



NOMINAL SIZE = 0.87 in x 0.5 in
(22,1 mm x 12,57 mm)

Features

- Up to 6-A Output Current
- 3.3-V Input Voltage
- Wide-Output Voltage Adjust (0.8 V to 2.5 V)
- Efficiencies up to 94 %
- 103 W/in³ Power Density
- On/Off Inhibit
- Pre-Bias Startup
- Under-Voltage Lockout
- Operating Temp: -40 to +85 °C
- Auto-Track™ Sequencing
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- IPC Lead Free 2
- Safety Agency Approvals: UL 1950, CSA 22.2 950, EN60950 VDE (Pending)
- Point-of-Load Alliance (POLA) Compatible

Description

The PTH03050 is one of the smallest non-isolated power modules from Texas Instruments that features Auto-Track™. Auto-Track simplifies supply voltage sequencing in power systems by enabling modules to track each other, or any other external voltage, during power up and power down.

Although small in size (0.87 in × 0.5 in), these modules are rated for up to 6 A of output current, and are an ideal choice in applications where space, performance, and a power-up sequencing capability are important attributes.

The product provides high-performance step-down conversion from a 3.3-V input bus voltage. The output voltage of the PTH03050W can be set to any voltage

over the range, 0.8 V to 2.5 V, using a single resistor.

Other operating features include an on/off inhibit, output voltage adjust (trim), and output over-current protection. For high efficiency these parts employ a synchronous rectifier output stage, but a pre-bias hold-off capability ensures that the output will not sink current during startup.

Target applications include telecom, industrial, and general purpose circuits, including low-power dual-voltage systems that use a DSP, microprocessor, ASIC, or FPGA.

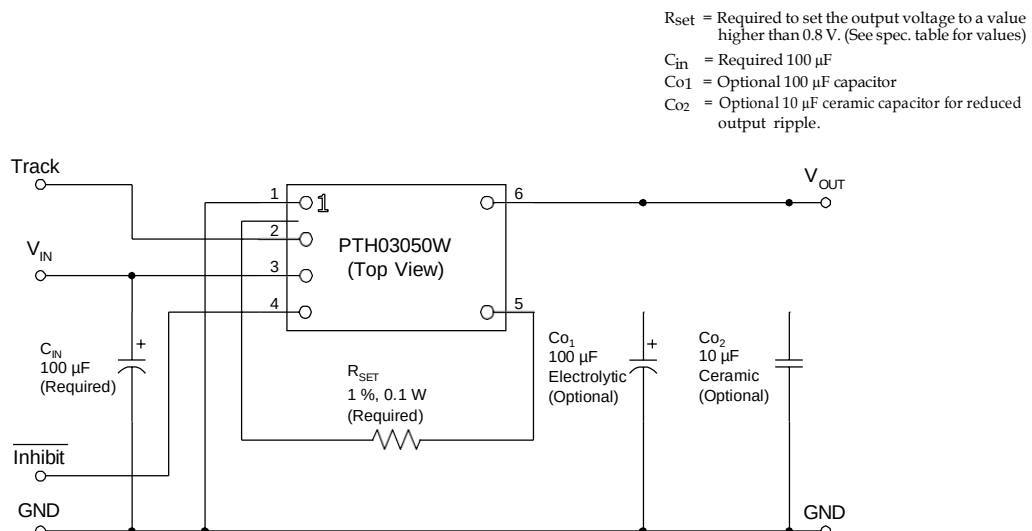
Package options include both through-hole and surface mount configurations.

Pin Configuration

Pin	Function
1	GND
2	Track
3	V _{IN}
4	Inhibit *
5	V _O Adjust
6	V _{OUT}

* Denotes negative logic:
Open = Normal operation
Ground = Function active

Standard Application



Ordering Information

Output Voltage (PTH03050 xx)		Package Options (PTH03050x) ⁽¹⁾		
Code	Voltage	Code	Description	Pkg Ref. ⁽²⁾
W	0.8 V – 2.5 V (Adjust)	AH	Horiz. T/H	(EUU)
		AS	SMD, Standard ⁽³⁾	(EUV)

Notes: (1) Add "T" to end of part number for tape and reel on SMD packages only.

(2) Reference the applicable package reference drawing for the dimensions and PC board layout

(3) "Standard" option specifies 63/37, Sn/Pb pin solder material.

Pin Descriptions

Vin: The positive input voltage power node to the module, which is referenced to common *GND*.

Vout: The regulated positive power output with respect to the *GND* node.

GND: This is the common ground connection for the *Vin* and *Vout* power connections. It is also the 0 VDC reference for the control inputs.

Vo Adjust: A 0.1 W 1 % resistor must be directly connected between this pin and *GND* to set the output voltage to a value higher than 0.8 V. The temperature stability of the resistor should be 100 ppm/°C (or better). The set-point range for the output voltage is from 0.8 V to 2.5 V. The resistor value required for a given output voltage may be calculated from the following formula. If this pin is left open circuit, the output voltage will default to its lowest value. For further information on output voltage adjustment consult the related application note.

$$R_{\text{set}} = 10 \text{ k}\Omega \cdot \frac{0.8 \text{ V}}{V_{\text{out}} - 0.8 \text{ V}} - 2.49 \text{ k}\Omega$$

The specification table gives the preferred resistor values for a number of standard output voltages.

Inhibit: The Inhibit pin is an open-collector/drain negative logic input that is referenced to *GND*. Applying a low-level ground signal to this input disables the module's output and turns off the output voltage. When the *Inhibit* control is active, the input current drawn by the regulator is significantly reduced. If the *Inhibit* pin is left open-circuit, the module will produce an output whenever a valid input source is applied.

Track: This is an analog control input that enables the output voltage to follow an external voltage. This pin becomes active typically 20 ms after the input voltage has been applied, and allows direct control of the output voltage from 0 V up to the nominal set-point voltage. Within this range the output will follow the voltage at the *Track* pin on a volt-for-volt basis. When the control voltage is raised above this range, the module regulates at its set-point voltage. The feature allows the output voltage to rise simultaneously with other modules powered from the same input bus. If unused, the input should be connected to *Vin*. *Note:* Due to the under-voltage lockout feature, the output of the module cannot follow its own input voltage during power up. For more information, consult the related application note.

Environmental & Absolute Maximum Ratings (Voltages are with respect to GND)

Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Track Input Voltage	V_{track}		-0.3	—	$V_{\text{in}} + 0.3$	V
Operating Temperature Range	T_a	Over V_{in} Range	-40 (i)	—	8	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 (ii)	°C
Storage Temperature	T_s	—	-40	—	125	°C
Mechanical Shock		Per Mil-STD-883D, Method 2002.3 1 msec, ½ Sine, mounted	—	500	—	G's
Mechanical Vibration		Mil-STD-883D, Method 2007.2 20-2000 Hz	—	20	—	G's
Weight	—		—	2.9	—	grams
Flammability	—	Meets UL 94V-O				

Notes: (i) For operation below 0 °C the external capacitors must have stable characteristics, use either a low ESR tantalum, Os-Con, or ceramic capacitor.
(ii) During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum.

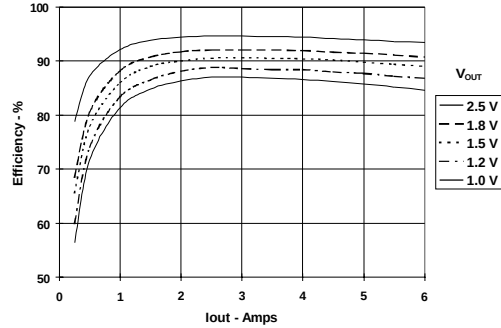
Specifications (Unless otherwise stated, $T_a = 25$ °C, $V_{\text{in}} = 3.3$ V, $V_o = 2.5$ V, $C_{\text{in}} = 100$ µF, $C_{o1} = 0$ µF, $C_{o2} = 0$ µF, and $I_o = I_{o\text{max}}$)

Characteristics	Symbols	Conditions	PTH03050W			Units
			Min	Typ	Max	
Output Current	I_o	$0.8 \text{ V} \leq V_o \leq 2.5 \text{ V}$, 85 °C, natural convection	0	—	6 (1)	A
Input Voltage Range	V_{in}	Over I_o range	2.9	—	3.6	V
Set-Point Voltage Tolerance	$V_o \text{ tol}$		—	—	± 2 (2)	% V_o
Temperature Variation	$\Delta \text{Reg}_{\text{temp}}$	-40 °C $< T_a < +85$ °C	—	± 0.5	—	% V_o
Line Regulation	$\Delta \text{Reg}_{\text{line}}$	Over V_{in} range	—	± 10	—	mV
Load Regulation	$\Delta \text{Reg}_{\text{load}}$	Over I_o range	—	± 12	—	mV
Total Output Variation	$\Delta \text{Reg}_{\text{tot}}$	Includes set-point, line, load, -40 °C $\leq T_a \leq +85$ °C	—	—	± 3 (2)	% V_o
Efficiency	η	$I_o = 4$ A $R_{\text{SET}} = 2.21 \text{ k}\Omega$ $V_o = 2.5 \text{ V}$ $R_{\text{SET}} = 4.12 \text{ k}\Omega$ $V_o = 2.0 \text{ V}$ $R_{\text{SET}} = 5.49 \text{ k}\Omega$ $V_o = 1.8 \text{ V}$ $R_{\text{SET}} = 8.87 \text{ k}\Omega$ $V_o = 1.5 \text{ V}$ $R_{\text{SET}} = 17.4 \text{ k}\Omega$ $V_o = 1.2 \text{ V}$ $R_{\text{SET}} = 36.5 \text{ k}\Omega$ $V_o = 1.0 \text{ V}$	— — — — — —	94 92 91 90 88 87	— — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth, $C_{o2} = 10$ µF ceramic	—	20 (3)	—	mVpp
Over-Current Threshold	$I_o \text{ trip}$	Reset, followed by auto-recovery	—	12	—	A
Transient Response	t_{tr} ΔV_{tr}	1 A/µs load step, 50 to 100 % $I_{o\text{max}}$, $C_{o1} = 100$ µF Recovery Time V_o over/undershoot	— —	70 100	— —	µSec mV
Track Input Current (pin 2)	$I_{\text{IL track}}$	Pin to GND	—	—	-130 (4)	µA
Track Slew Rate Capability	dV_{track}/dt	$C_{\text{out}} \leq C_{\text{out(max)}}$	—	—	1	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 2.2	2.4 2.40	2.8 —	V
Inhibit Control (pin4) Input High Voltage Input Low Voltage Input Low Current	V_{IH} V_{IL} $I_{\text{IL inhibit}}$	Referenced to GND Pin to GND	$V_{\text{in}} - 0.2$ — —	— — -130	Open (4) 0.6 —	V µA
Input Standby Current	$I_{\text{in inh}}$	Inhibit (pin 4) to GND, Track (pin 2) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	550	600	650	kHz
External Input Capacitance	C_{in}		100 (5)	—	—	µF
External Output Capacitance	C_{o1}, C_{o2}	Capacitance value	0	100 (6)	3,300 (7)	µF
		non-ceramic	0	—	300	
		ceramic	4 (8)	—	—	mΩ
Reliability	MTBF	Per Bellcore TR-332 50 % stress, $T_a = 40$ °C, ground benign	6	—	—	10 ⁶ Hrs

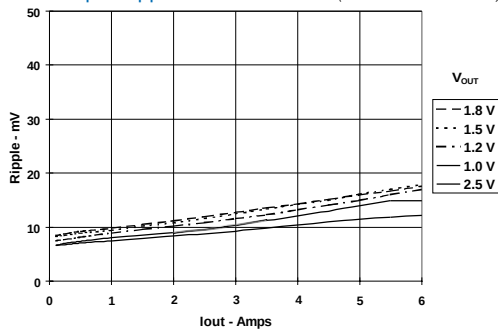
Notes: (1) No derating is required when the module is soldered directly to a 4-layer PCB with 1 oz. copper.
(2) The set-point voltage tolerance is affected by the tolerance and stability of R_{SET} . The stated limit is unconditionally met if R_{SET} has a tolerance of 1 % with 100 ppm/°C or better temperature stability.
(3) The pk-pk output ripple voltage is measured with an external 10 µF ceramic capacitor. See the standard application schematic.
(4) This control pin has an internal pull-up to the input voltage V_{in} . If it is left open-circuit the module will operate when input power is applied. A small low-leakage (<100 nA) MOSFET is recommended for control. For further information, consult the related application note.
(5) A 100 µF input capacitor is required for proper operation. The capacitor must be rated for a minimum of 300 mA rms of ripple current.
(6) An external output capacitor is not required for basic operation. Adding 100 µF of distributed capacitance at the load will improve the transient response.
(7) This is the calculated maximum. The minimum ESR limitation will often result in a lower value. Consult the application notes for further guidance.
(8) This is the typical ESR for all the electrolytic (non-ceramic) output capacitance. Use 7 mΩ as the minimum when using max-ESR values to calculate.

Characteristic Data; $V_{in} = 3.3\text{ V}$ (See Note A)

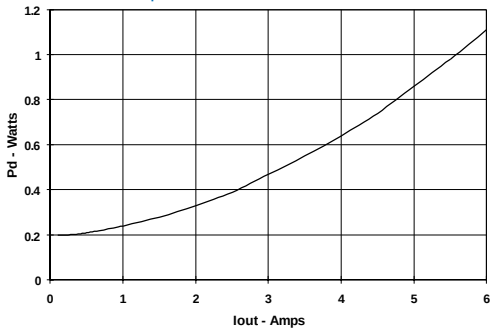
Efficiency vs Load Current



Output Ripple vs Load Current (See Note 3 to Table)



Power Dissipation vs Load Current



Note A: Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the Converter.

Capacitor Recommendations for the PTH03050 & PTH05050 Series of Power Modules

Input Capacitor

The recommended input capacitor(s) is determined by the 100 μF [1] minimum capacitance and 300 mArms minimum ripple current rating.

Ripple current, less than 100 m Ω equivalent series resistance (ESR), and temperature are the major considerations when selecting input capacitors. Unlike polymer tantalum, regular tantalum capacitors have a recommended minimum voltage rating of $2 \times (\text{maximum DC voltage} + \text{AC ripple})$. This is standard practice to ensure reliability.

For improved ripple reduction on the input bus, ceramic capacitors may be used to complement electrolytic types and achieve the minimum required capacitance.

Output Capacitors (Optional)

For applications with load transients (sudden changes in load current), regulator response will benefit from an external output capacitance. The recommended output capacitance of 100 μF will allow the module to meet its transient response specification (see product data sheet). For most applications, a high quality computer-grade aluminum electrolytic capacitor is adequate. These capacitors provide decoupling over the frequency range, 2 kHz to 150 kHz, and are suitable when ambient temperatures above 0 °C. For operation below 0 °C tantalum, ceramic or Os-Con type capacitors are recommended. When using one or more non-ceramic capacitors, the calculated equivalent ESR should be no lower than 4 m Ω (7 m Ω using the manufacturer's maximum ESR for a single capacitor). A list of preferred low-ESR type capacitors are identified in Table 1-1.

Ceramic Capacitors

Above 150 kHz the performance of aluminum electrolytic capacitors becomes less effective. To further improve the reflected input ripple current or the output transient response, multilayer ceramic capacitors can also be added. Ceramic capacitors have very low ESR and their resonant frequency is higher than the bandwidth of the regulator. When used on the output their combined ESR is not critical as long as the total value of ceramic capacitance does not exceed 300 μF . Also, to prevent the formation of local resonances, do not place more than five identical ceramic capacitors in parallel with values of 10 μF or greater.

Tantalum Capacitors

Tantalum type capacitors can be used at both the input and output, and are recommended for applications where the ambient operating temperature can be less than 0 °C. The AVX TPS, Sprague 593D/594/595 and Kemet T495/

T510 capacitor series are suggested over many other tantalum types due to their higher rated surge, power dissipation, and ripple current capability. As a caution many general purpose tantalum capacitors have considerably higher ESR, reduced power dissipation and lower ripple current capability. These capacitors are also less reliable as they have reduced power dissipation and surge current ratings. Tantalum capacitors that do not have a stated ESR or surge current rating are not recommended for power applications.

When specifying Os-Con and polymer tantalum capacitors for the output, the minimum ESR limit will be encountered well before the maximum capacitance value is reached.

Capacitor Table

Table 1-1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The recommended number of capacitors required at both the input and output buses is identified for each capacitor type.

This is not an extensive capacitor list. Capacitors from other vendors are available with comparable specifications. Those listed are for guidance. The RMS ripple current rating and ESR (at 100kHz) are critical parameters necessary to insure both optimum regulator performance and long capacitor life.

Designing for Very Fast Load Transients

The transient response of the DC/DC converter has been characterized using a load transient with a di/dt of 1 A/ μs . The typical voltage deviation for this load transient is given in the data sheet specification table using the optional value of output capacitance. As the di/dt of a transient is increased, the response of a converter's regulation circuit ultimately depends on its output capacitor decoupling network. This is an inherent limitation with any DC/DC converter once the speed of the transient exceeds its bandwidth capability. If the target application specifies a higher di/dt or lower voltage deviation, the requirement can only be met with additional output capacitor decoupling. In these cases special attention must be paid to the type, value and ESR of the capacitors selected.

If the transient performance requirements exceed that specified in the data sheet, or the total amount of load capacitance is above 3,000 μF , the selection of output capacitors becomes more important. For further guidance consult the separate application note, "Selecting Output Capacitors for PTH Products in High-Performance Applications."

Table 1-1: Input/Output Capacitors

Capacitor Vendor, Type Series (Style)	Capacitor Characteristics					Quantity		Vendor Number
	Working Voltage	Value (μF)	Max. (ESR) at 100 kHz	Max. Ripple at 85 °C Current (Irms)	Physical Size (mm)	Input Bus	Output Bus	
Panasonic FC, Aluminum (SMD) WA, Poly-Aluminum (SMD)	25 V 10 V	100 μF 120 μF	0.300 Ω 0.035 Ω	450 mA 2800 mA	8×10 8.3×6.9	1 1	1 ≤5	EEVFC1E101P EEFWA1A121P
Panasonic, Aluminum FC (Radial) FK (SMD)	16 V 16 V	220 μF 330 μF	0.150 Ω 0.160 Ω	555 mA 600 mA	10×10.2 8×10.2	1 1	1 1	EEUFC1C221 EEVFK1C331P
United Chemi-Con FS, Os-con (Radial) PXA, Poly-Alum (SMD) MVZ, Aluminum (SMD) PS, Poly-Alum. (Radial)	10 V 10 V 16 V 10 V	100 μF 120 μF 220 μF 100 μF	0.040 Ω 0.027 Ω 0.170 Ω 0.024 Ω	2100 mA 2430 mA 450 mA 4420 mA	6.3×9.8 8×6.7 8×10 8×11.5	1 1 1 1	≤5 ≤4 1 ≤4	10FS100M PXA10VC121MH80TP MVZ25VC221MH10TP 10PS270MH11
Nichicon, Aluminum WG, Aluminum (SMD) PM, (Radial) F55, Tantalum (SMD)	35 V 25 V 10 V	100 μF 150 μF 100 μF	0.150 Ω 0.160 Ω 0.055 Ω	670 mA 460 mA 2000 mA	10×10 10×11.5 7.7×4.3	1 1 1	1 1 1	UWG1V101MNR1GS UPM1E151MPH F551A107MN
Sanyo SVP, Os-con (SMD) SP, Os-con (Radial) TPE Poscap Polymer (SMD)	10 V 16 V 10 V	120 μF 100 μF 220 μF	0.040 Ω 0.025 Ω 0.025 Ω	>2500 mA >2800 mA >2400mA	7×8 6.3×9.8 7.3×5.7	1 1 1	≤5 ≤4 ≤4	10SVP120M 16SPS100M 10TPE220ML
AVX, Tantalum TPS (SMD)	10 V 10 V	100 μF 220 μF	0.100 Ω 0.100 Ω	>1090 mA >1414 mA	7.3L ×4.3W ×4.1H	1 1	≤5 ≤5	TPSD107M010R0100 TPSV227M010R0100
Kemet T520, Poly-Alum (SMD) T495, Tantalum (SMD) A700-Poly-Alum. (SMD)	10 V 10 V 6.3 V	100 μF 100 μF 100 μF	0.080 Ω 0.100 Ω 0.018 Ω	1200 mA >1100 mA 2900 mA	7.3L ×5.7W ×4.0H	1 1 1	1 1 ≤3	T520D107M010AS T495X107M010AS A700D107M006AT
Vishay-Sprague 594D, Tantalum (SMD) 595D, Tantalum (SMD) 94SA, Os-con (Radial)	10 V 10 V 10 V	150 μF 120 μF 100 μF	0.090 Ω 0.140 Ω 0.030 Ω	1100 mA >1000 mA 2670 mA	7.3L ×6.0W ×4.1H 8×10.5	1 1 1	1 1 ≤4	594D157X0010C2T 595D127X0010D2T 94SA107X0010EBP
Kemet, Ceramic X5R (SMD)	16 V 6.3 V	10 47	0.002 Ω 0.002 Ω	—	1210 case 3225 mm	1 2 [1]	≤5 ≤5	C1210C106M4PAC C1210C476K9PAC
Murata, Ceramic X5R (SMD)	6.3 V 6.3 V 16 V 16 V	100 47 22 10	0.002 Ω	—	1210 case 3225 mm	1 2 [1] 5 1 [2]	≤3 ≤5 ≤5 ≤5	GRM32ER60J107M GRM32ER60J476M GRM32ER61C226K GRM32DR61C106K
TDK, Ceramic X5R (SMD)	6.3 V 6.3 V 16 V 16 V	100 47 22 10	0.002 Ω	—	1210 case 3225 mm	1 2 [1] 5 1 [2]	≤3 ≤5 ≤5 ≤5	C3225X5R0J107MT C3225X5R0J476MT C3225X5R1C226MT C3225X5R1C106MT

[1] Total capacitance of 94 μF is acceptable based on the combined ripple current rating.

[2] Small ceramic capacitors may be used to complement electrolytic types at the input to reduce high-frequency ripple current.

Adjusting the Output Voltage of the PTH03050W & PTH05050W Wide-Output Adjust Power Modules

The V_o Adjust control (pin 5) sets the output voltage to a value higher than 0.8 V. The adjustment range of the PTH03050W (3.3-V input) is from 0.8 V to 2.5 V¹, and the PTH05050W (5-V input) from 0.8 V to 3.6 V. The adjustment method requires the addition of a single external resistor, R_{set} , that must be connected directly between the V_o Adjust and GND pins². Table 2-1 gives the preferred value of the external resistor for a number of standard voltages, along with the actual output voltage that this resistance value provides.

For other output voltages the value of the required resistor can either be calculated using the following formula, or simply selected from the range of values given in Table 2-2. Figure 2-1 shows the placement of the required resistor.

$$R_{set} = 10 \text{ k}\Omega \cdot \frac{0.8 \text{ V}}{V_{out} - 0.8 \text{ V}} - 2.49 \text{ k}\Omega$$

Table 2-1; Preferred Values of R_{set} for Standard Output Voltages

V_{out} (Standard)	R_{set} (Pref'd Value)	V_{out} (Actual)
3.3 V ¹	698 Ω	3.309V
2.5 V	2.21 k Ω	2.502 V
2 V	4.12 k Ω	2.010 V
1.8 V	5.49 k Ω	1.803 V
1.5 V	8.87 k Ω	1.504 V
1.2 V	17.4 k Ω	1.202 V
1 V	36.5 k Ω	1.005 V
0.8 V	Open	0.8 V

Figure 2-1; V_o Adjust Resistor Placement

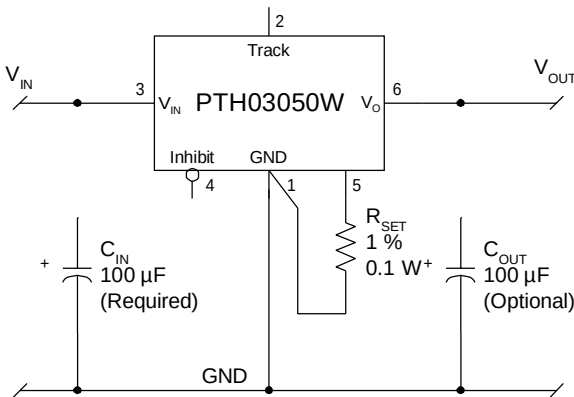


Table 2-2; Output Voltage Set-Point Resistor Values

V_a Req'd	R_{set}	V_a Req'd	R_{set}
0.800	Open	2.00	4.18 k Ω
0.825	318 k Ω	2.05	3.91 k Ω
0.850	158 k Ω	2.10	3.66 k Ω
0.875	104 k Ω	2.15	3.44 k Ω
0.900	77.5 k Ω	2.20	3.22 k Ω
0.925	61.5 k Ω	2.25	3.03 k Ω
0.950	50.8 k Ω	2.30	2.84 k Ω
0.975	43.2 k Ω	2.35	2.67 k Ω
1.000	37.5 k Ω	2.40	2.51 k Ω
1.025	33.1 k Ω	2.45	2.36 k Ω
1.050	29.5 k Ω	2.50	2.22 k Ω
1.075	26.6 k Ω	2.55	2.08 k Ω
1.100	24.2 k Ω	2.60	1.95 k Ω
1.125	22.1 k Ω	2.65	1.83 k Ω
1.150	20.4 k Ω	2.70	1.72 k Ω
1.175	18.8 k Ω	2.75	1.61 k Ω
1.200	17.5 k Ω	2.80	1.51 k Ω
1.225	16.3 k Ω	2.85	1.41 k Ω
1.250	15.3 k Ω	2.90	1.32 k Ω
1.275	14.4 k Ω	2.95	1.23 k Ω
1.300	13.5 k Ω	3.00	1.15 k Ω
1.325	12.7 k Ω	3.05	1.07 k Ω
1.350	12.1 k Ω	3.10	988 Ω
1.375	11.4 k Ω	3.15	914 Ω
1.400	10.8 k Ω	3.20	843 Ω
1.425	10.3 k Ω	3.25	775 Ω
1.450	9.82 k Ω	3.30	710 Ω
1.475	9.36 k Ω	3.35	647 Ω
1.50	8.94 k Ω	3.40	587 Ω
1.55	8.18 k Ω	3.45	529 Ω
1.60	7.51 k Ω	3.50	473 Ω
1.65	6.92 k Ω	3.55	419 Ω
1.70	6.4 k Ω	3.60	367 Ω
1.75	5.93 k Ω		
1.80	5.51 k Ω		
1.85	5.13 k Ω		
1.90	4.78 k Ω		
1.95	4.47 k Ω		

Notes:

1. Modules that operate from a 3.3-V input bus should not be adjusted higher than 2.5 V.
2. A 0.05-W resistor may be used. The tolerance should be 1%, with temperature stability of 100 ppm/ $^{\circ}$ C (or better). Place the resistor as close to the regulator as possible. Connect the resistor directly between pins 5 and 1 using dedicated PCB traces.
3. Never connect capacitors from V_o Adjust to either GND or V_{out} . Any capacitance added to the V_o Adjust pin will affect the stability of the regulator.

以上内容仅为本文档的试下载部分，为可阅读页数的一半内容。如要下载或阅读全文，请访问：<https://d.book118.com/136045135001010035>