

Typical units

## FEATURES

- Compatible to Point-of-Load Alliance (POLA) Specifications
- Surface-mount or through-hole small footprint package
- Three user-selectable output voltage ranges covering 0.8V to 5.5V
- Outline dimensions less than one square inch
- 3.3V, 5V and 12 Vdc nominal inputs
- High efficiency up to 95% typical
- Tracking input for sequenced startup/shutdown
- Outstanding thermal performance and derating
- -40 to +85 degrees Celsius operating range
- Extensive self-protection, voltage limits and short circuit features
- On/Off control, trim and pre-bias start-up functions

## DESCRIPTION

The MPDTH series non-isolated DC/DC power modules are small in size but big on performance and flexibility. Their high output current, compact footprint and industry-leading features offer system designers versatile modules for powering complex multi-processor digital systems. Standard inputs are 3.3V, 5V, or 12 Volts DC nominal.

Two mounting styles are offered, either a pinned through-hole model with slightly lower height or a surface mount model, both with identical length and width. Respective models all share the same pinout and comply with the POLA DC/DC converter standard.

The output voltage is adjustable in three ranges from 0.8 V to 5.5 V and can be set with a single external resistor. The series also includes Auto-Track sequencing, enabling modules to track each other's output voltage in multi-powered systems during power-up and power-down.

Other operating features include a remote on/off control and the ability to start up into an existing (prebias) output voltage. Extensive self-protection features include input under-voltage lockout (UV), output short circuit protection and output overcurrent shutdown (OC) using an automatic restart. All models meet RoHS6 hazardous substance compliance.

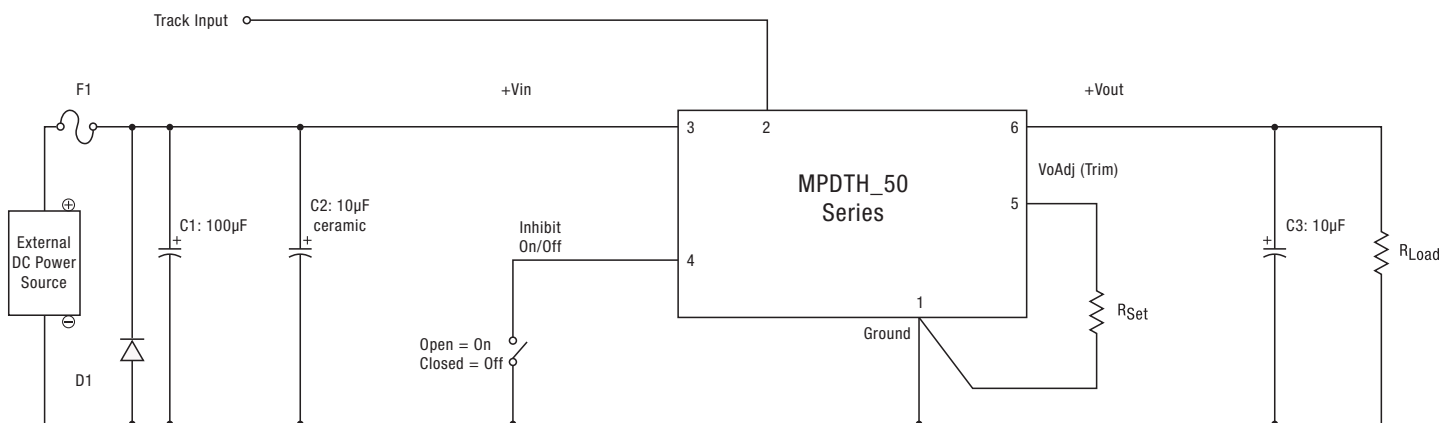


Figure 1. Connection Diagram

### Notes:

1. Murata Power Solutions strongly recommends an external fuse, F1. Fuse rating = 2 x I<sub>in</sub> max.
2. Consider using diode D1 to blow the fuse in case of reversed polarity.
3. C1: 100µF/25V, aluminum electrolytic capacitor, required for all models.  
C2: 10µF/25V, ceramic capacitor, required for MPDTH12050 models.  
C3: 10µF ceramic, recommended for all models. Voltage rating ≥ 2 x V<sub>out</sub>.
4. Track input is referred to ground.
5. See trim information for R<sub>Set</sub>.



### SPECIFICATION SUMMARY AND ORDERING GUIDE ①

Model Number	Output					Input		Efficiency (%)	Package		
	Vout (Volts)	Iout (Amps) max.	Power (Watts)	Ripple&Noise (mV pk-pk)	Regulation Line Load	Vin nom. (Volts)	Range (Volts)		Case(inches)	Case(mm)	Type(2)
MPDTH03050WAH	0.8-2.5	6	15	20(6)	±1.25% ±1.5%	3.3	2.95-3.65	94(3)	0.87x0.495x0.335	22.10x12.57x8.5	TH
MPDTH03050WAS	0.8-2.5	6	15	20(6)	±1.25% ±1.5%	3.3	2.95-3.65	94(3)	0.87x0.495x0.358	22.10x12.57x9.09	SM
MPDTH05050WAH	0.8-3.6	6	21.6	20(7)	±1.25% ±1.5%	5.0	4.5-5.5	95(4)	0.87x0.495x0.335	22.10x12.57x8.5	TH
MPDTH05050WAS	0.8-3.6	6	21.6	20(7)	±1.25% ±1.5%	5.0	4.5-5.5	95(4)	0.87x0.495x0.358	22.10x12.57x9.09	SM
MPDTH12050WAH	1.2-5.5	6	33	33(8)	±0.4% ±0.4%	12.0	10.8-13.2	93(5)	0.87x0.495x0.335	22.10x12.57x8.5	TH
MPDTH12050WAS	1.2-5.5	6	33	33(8)	±0.4% ±0.4%	12.0	10.8-13.2	93(5)	0.87x0.495x0.358	22.10x12.57x9.09	SM

#### Notes:

- ① All specifications are typical at nominal input line voltage, nominal output voltage and full load, Ta=+25 deg.C. unless otherwise noted. See detailed specifications.
- ② "TH" is a pinned through-hole package. "SM" is a surface mount package.
- ③ Vin=3.3V, Vout=2.5V, Iout=4A
- ④ Vin=5V, Vout=3.3V, Iout=4A

- ⑤ Vin=12V, Vout=5V, Iout=5A
- ⑥ Vin=3.3V, Vout=2.5V, Iout=6A
- ⑦ Vin=5V, Vout=3.3V, Iout=6A
- ⑧ Vin=12V, Vout=5V, Iout=6A
- ⑨ RoHS6 compliance does not claim EU RoHS exemption 7b (lead in solder).

### MPDTH\*\*050 Series Performance and Functional Specifications

All specifications are typical unless noted.

Input	
<b>Input Voltage Range</b>	See Ordering Guide
<b>Start-Up Voltage</b>	2.45 Volts (MPDTH03050) 4.3 Volts (MPDTH05050) 9.5 Volts (MPDTH12050)
<b>Undervoltage Shutdown</b>	2.4 Volts (MPDTH03050) 3.7 Volts (MPDTH05050) 9.0 Volts (MPDTH12050)
<b>External Input Capacitor</b> (See note 3)	100 µF, required (MPDTH03050 and MPDTH05050) 100 µF + 10 µF required (MPDTH12050)
<b>Remote On/Off Inhibit Control</b>	
Positive Logic	OFF = -0.2V to +0.6 V max. or ground pin ON = open pin (internal pullup)
Current	-130 µA [5]
<b>Tracking Input</b>	
Current when grounded	-130 µA
Slew rate	1 Volt per mSec max.
Tracking Input Range	-0.3V to (+Vin + 0.3V)
Output	
<b>Minimum Loading</b>	No minimum load
<b>Nominal Accuracy</b>	±2 % max. of Vsetting
<b>Voltage Adjustment Range</b>	See Ordering Guide
<b>Temperature Coefficient</b>	±40 ppm. per °C. of Vout
<b>Ripple/Noise</b>	See Ordering Guide

<b>Line/Load Regulation</b>	See Ordering Guide
<b>Efficiency</b>	See Ordering Guide
<b>Maximum Capacitive Loading</b>	
Cap-ESR ≥ 0.004 Ohms	3,300 µF non-ceramic [2]
Cap-ESR < 0.004 Ohms	300 µF ceramic
<b>Current Limit Inception</b>	12 Amps
<b>Short Circuit Mode</b>	
Protection Method	Autorecovery after overload removal
Short Circuit Duration	Continuous, no damage (output shorted to ground)
<b>Sequencing</b>	Start-up of multiple units may be synchronized by connecting track pins.
Dynamic Characteristics	
<b>Dynamic Load Response</b>	70 µSec to within ±2% of final value (50 to 100% load step, 1A/µSec load step, 100 µF external output cap)
<b>Switching Frequency</b>	600 KHz
Environmental	
<b>Calculated MTBF [4]</b>	6 million hours,min. (MPDTH03050 and MPDTH05050) 5.9 million hours,min. (MPDTH12050)
<b>Operating Temperature Range</b>	-40 to +85 deg.C.
<b>Storage Temperature Range</b>	-40 to +125 deg.C.

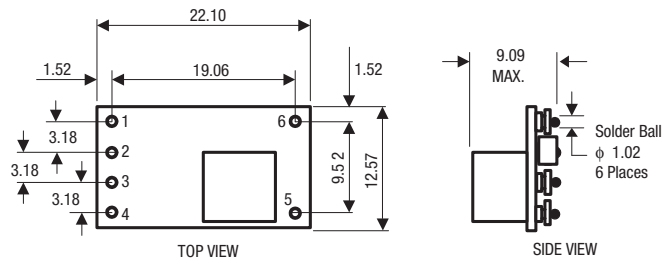
#### Specification Notes:

- (1) All specifications are typical unless noted. General conditions for Specifications are +25 deg.C ambient, Vin=nominal, Vout=+2.5V, full load, Cin=100 µF, Cout= 0 µF. Adequate airflow must be supplied for extended testing under power. For model MPDTH12050, an additional parallel 10 µF ceramic input capacitor is required. See note 3.
- (2) An external output capacitor is not required. However, a 100 µF output capacitor improves transient response.
- (3) The required input capacitor must have a ripple current rating of 300 mA RMS or greater for models MPDTH03050 and MPDTH05050. For model MPDTH12050, the ripple rating must be 750 mA RMS or greater. For model MPDTH12050, an additional parallel 10 µF ceramic input capacitor is required.

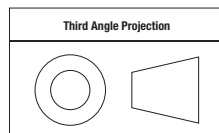
- (4) Mean Time Before Failure is calculated using the Telcordia (Belcore) TR-332 50% stress, ground benign conditions, Tambient=+40 deg.C.
- (5) Track input is grounded or equal to Vin.
- (6) There is no input protection against overvoltage or reversed polarity. Please provide proper fusing and a back-biased diode if there is the possibility of improper polarity. Refer to the Connection Diagram.
- (7) The outputs are not intended to sink appreciable reverse current.
- (8) Output current limit and short circuit protection is non-latching. When the overcurrent fault is removed, the converter will immediately recover.

## MECHANICAL SPECIFICATIONS

### Surface Mount Models MPDTH\_WAS



Dimensions are in mm.



Tolerances (unless otherwise specified):

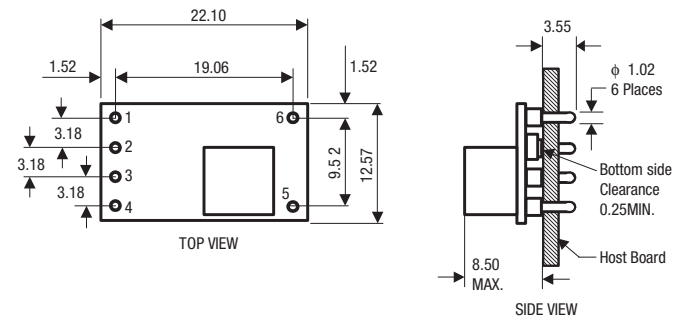
.XX ± 0.02 (0.5)

.XXX ± 0.010 (0.25)

Angles ± 2°

Components are shown for reference only.

### Through-hole Pins Models MPDTH\_WAH



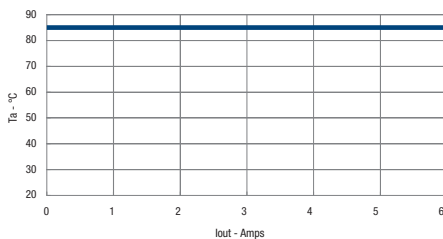
Dimensions are in millimeters.

#### I/O CONNECTIONS (Bottom view shown)

Pin/Pad	Function	Pin/Pad	Function
6	Output (Vout)	1	Ground
		2	Track Input
		3	Input (Vin)
5	Vout Adjust (trim)	4	Inhibit remote On/Off control

## MAXIMUM SAFE OPERATING AREA (DERATING)

### MPDTH03050

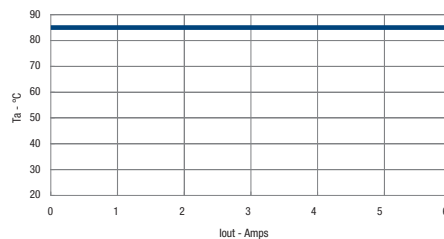


Vout = 2.5V

Natural convection

Units soldered to a 4" x 4" 4-layer PCB  
with 1 oz. copper.

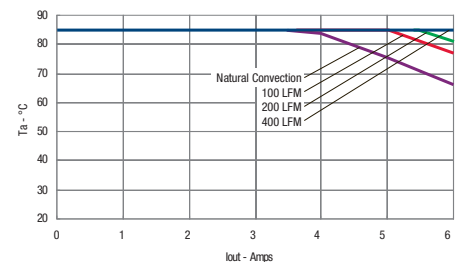
### MPDTH05050



Vin = 5V, Vout = 3.3V

Natural convection

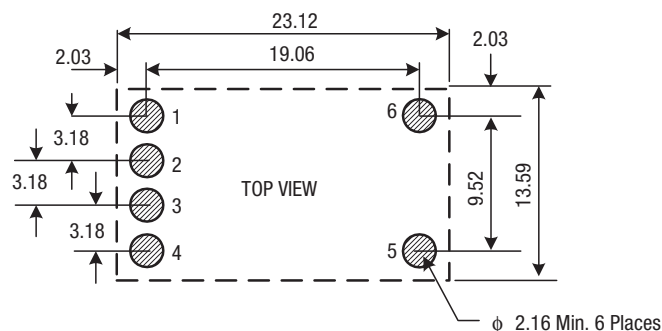
### MPDTH12050



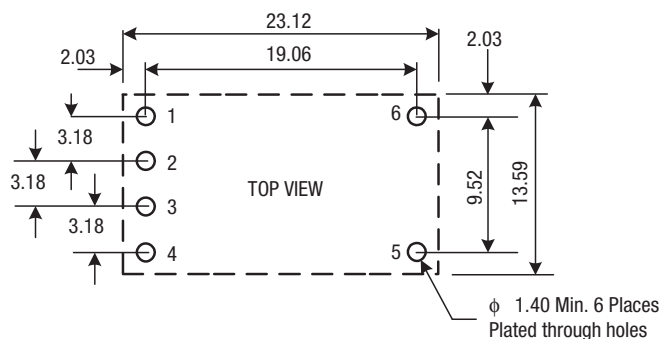
All output voltages

## PRINTED CIRCUIT LAYOUT PATTERN RECOMMENDATION

### Surface Mount Models MPDTH\_WAS



### Through-hole Pins Models MPDTH\_WAH



## EFFICIENCY VS. OUTPUT VOLTAGE

### Models MPDTH03050WAS/WAH

Vout	Efficiency (typ.)	Rset Trim Resistor
2.5 V.	94%	2.21 K $\Omega$
2.0 V.	92%	4.12 K $\Omega$
1.8 V.	91%	5.49 K $\Omega$
1.5 V.	90%	8.87 K $\Omega$
1.2 V.	88%	17.4 K $\Omega$
1.0 V.	87%	36.5 K $\Omega$

I<sub>out</sub>=4 Amps

### Models MPDTH05050WAS/WAH

Vout	Efficiency (typ.)	Rset Trim Resistor
3.3 V.	95%	698 $\Omega$
2.5 V.	93%	2.21 K $\Omega$
2.0 V.	91%	4.12 K $\Omega$
1.8 V.	90%	5.49 K $\Omega$
1.5 V.	89%	8.87 K $\Omega$
1.2 V.	87%	17.4 K $\Omega$
1.0 V.	85%	36.5 K $\Omega$

I<sub>out</sub>=4 Amps

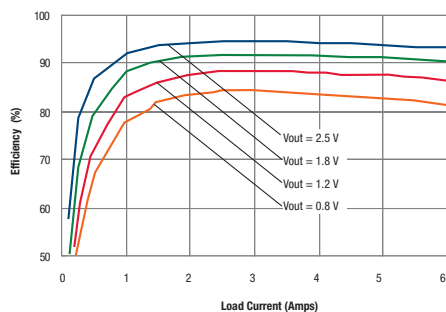
### Models MPDTH12050WAS/WAH

Vout	Efficiency (typ.)	Rset Trim Resistor
5.0 V.	93%	280 $\Omega$
3.3 V.	91%	2.0 K $\Omega$
2.5 V.	89%	4.32 K $\Omega$
2.0 V.	88%	8.06 K $\Omega$
1.8 V.	87%	11.5 K $\Omega$
1.5 V.	86%	24.3 K $\Omega$
1.2 V.	84%	Open

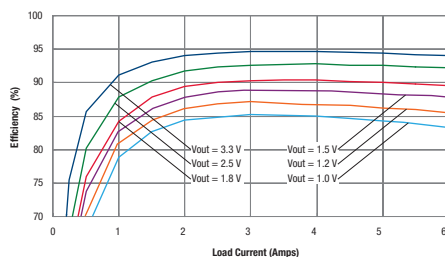
I<sub>out</sub>=5 Amps

## EFFICIENCY VS. OUTPUT VOLTAGE AND LOAD CURRENT @ 25°C

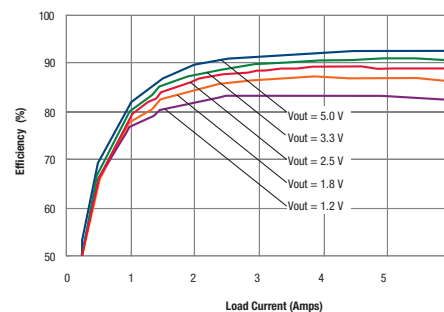
### MPDTH03050W (Vin = 3.3V)



### MPDTH05050W (Vin = 5V)



### MPDTH12050W (Vin = 12V)



## OUTPUT VOLTAGE ADJUSTMENT

The output voltage may be adjusted over a limited range by connecting an external trim resistor (Rset) between the VoutAdjust (trim) pin and Ground. The Rset resistor must be a 1/10 Watt precision metal film type,  $\pm 1\%$  accuracy or lower with low temperature coefficient,  $\pm 100$  ppm/°C. or better. Mount the resistor close to the converter with short leads.

In the tables below, the calculated resistance is given and an equivalent using two series-connected standard value resistors. Do not exceed the specified limits of the output voltage or the converter's maximum power rating when applying these resistors. Also, avoid high noise at the VoutAdjust input. However, you should never connect any capacitors to VoutAdjust to either Ground or Vout to prevent instability.

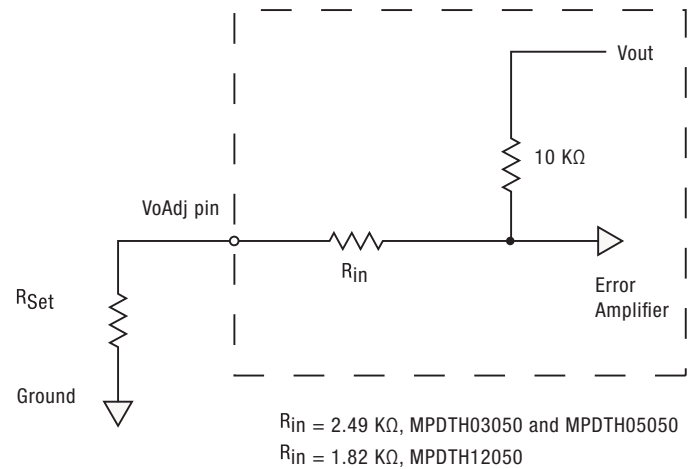


Figure 2. Vout Adjust Input Circuit

### MPDTH03050WAS/WAH

Output Voltage	Calculated Rset (KΩ)	Standard value resistors
2.5 V.	2.22	2 KΩ + 220 Ω
2.0 V.	4.18	3.9 KΩ + 270 Ω
1.8 V.	5.51	5.1 KΩ + 390 Ω
1.5 V.	8.94	8.2 KΩ + 750 Ω
1.2 V.	17.5	16 KΩ + 1.5 KΩ
1.0 V.	37.5	36 KΩ + 1.5 KΩ
0.8 V.	∞	Open

$$R_{set} \text{ (K}\Omega\text{)} = 10 \text{ K}\Omega \times \frac{0.8\text{V}}{V_{out} - 0.8\text{V}} - 2.49 \text{ K}\Omega$$

### MPDTH05050WAS/WAH

Output Voltage	Calculated Rset (KΩ)	Standard value resistors
3.3 V.	0.71	680 Ω + 30 Ω
2.5 V.	2.22	2 KΩ + 220 Ω
2.0 V.	4.18	3.9 KΩ + 270 Ω
1.8 V.	5.51	5.1 KΩ + 390 Ω
1.5 V.	8.94	8.2 KΩ + 750 Ω
1.2 V.	17.5	16 KΩ + 1.5 KΩ
1.0 V.	37.5	36 KΩ + 1.5 KΩ
0.8 V.	∞	Open

$$R_{set} \text{ (K}\Omega\text{)} = 10 \text{ K}\Omega \times \frac{0.8\text{V}}{V_{out} - 0.8\text{V}} - 2.49 \text{ K}\Omega$$

### MPDTH12050WAS/WAH

Output Voltage	Calculated Rset (KΩ)	Standard value resistors
5.0 V.	0.29	270 Ω + 20 Ω
3.3 V.	1.99	2 KΩ
2.5 V.	4.33	4.3 KΩ + 30 Ω
2.0 V.	8.18	7.5 KΩ + 680 Ω
1.8 V.	11.51	11 KΩ + 510 Ω
1.5 V.	24.85	24 KΩ + 820 Ω
1.2 V.	∞	Open

$$R_{set} \text{ (K}\Omega\text{)} = 10 \text{ K}\Omega \times \frac{0.8\text{V}}{V_{out} - 1.2\text{V}} - 1.82 \text{ K}\Omega$$

**APPLICATION NOTES****Tracking Input**

When enabled, the tracking function allows the output to follow an external analog signal presented at the Tracking input. This pin becomes active approximately 50 mS after the input voltage has been applied and the converter reaches regulation. External track inputs must be referred to Ground. Several converters may be Tracked in parallel to generate outputs which rise and fall together.

The Tracking input range is zero Volts up to the nominal set-point output voltage. If the Tracking input rises above the Vout nominal voltage, Vout will remain at the set point after the power up ramp. If Track is unused, it should be connected to +Vin.

Please note that because of the Under Voltage input lockout feature (UVLO), the output cannot follow Track In during power up.

**Over-Current Output Protection**

If excess current is drawn from the converter, the output will shut down and then periodically attempt to restart with narrow full power cycles. If the excess load is reduced to within the rated maximum load, the converter will immediately restart and operate normally. If the load is still too great, another power-down cycle will begin. This is called "hiccup" operation. It significantly reduces the output power to avoid damage. The converter will quickly and automatically recover once the load is reduced.

**Pre-Bias Operation**

The MPDTHxx050 series of converters use synchronous rectification in their output circuits. Normally, synchronous rectification may cause excess current being sunk back in to the converter if there is higher external output

voltage present. If such prebias voltage is present on the output at the time of startup, the converter will operate in a manner which avoids excessive reverse current being sourced back into the output. This pre-bias protection will continue until the converter achieves normal regulation at its set-point output voltage.

In order to achieve successful pre-bias voltage protection, several conditions must be met:

[1] The pre-bias voltage must be lower than the expected final set-point output voltage. If the pre-bias voltage remains higher than the set-point and is capable of back-driving excess current, possible output damage may occur. If the pre-bias voltage has high impedance or has very limited current capability, normal startup will proceed.

[2] Tracking operation must not be used during pre-bias startup. The Tracking input should be either open or connected to Vin so that normal soft start will proceed. After successful startup of approximately 50 mSec, Tracking may be resumed.

[3] Carefully examine any output circuits with large external output capacitors and low-ESR. If there is no bleeder circuit or other method to reduce the stored voltage AND the cap voltage is higher than the expected set-point, operation may fail or the output may be damaged. Smaller capacitors with lower energy storage should not interfere with startup. See the recommended Connection Diagram. Use only as much output capacitance as needed.

Also be careful immediately turning the converter back on after the Inhibit control turns the converter off. Any energy stored in larger output capacitors may cause the problems described above.



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