [15.2]
- Pin 37 to Pin 38 pitch: 0.60 [15.2]
- Pin 38 to Pin 39 pitch: 0.60 [15.2]
- Pin 39 to Pin 40 pitch: 0.60 [15.2]
- Pin 40 to Pin 41 pitch: 0.60 [15.2]
- Pin 41 to Pin 42 pitch: 0.60 [15.2]
- Pin 42 to Pin 43 pitch: 0.60 [15.2]
- Pin 43 to Pin 44 pitch: 0.60 [15.2]
- Pin 44 to Pin 45 pitch: 0.60 [15.2]
- Pin 45 to Pin 46 pitch: 0.60 [15.2]
- Pin 46 to Pin 47 pitch: 0.60 [15.2]
- Pin 47 to Pin 48 pitch: 0.60 [15.2]
- Pin 48 to Pin 49 pitch: 0.60 [15.2]
- Pin 49 to Pin 50 pitch: 0.60 [15.2]
- Pin 50 to Pin 51 pitch: 0.60 [15.2]
- Pin 51 to Pin 52 pitch: 0.60 [15.2]
- Pin 52 to Pin 53 pitch: 0.60 [15.2]
- Pin 53 to Pin 54 pitch: 0.60 [15.2]
- Pin 54 to Pin 55 pitch: 0.60 [15.2]
- Pin 55 to Pin 56 pitch: 0.60 [15.2]
- Pin 56 to Pin 57 pitch: 0.60 [15.2]
- Pin 57 to Pin 58 pitch: 0.60 [15.2]
- Pin 58 to Pin 59 pitch: 0.60 [15.2]
- Pin 59 to Pin 60 pitch: 0.60 [15.2]
- Pin 60 to Pin 61 pitch: 0.60 [15.2]
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- Pin 66 to Pin 67 pitch: 0.60 [15.2]
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- Pin 69 to Pin 70 pitch: 0.60 [15.2]
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- Pin 129 to Pin 130 pitch: 0.60 [15.2]
- Pin 130 to Pin 131 pitch: 0.60 [15.2]
- Pin 131 to Pin 132 pitch: 0.60 [15.2]
- Pin 132 to Pin 133 pitch: 0.60 [15.2]
- Pin 133 to Pin 134 pitch: 0.60 [15.2]
- Pin 134 to Pin 1

ORDERING INFORMATION:

Product Identifier	Output Current	Output Voltage	Input Voltage	Enable logic option	Additional features
CPT	8	A	18	N or P	S or B
"Cool Power Technologies"	8 Amps	5 Volts	9 – 36V	N = Negative P = Positive	S = Surface Mount B = Baseplate Option

Rev 1.31, 9-May-19



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