PP42 *Revised August 1996*

OUTPUT VOLTAGE TRIMMING
PD SERIES

Overview

PD150 series DC-to-DC converters allow for output voltage trimming external to the converter. Table 1 shows the factory preset voltage and the voltage ranges available if it is necessary to trim the output voltage. If the factory preset voltage is acceptable for your application, leave the trim pin unconnected. There are two ways to trim the output voltage: (1) with resistors connected between the sense pins and the trim pin, or (2) with a voltage or current source connected to the trim pin.

Although most of the text in this Power Page describes trimming methods for PD150 converters, all of the discussion is valid for Model PD300 (a 300 watt DC-to-DC converter) as well.

Nominal Output	Factory Preset Output Voltage	Output Voltage Trim Range
3.3V	3.3 ± 0.03V	3.25V – 4.5V
5.0V	5.0 ± 0.05V	3.25V – 5.5V
12.0V	12.0 ± 0.12V	7.8 V – 13.2V
15.0V	15.0 ± 0.15V	9.75V – 16.5V
24.0V	24.0 ± 0.24V	15.6 V – 26.4V
28.0V	28.0 ± 0.28V	18.2 V – 30.8V

Table 1. Output Voltage Trim Range

Output Trim Procedure Using Resistors

The output voltage can be trimmed by either (1) using a single fixed resistor for fixed output voltage trim or (2) using a potentiometer and two resistors for variable output voltage trim.

Fixed Output Voltage Trim: The output voltage is trimmed by using one external resistor – either R1 (Figure 1) for obtaining voltage higher than factory preset voltage (Trim-Up) or R2 for obtaining voltage lower than factory preset voltage (Trim-Down).

To Trim Up, R1 is determined by the equation:

$$(1)\quad R1 = \frac{4{,}000 V_{OUT}(V_{NOM} - 2.5)}{V_{OUT} - V_{NOM}}\ \Omega$$

R2 = Open

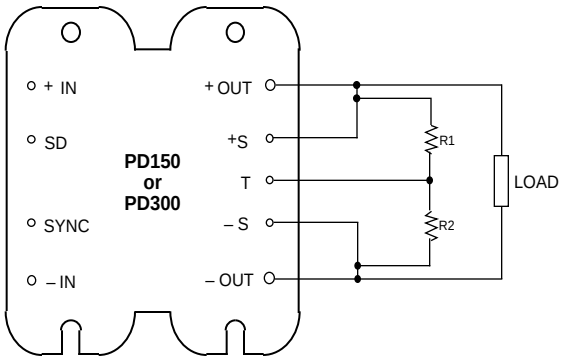

Figure 1. Fixed Output Voltage Trim

Where: V_{OUT} = Desired output voltage
V_{NOM} = Factory set output voltage

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Output Trim Procedure Using Resistors (Continued)

Example 1: Trim up 5 volts to 5.2 volts

$$V_{OUT} = 5.2V$$
$$V_{NOM} = 5.0V$$

$$R1 = \frac{4000 \times 5.2 \times (5.0 - 2.5)}{5.2 - 5.0} \ \Omega$$

$$R1 = 260K\Omega$$

Connect R1 from the positive sense (+S) to trim pin (T). Make sure that the resistor is connected to the positive sense pin and **not** the positive output pin. If the resistor is connected to the positive output pin, the drops in the positive output lead as a function of load will cause problems with load regulation.

Table 2 provides trim-up values for the R1 resistor for different output voltage models at various trim-up percentages.

To Trim Down, R2 is determined by the equation:

$$(2)\ R2 = \frac{10{,}000 \times V_{OUT}}{V_{NOM} - V_{OUT}} \ \Omega$$

R1 = Open

Example 2: Trim down 12 volts to 9.0 volts

$$V_{OUT} = 9.0V$$
$$V_{NOM} = 12.0V$$

$$R2 = \frac{10{,}000 \times 9.0}{12.0 - 9.0} \ \Omega$$

$$R2 = 30K\Omega$$

Trim-up Percent	For Nominal Output Voltage (V_{NOM})*					
	3.3	5.0	12	15	24	28
+2%	163K	510K	1.94M	2.55M	4.39M	5.20M
+4%	83.2K	260K	988K	1.30M	2.24M	2.65M
+5%	67.2K	210K	798K	1.05M	1.81M	2.14M
+6%	56.5K	177K	671K	883K	1.52M	1.80M
+8%	43.2K	135K	513K	675K	1.16M	1.38M
+10%	35.2K	110K	418K	550K	946K	1.12M

*All values in Ohms (KΩ or MΩ).

Table 2. Trim-up Values for R1 (R2=Open)

Connect R2 from the negative sense (–S) to the trim pin (T). Make sure that the resistor is connected to the negative sense pin and **not** the negative output pin. If the resistor is connected to the negative output pin, the drops in the negative output lead as a function of load will cause problems with load regulation.

Table 3 provides trim down values for R2 resistors at various trim down percentages. Note that for a given percentage of trim down the value of R2 is independent of output voltage.

Trim-down Percent	Resistor R2
–35%	18.6KΩ
–30%	23.3KΩ
–25%	30.0KΩ
–20%	40.0KΩ
–15%	56.7KΩ
–10%	90.0KΩ
–5%	190.0KΩ

Table 3. Trim-down Values for R2 (R1=Open) All Output Voltages

Output Trim Procedure Using Resistors (Continued)

Variable Output Voltage Trim: The output voltage is trimmed by using a potentiometer R4 and two fixed resistors R3 and R5 (Figure 2). The values of resistors R3 and R5 are determined by the equations:

$$(3)\quad R5 = \frac{R4 \times V_{LO}}{V_{NOM} - V_{LO}} \quad \Omega$$

$$(4)\quad R3 = \frac{R4 \times [V_{NOM}\,(4000V_{HI} + R5) - V_{HI}\,(10{,}000 + R5)]}{V_{HI}\,(10{,}000 + R4 + R5) - V_{NOM}\,(R4 + R5)}$$

Where: V_{LO} = Desired output voltage Lower limit

V_{HI} = Desired output voltage Upper Limit

V_{NOM} = Factory set output voltage

Example 3: 12 volt output module, adjustable from 9.0 volts (–25%) to 13.2 volts (+10%).

For this example we selected a potentiometer of 10KΩ for R4.

First, value of R5 is calculated by using equation 3 above.

$$R5 = \frac{10{,}000 \times 9.0}{12.0 - 9.0} \quad \Omega$$

$$R5 = 30K\Omega$$

The value of resistor R3 is calculated by using equation 4 and substituting 10,000 for R4, and 30,000 for R5.

$$R3 = \frac{R4 \times [V_{NOM}\,(4000V_{HI} + R5) - V_{HI}\,(10{,}000 + R5)]}{V_{HI}\,(10{,}000 + R4 + R5) - V_{NOM}\,(R4 + R5)}$$

$$(4)\quad R3 = \frac{10{,}000 \times [9993.6 - 528]}{660 - 480} \quad \Omega$$

$$R3 = 25.87K\Omega$$

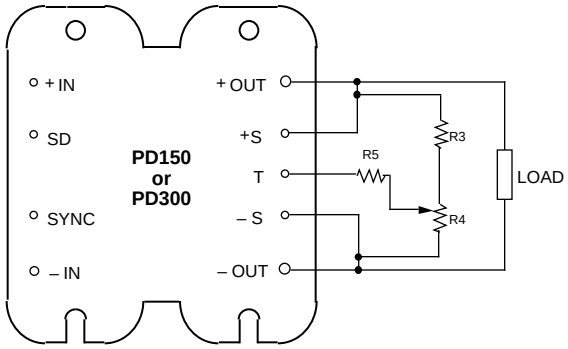

Figure 2. Variable Ouput Voltage Trim

Again note that resistor R3 should be connected to positive sense pin (+S) and **not** to positive output pin. Also potentiometer is connected to negative sense pin (–S) and **not** negative output pin**.**

To trim the converter from a low of –5% to –35% to a high of +10%, Table 4 (see page 4) provides the values of resistors R3 and R5. For normal ouput of 5V or less, the R4 (potentiometer) of 1KΩ value is recommended.

Note that for a given percentage of trim down, the value of R5 is independent of output voltage and varies in direct proportion to the value of the potentiometer (see Equation 3).

Powercube offers a computer disk, **free of charge**, which will calculate the trim resistors for your application. Call 1-800-866-3590 for your copy.

Output Trim Procedure Using a Voltage or Current Source:

By varying the voltage of the trim pin, the output voltage of the module is varied accordingly. The trim pin has an open circuit voltage of +2.5V (referenced to –S), and an output resistance of 10KΩ. Adjusting the voltage of the trim pin to 65% of 2.5V (1.625V) will cause the output voltage to be reduced to 65% of its nominal voltage. Likewise, adjusting the voltage of

R4 = 10KΩ

Trim Range Percent	R5 (KΩ) All Outputs	R3 (KΩ) For Nominal Output Voltage (V_{NOM})			
		12	15	24	28
-35% to +10%	18.6	28.8	38.3	66.9	79.6
-30% to +10%	23.3	27.5	36.7	64.4	76.7
-25% to +10%	30.0	25.9	34.7	61.1	72.8
-20% to +10%	40.0	23.6	31.9	56.6	67.6
-15% to +10%	56.7	20.5	27.9	50.3	60.3
-10% to +10%	90.0	15.6	21.9	40.8	49.1
- 5% to +10%	190.0	7.35	11.6	24.4	30.1

R4 = 1KΩ

R5 (KΩ) All Outputs	R3 (Ohms) (V_{NOM})	
	3.3	5.0
1.86	NT	958
2.33	NT	950
3.00	NT	939
4.00	NT	922
5.67	NT	894
9.00	NT	842
19.00	125	700

NT = Not Trimmable

Table 4. Resistor Values of Trim Resistor R3, R4 (Potentiometer) and R5

Variable Output Voltage Trim
(Trim-up: +10% Trim-down: –5% to –35%)

the trim pin to 110% of 2.5V (2.75V) will cause the output voltage to be increased to 110% of its nominal voltage. Exceeding 2.75V on the trim pin may cause the overvoltage protection circuitry to be activated.

Here are a few things to remember when using the trim capabilities of these modules:

1. All of the converters have a fixed current limit. As the output voltage is trimmed down, the current limit set point remains the same. Therefore, if the unit is trimmed down, available output power is reduced accordingly.

2. Do not attempt to trim the modules higher than 110% of nominal output, or the overvoltage protect circuit may activate.

3. Do not exceed the maximum rated output power when the module is trimmed up.

4. Do not attempt to trim the module lower than the range shown in Table 1, or the output voltage may become unstable under certain line, load and temperature conditions.

5. As the output is trimmed down, input voltage range widens, efficiency goes down and output ripple as a percentage of output voltage goes up. When the ouput is trimmed up, the input voltage range is reduced, efficiency goes up, and output ripple as a percentage of ouput voltage goes down. As a general rule, select the converter module with a factory preset output voltage closest to the desired trimmed voltage in order to maximize electrical performance.

6. The resistors used for trimming should be stable over temperature and after aging. Metal film resistors with a temperature coefficient of 50 PPM are often the best choice. Do not use carbon composition resistors as their values change up to ± 20% over time.

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