muRata Ps
Murata Power Solutions

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 94% typical
- Tracking input for sequenced startup/shutdown
- Sense input for load accuracy compensation
- 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, margin controls 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. Margin controls provide a fixed step to the output voltage either 5% up or down. 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.
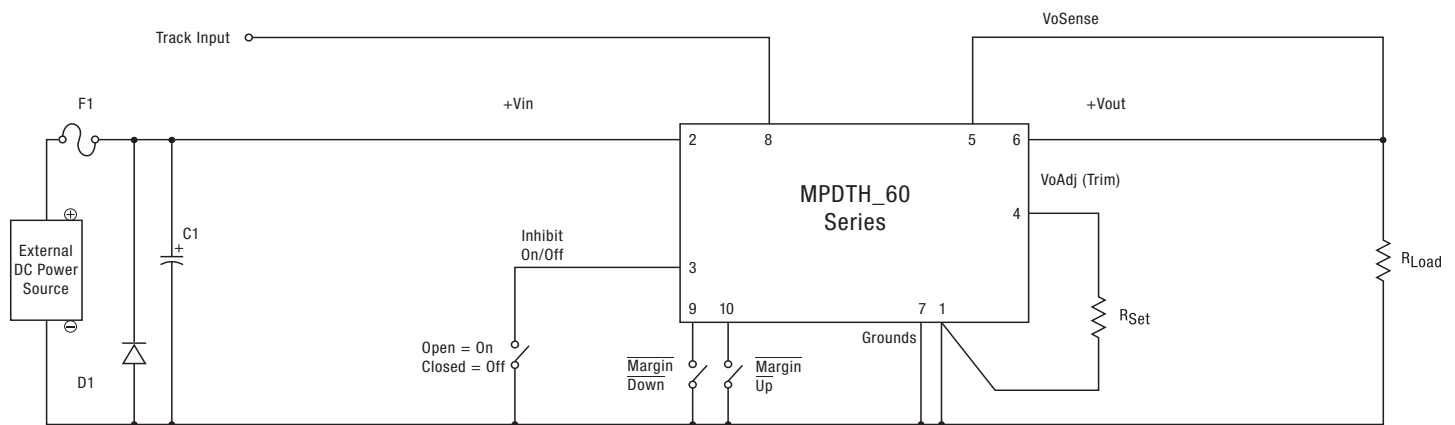

Figure 1. Connection Diagram

Notes:
1. Murata Power Solutions strongly recommends an external fuse, F1. Fuse rating = 2 x Iin max.
2. Consider using diode D1 to blow the fuse in case of reversed polarity.
3.   C1: 330μF/25V, aluminum electrolytic capacitor, required for MPDTH03060, 05060 models.
     C1: 560μF/25V, aluminum electrolytic capacitor, required for MPDTH12060 models.
4. Track input is referred to ground.
5. See trim information for R_{Set}.

SPECIFICATION SUMMARY AND ORDERING GUIDE ①

| Model Number | Output | | | | | | Input (9) | | Efficiency | Package | | |
	Vout (Volts)	Iout (Amps, max.)	Power (Watts)	Ripple&Noise (mV pk-pk)	Regulation Line	Regulation Load	Vin nom. (Volts)	Range (Volts)	(%)	Case(inches)	Case(mm)	Type(2)
MPDTH03060WAH	0.8-2.5	10	25	25(6)	±1.25%	±1.5%	3.3	3-3.6	93(3)	0.995x0.62x0.35	25.27x15.75x9.0	TH
MPDTH03060WAS	0.8-2.5	10	25	25(6)	±1.25%	±1.5%	3.3	3-3.6	93(3)	0.995x0.62x0.38	25.27x15.75x9.57	SM
MPDTH05060WAH	0.8-3.6	10	36	25(7)	±1.25%	±1.5%	5.0	4.5-5.5	94(4)	0.995x0.62x0.35	25.27x15.75x9.0	TH
MPDTH05060WAS	0.8-3.6	10	36	25(7)	±1.25%	±1.5%	5.0	4.5-5.5	94(4)	0.995x0.62x0.38	25.27x15.75x9.57	SM
MPDTH12060WAH	1.2-5.5	10	55	33(8)	±1.25%	±1.5%	12.0	10.8-13.2	94(5)	0.995x0.62x0.35	25.27x15.75x9.0	TH
MPDTH12060WAS	1.2-5.5	10	55	33(8)	±1.25%	±1.5%	12.0	10.8-13.2	94(5)	0.995x0.62x0.38	25.27x15.75x9.57	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=7A

④ Vin=5V, Vout=3.3V, Iout=7A

⑤ Vin=12V, Vout=5V, Iout=8A

⑥ Vin=3.3V, Vout=2V, Iout=10A

⑦ Vin=5V, Vout=3.3V, Iout=10A

⑧ Vin=12V, Vout=3.3V, Iout=10A

⑨ The minimum input voltage is +2.95V. Or (Vout + 0.65V.), whichever is greater.

⑩ RoHS6 compliance does not claim EU RoHS exemption 7b (lead in solder).

MPDTH**060 Series Performance and Functional Specifications

All specifications are typical unless noted.

Input

Input Voltage Range	See Ordering Guide
Start-Up Voltage	2.45 Volts (MPDTH03060) 4.3 Volts (MPDTH05060) 9.5 Volts (MPDTH12060)
Undervoltage Shutdown	2.4 Volts (MPDTH03060) 3.7 Volts (MPDTH05060) 9.0 Volts (MPDTH12060)
External Input Capacitor (See note 3)	330 μF, required (MPDTH03060 and MPDTH05060) 560 μF required (MPDTH12060)
Remote On/Off Inhibit Control Positive Logic Current	OFF = -0.2V to +0.5 V max. or ground pin ON = open pin (internal pullup) -130 μA [5]
Tracking Input Current when grounded Slew rate Tracking Input Range	 -130 μA 1 Volt per mSec max. -0.3V to (+Vin + 0.3V)
Margin Controls	-5% or +5% adjustment of Vout when the respective margin control is grounded. Current, -8 μA sink.

Output

Minimum Loading	No minimum load
Nominal Accuracy	±2 % max. of Vsetting
Voltage Adjustment Range	See Ordering Guide
Temperature Coefficient	±40 ppm. per °C. of Vout
Ripple/Noise	See Ordering Guide

Line/Load Regulation	See Ordering Guide
Efficiency	See Ordering Guide
Maximum Capacitive Loading	
Cap-ESR>=0.004 Ohms Cap-ESR <0.004 Ohms	5,500 μF non-ceramic [2] 300 μF ceramic
Current Limit Inception	20 Amps
Short Circuit Mode	
Protection Method Short Circuit Duration	Autorecovery after overload removal Continuous, no damage (output shorted to ground)
Sequencing	Start-up of multiple units may be synchronized by connecting tracking pins.
VoSense Input	Connect Sense to Vout remotely at the load for optimal accuracy. If not used at the load, connect VoSense to Vout at the converter.

Dynamic Characteristics

Dynamic Load Response	70 μSec to within ±2% of final value (50 to 100% load step, 1A/μSec load step, 330 μF external output cap)
Switching Frequency	300 KHz (MPDTH03060 and MPDTH05060) 350 KHz (MPDTH12060)

Environmental

|	
Calculated MTBF [4]	6 million hours,min. (MPDTH03060 and MPDTH03060) 5.9 million hours,min. (MPDTH12060)
Operating Temperature Range	-40 to +85 deg.C.
Storage Temperature Range	-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 MPDTH12060, the required input capacitor is 560 μF. See note 3.

(2) An external output capacitor is not required. However, a 330 μF output capacitor improves transient response.

(3) The required input capacitor must have a ripple current rating of 500 mA RMS or greater for models MPDTH03060 and MPDTH05060. For model MPDTH12060, the ripple rating must be 1050 mA RMS or greater.

(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.

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MECHANICAL SPECIFICATIONS

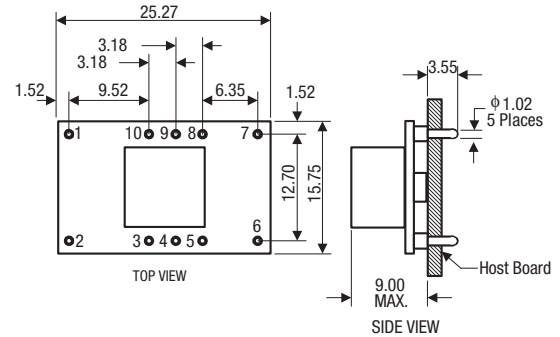### Surface Mount Models MPDTH_WAS
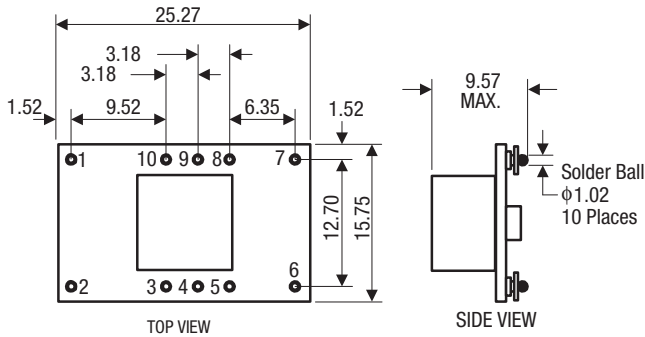
Dimensions are in mm.

Third Angle Projection
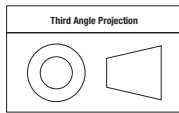
Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2°

Components are shown for reference only.

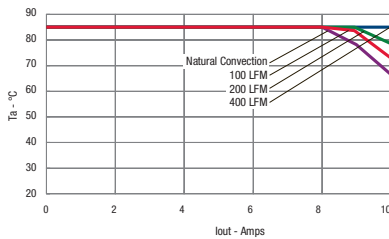### Through-hole Pins Models MPDTH_WAH

Dimensions are in millimeters.

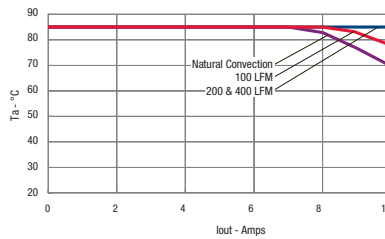| PIN NUMBER AND FUNCTION			
Pin	Function	Pin	Function
1	Ground	6	Output (Vout)
2	Input (Vin)	7	Ground
3	Inhibit remote On/Off control	8	Track Input
4	Vout Adjust (trim)	9	Margin Down Input
5	Vout Sense	10	Margin Up Input

MAXIMUM SAFE OPERATING AREA (DERATING)
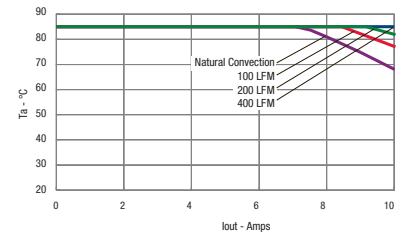
MPDTH03060

Vout = 2.5V

Units soldered to a 4" x 4" 4-layer PCB
with 1 oz. copper.
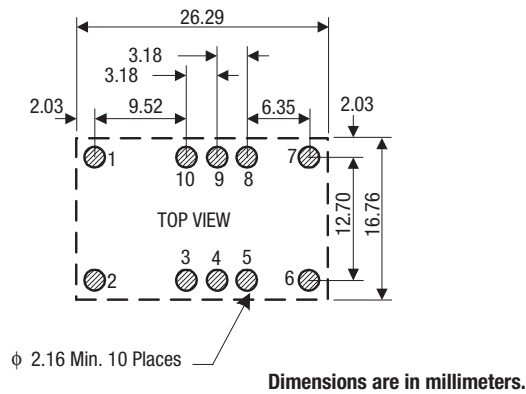
MPDTH05060

Vout = 3.3V

MPDTH12060

Vout = 5.0V

PRINTED CIRCUIT LAYOUT PATTERN RECOMMENDATION

Surface Mount Models MPDTH_WAS

26.29
3.18
3.18
2.03
9.52
6.35
2.03

12.70
16.76

TOP VIEW

φ 2.16 Min. 10 Places

Dimensions are in millimeters.

Through-hole Pins Models MPDTH_WAH

26.29
3.18
3.18
2.03
9.52
6.35
2.03

12.70
16.76

TOP VIEW

φ 1.40 Min. 10 Places
Plated through holes

Dimensions are in millimeters.
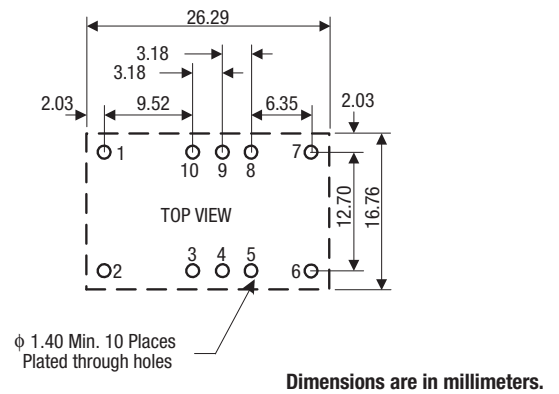
EFFICIENCY VS. OUTPUT VOLTAGE

Models MPDTH03060WAS/WAH		
Vout	Efficiency (typ.)	Rset Trim Resistor
2.5 V.	93%	2.21 KΩ
2.0 V.	92%	4.12 KΩ
1.8 V.	91%	5.49 KΩ
1.5 V.	89%	8.87 KΩ
1.2 V.	87%	17.4 KΩ
1.0 V.	85%	36.5 KΩ
Iout=7 Amps		

Models MPDTH05060WAS/WAH		
Vout	Efficiency (typ.)	Rset Trim Resistor
3.3 V.	94%	698 Ω
2.5 V.	92%	2.21 KΩ
2.0 V.	91%	4.12 KΩ
1.8 V.	90%	5.49 KΩ
1.5 V.	89%	8.87 KΩ
1.2 V.	86%	17.4 KΩ
1.0 V.	85%	36.5 KΩ
Iout=7 Amps		

Models MPDTH12060WAS/WAH		
Vout	Efficiency (typ.)	Rset Trim Resistor
5.0 V.	94%	280 Ω
3.3 V.	92%	2.0 KΩ
2.5 V.	90%	4.32 KΩ
2.0 V.	88%	8.06 KΩ
1.8 V.	87%	11.5 KΩ
1.5 V.	85%	24.3 KΩ
1.2 V.	83%	Open
Iout=8 Amps		

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

MPDTH03060W (Vin = 3.3V)

Efficiency (%)

Load Current (Amps)

Vout = 2.5 V
Vout = 1.8 V
Vout = 1.2 V
Vout = 1.0 V

MPDTH05060W (Vin = 5V)

Efficiency (%)

Load Current (Amps)

Vout = 3.3 V
Vout = 2.5 V
Vout = 1.8 V
Vout = 1.2 V

MPDTH12060W (Vin = 12V)

Efficiency (%)

Load Current (Amps)
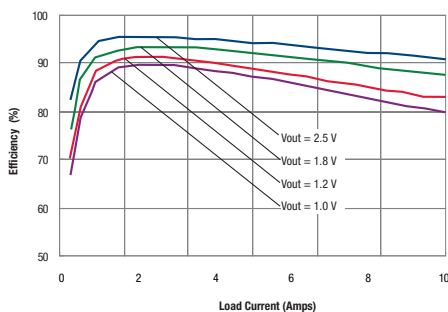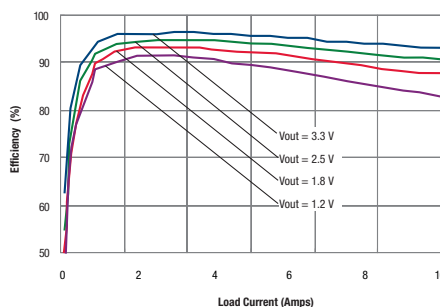
Vout = 5.0 V
Vout = 3.3 V
Vout = 2.5 V
Vout = 1.8 V
Vout = 1.2 V
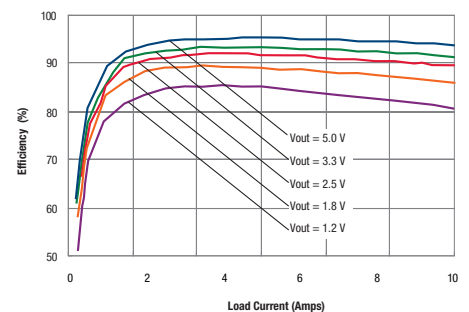
OUTPUT VOLTAGE ADJUSTMENT

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, ±1% accuracy or lower with low temperature coefficient, ±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.
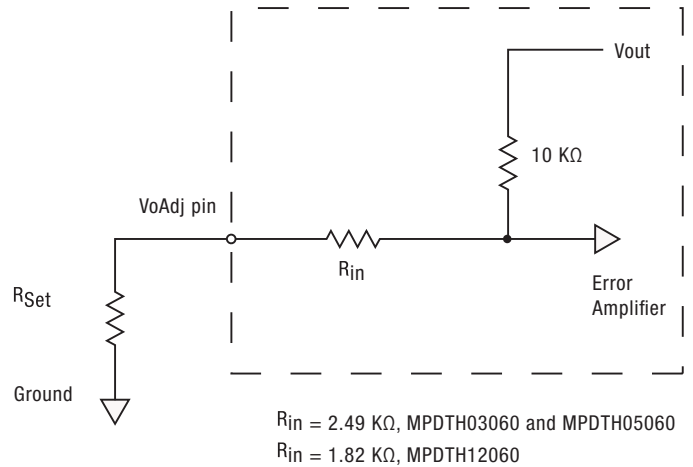

R_{in} = 2.49 KΩ, MPDTH03060 and MPDTH05060
R_{in} = 1.82 KΩ, MPDTH12060

Figure 2. Vout Adjust Input Circuit

MPDTH03060WAS/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

$$\text{Rset (K}\Omega) = 10 \text{ K}\Omega \times \frac{0.8V}{Vout - 0.8V} - 2.49 \text{ K}\Omega$$

MPDTH05060WAS/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

$$\text{Rset (K}\Omega) = 10 \text{ K}\Omega \times \frac{0.8V}{Vout - 0.8V} - 2.49 \text{ K}\Omega$$

MPDTH12060WAS/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

$$\text{Rset (K}\Omega) = 10 \text{ K}\Omega \times \frac{0.8V}{Vout - 1.2V} - 1.82 \text{ K}\Omega$$

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 MPDTHxx060 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 sunk 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.

Margin Up/Down Controls

Ground each Margin control to increase or decrease the output voltage by ±5% from its setpoint value. If not needed, leave the margin controls unconnected (open).

The margin controls are analog inputs and are not logic compatible. If a switch is not used to ground, a small signal transistor (such as an n-channel MOSFET with low off-state leakage) will work if biased fully into either pinchoff/cutoff or saturation. Sink current is approximately -8 µA when ON and the open circuit voltage is approximately 0.8 Volts when OFF. Do not ground both margin controls simultaneously.

For output changes less than ±5%, insert an additional resistor in series with the switch or transistor to ground. The margin adjustment equation is:

R-up or R-down (in KΩ) = (499 / delta%) – 99.8

Where "delta%" is the desired change in percent of Vout up or down relative to the set-point output. Be sure to use low tempco precision resistors.

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