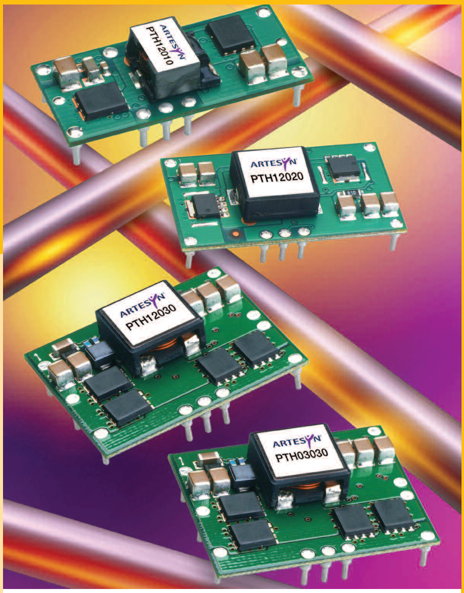
PTH12050 12Vin Single

Application Note 163



POLA Point-of-Load Alliance

RoHS 2002/95/EC

ARTESYN TECHNOLOGIES

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1. Introduction

The PTH family of non-isolated, wide-output adjust power modules from Artesyn Technologies are optimized for applications that require a flexible, high performance module that is small in size. These products are part of the “Point-of-Load Alliance” (POLA), which ensures compatible footprint, interoperability and true second sourcing for customer design flexibility. The POLA is a collaboration between Artesyn Technologies, Astec Power and Texas Instruments to offer customers advanced non-isolated modules that provide the same functionality and form factor. Product series covered by the alliance includes the PTHxx050W (6A), PTHxx060W (10A), PTHxx010W (15/12A), PTHxx020W (22/18A), and the PTHxx030W (30/26A).

From the basic, “Just Plug it In” functionality of the 6A modules, to the 30A rated feature-rich PTHxx030W, series these products were designed to be very flexible, yet simple to use. The features vary with each product series. Table 1 provides a quick reference to the available features by series and input bus voltage.

For simple point-of-use applications, the PTHxx050W series provides operating features such as an ON/OFF inhibit, output voltage trim, pre-bias start-up (3.3/5V input only), and overcurrent protection. The PTHxx060W (10A), and PTHxx010W (15/12A) series add an output voltage sense, and margin up/down controls. The higher output current, PTHxx020W and PTHxx030W series also incorporates overtemperature and shutdown protection. All of the products referenced in Table 1 include Auto-Track™.

This is a feature unique to the PTH family, and was specifically designed to simplify the task of sequencing the supply voltage in a power system. These and other features are described in the following sections.

SERIES	INPUT BUS	I_{OUT}	ADJUST TRIM	ON/OFF INHIBIT	OVER-CURRENT	PRE-BIAS START-UP	AUTO-TRACK™*	MARGIN UP/DOWN	OUTPUT SENSE	THERMAL SHUTDOWN
PTHxx050	3.3V 5V 12V	6A 6A 6A	● ● ●	● ● ●	● ● ●	● ●	● ● ●			
PTHxx060	3.3V/5V 12V	10A 10A	● ●	● ●	● ●	●	● ●	● ●	● ●	
PTHxx010	3.3V/5V 12V	15A 12A	● ●	● ●	● ●	●	● ●	● ●	● ●	
PTHxx020	3.3V/5V 12V	22A 18A	● ●	● ●	● ●	●	● ●	● ●	● ●	● ●
PTHxx030	3.3V/5V 12V	30A 26A	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●

Table 1 - Operating Features by Series and Input Bus Voltage

RoHS Compliance Ordering Information	
PTH12050WAST	To order Pb-free (RoHS compatible) surface-mount parts replace the mounting option ‘S’ with ‘Z’, e.g. PTH12050WAZT. To order Pb-free (RoHS compatible) through-hole parts replace the mounting option ‘H’ with ‘D’, e.g. PTH12050WADT.

*Auto-track™ is a trade mark of Texas Instruments

2. System Interface Information

2.1 Input Capacitor

The recommended input capacitor(s) is determined by the 100µF minimum capacitance and 750mArms minimum ripple current rating. A 10µF X5R/X7R ceramic capacitor may also be added to reduce the reflected input ripple current. This is recommended for output voltage set-points of 3.3V and higher

Ripple current, less than 100mΩ equivalent series resistance (ESR) and temperature are major considerations when selecting input capacitors. Unlike polymer-tantalum capacitors, regular tantalum capacitors have a recommended minimum voltage rating of 2 x (max. DC voltage + AC ripple). This is standard practice to ensure reliability. Only a few tantalum capacitors have sufficient voltage rating to meet this requirement. At temperatures below 0ºC, the ESR of aluminum electrolytic capacitors increases. For these applications Os-Con, polymer-tantalum, and polymer-aluminum types should be considered.

2.2 Output Capacitance (Optional)

For applications with load transients (sudden changes in load current), regulator response will benefit from external output capacitance. The value of 330µF is used to define the transient response specification (see datasheet). For most applications, a high quality computer-grade aluminum electrolytic capacitor is adequate. These capacitors provide decoupling over the frequency range, 2kHz to 150kHz, and are suitable for ambient temperatures above 0ºC. Below 0ºC, 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 4mΩ (7mΩ using the manufacturer's maximum ESR for a single capacitor). A list of preferred low-ESR type capacitors are identified in Table 2.

In addition to electrolytic capacitance, adding a 10-µF X5R/X7R ceramic capacitor to the output will reduce the output ripple voltage and improve the regulator's transient response. The measurement of both the output ripple and transient response is also best achieved across a 10µF ceramic capacitor.

2.2.1 Tantalum Capacitors

Tantalum type capacitors are most suited for use on the output bus, and are recommended for applications where the ambient operating temperature can be less than 0ºC. The AVX TPS, Sprague 593D/594/595 and Kemet T495/T510 capacitor series are suggested over 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 no surge current rating. 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.

2.2.2 Ceramic Capacitors

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

2.2.3 Capacitor Table

Table 2 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.

2.2.4 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 1A/µs. The typical voltage deviation for this load transient is given in the datasheet 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 datasheet, or the total amount of load capacitance is above 3,000µF, the selection of output capacitors becomes more important.

CAPACITOR VENDOR/ SERIES	CAPACITOR CHARACTERISTICS					QUANTITY		
	WORKING VOLTAGE	VALUE (µF)	MAX. ESR AT 100 kHZ	MAX RIPPLE CURRENT AT 85°C (Irms)	PHYSICAL SIZE (MM) (L X W)	INPUT BUS	OPTIONAL OUTPUT BUS	VENDOR PART NUMBER
Panasonic								
FC (Radial)	25V	330	0.090Ω	755mA	10.0 x 12.5	1	1	EEUFC1E331
	35V	180	0.090Ω	755mA	10.0 x 12.5	1	1	EEUFC1V181
FK (SMD)	25V	470	0.080Ω	850mA	10.0 x 12.2	1	1	EEVFK1E471P
United Chemi-Con								
PXA (SMD)	16V	150	0.026Ω	3430mA	10.0 x 7.7	1	≤4	PXA16VC151MJ80TP
FP (Radial)	20V	120	0.024Ω	3100mA	8.0 x 10.5	1	≤4	20FP120MG
FS (Radial)	20V	100	0.030Ω	2740mA	8.0 x 10.5	1	≤4	20FS100M
LXZ (Radial)	35V	220	0.090Ω	760mA	10.0 x 12.5	1	1	LXZ35VB221M10X12LL
Nichicon								
HD (Radial)	25V	220	0.072Ω	760mA	8.0 x 11.5	1	1	UHD1E221MPR
PM (Radial)	35V	220	0.090Ω	770mA	10.0 x 15.0	1	1	UPM1V221MHH6
Panasonic, Poly-Aluminum								
WA (SMD)	16V	100	0.039Ω	2500mA	8.0 x 6.9	1	≤5	EEFWA1C101P
S/SE (SMD)	6.3V	180	0.005Ω	4000mA	7.3 x 4.3	N/R[2]	≤1	EEFSE0J181R (V_o≤5.1V)
SANYO Os-Con								
SVP (SMD)	20V	100	0.024Ω	>3300mA	8.0 x 12.0	1	≤4	20SVP100M
SP (Radial)	20V	120	0.024Ω	>3100mA	8.0 x 10.5	1	≤4	20SP120M
TPE (SMD)	10V	220	0.025Ω	>2400mA	7.3 x 5.7	1	≤4	10TPE220ML
AVX Tantalum TPS	10V	100	0.100Ω	>1090mA	7.3 x 4.3	N/R[2]	≤5	TPSD107M010R0100
(SMD)	10V	220	0.100Ω	>1414mA	7.3 x 4.3	N/R[2]	≤5	TPSV227M010R0100
	25V	68	0.095Ω	>1451mA	7.3 x 4.3	2	≤5	TPSV686M025R0095
Kemet (SMD)								
T520 (SMD)	10V	100	0.080Ω	1200mA	7.3 x 5.7	N/R[2]	≤5	T520D107M010AS
T495 (SMD)	10V	100	0.100Ω	>1100mA	7.3 x 5.7	N/R[2]	≤5	T495X107M010AS
Vishay-Sprague								
594D (SMD)	10V	150	0.090Ω	1100mA	7.3 x 6.0	N/R[2]	≤5	594D157X0010C2T
	25V	68	0.095Ω	1600mA	7.3 x 6.0	2	≤5	595D686X0025R2T
94SP (Radial)	16V	100	0.070Ω	2890mA	10.0 x 10.5	1	≤5	94SP107X0016FBP
Kemet, Ceramic	16V	10	0.002Ω		1210 case	1[3]	≤5	C1210C106M4PAC
X5R (SMD)	6.3V	47	0.002Ω		3225mm	N/R[2]	≤5	C1210C476K9PAC
Murata, Ceramic	6.3V	100	0.002Ω		1210 case	N/R[2]	≤3	GRM32ER60J107M
X5R (SMD)	6.3V	47			3225mm	N/R[2]	≤5	GRM32ER60J476M
	16V	22				1[3]	≤5	GRM32ER61C226K
	16V	10				1[3]	≤5	GRM32DR61C106K
TDK, Ceramic	6.3V	100	0.002Ω		1210 case	N/R[2]	≤3	C3225X5R0J107MT
X5R (SMD)	6.3V	47			3225mm	N/R[2]	≤5	C3225X5R0J476MT
	16V	22				1[3]	≤5	C3225X5R1C226MT
	16V	10				1[3]	≤5	C3225X5R1C106MT

(1) The voltage rating of this capacitor only allows it to be used for output voltages that are equal to or less than 5.1V.

(2) N/R – Not recommended. The capacitor voltage rating does not meet the minimum derated operating limits.

(3) Ceramic capacitors may be used to compliment electrolytic types at the input to further reduce high-frequency ripple current.

Table 2 - Recommended Input/Output Capacitors

3. Mechanical Information

3.1 Mechanical Outline Drawings

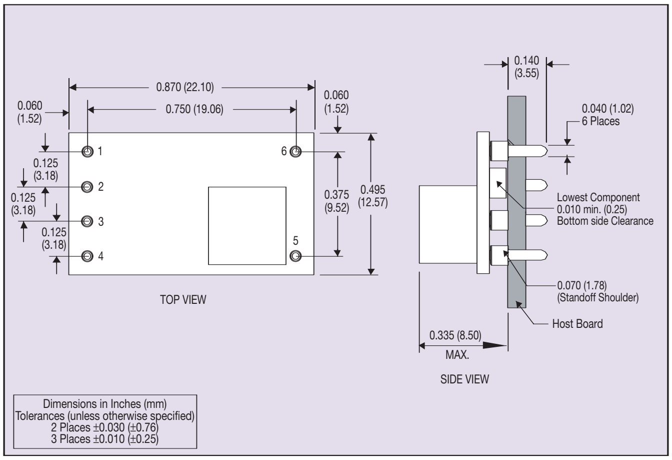


Figure 1 - Plated Through-Hole Mechanical Drawing - Suffix H

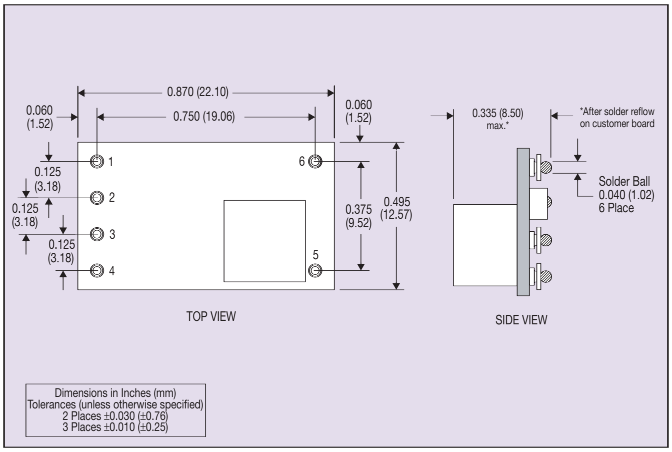


Figure 2 - Surfact Mount Mechanical Drawing - Suffix S

3.2 Pin-out Table

PIN CONNECTIONS	
PIN NUMBER	**FUNCTION**
1	Ground
2	Track
3	V_{in}
4	Inhibit
5	$V_{o\ adjust}$
6	V_{out}

Table 3 - Pin Connections

3.3 Pin Description

3.3.1 Ground

This is the common ground connection for the V_{in} and V_{out} power connections. It is also the 0VDC reference for the control inputs.

3.3.2 Track

This is an analog control input that enables the output voltage to follow an external voltage. This pin becomes active typically 20ms after the input voltage has been applied, and allows direct control of the output voltage from 0V 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 undervoltage lockout feature, the output of the module cannot follow its own input voltage during power-up. For more information, see Sectin 10.0.

3.3.3 V_{in}

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

3.3.4 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.

3.3.5 $V_{o\ Adjust}$

A 1% resistor must be directly connected between this pin and pin 1 (GND) to set the output voltage to a value higher than its lowest value. The temperature stability of the resistor should be 100ppm/°C (or better). The set-point range is from 1.2V to 5.5V for the '-W' Suffix model and 0.8V to 1.8V for the '-L' Suffix model. The resistor required for a given output voltage may be calculated from the equations in Section 7.1. If left open-circuit the output voltage will default to its lowest value. For further information on output voltage adjustment please see Section 7.

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

3.3.6 V_{out}

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

4. Packaging Information

4.1 Packaging

The PTH12050 are available in trays of 28 units and tape and reel format in quantities of 250 units per reel.

Tray and tape dimensions including pick point are shown in Figures 3 and 4.

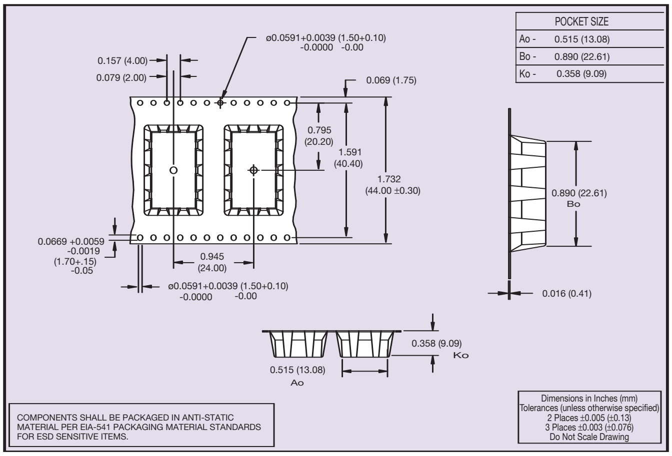


Figure 3 - Tape Dimensions

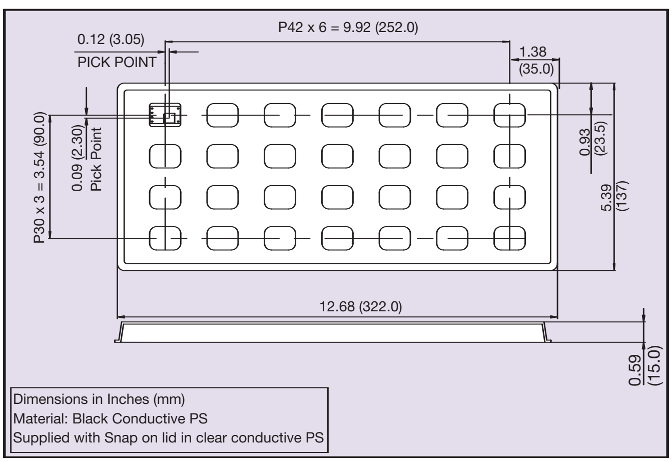


Figure 4 - Tray

4.2 Labeling and Part Numbering Sequence

All units in the series will be clearly marked to allow ease of identification for the end user. Figure 5 gives details of all the models.

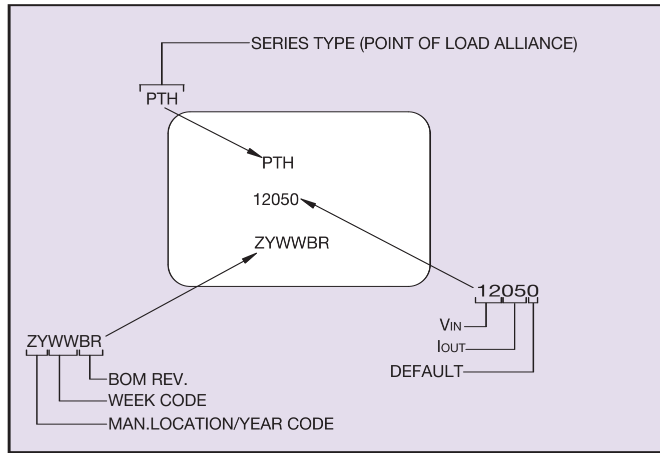


Figure 5 - PTH12050 Part Numbering

5. Safety Information

5.1 Safety Standards and Approvals

All models will have full international safety approval including EN60950 and UL/cUL1950. Models have been submitted to independent safety agencies for approval.

5.2 Fuse Information

Any suitable value fuse (based on the input ratings) maybe used in the unearthed input line. However this is not required for compliance with safety.

5.3 Safety Considerations

The converter must be installed as per guidelines outlined by the various safety agency approvals, if safety agency approval is required for the overall system.

6. Operating Information

6.1 Overtemperature Protection (OTP)
Only the PTHxx020 and PTHxx030 series of products have overtemperature protection. These products have an on-board temperature sensor that protects the module's internal circuitry against excessively high temperatures. A rise in the internal temperature may be the result of a drop in airflow, or a high ambient temperature. If the internal temperature exceeds the OTP threshold (see datasheet specifications), the module's Inhibit control is automatically pulled low. This disables the regulator allowing the output voltage to drop to zero. (The external output capacitors will be discharged by the load circuit). The recovery is automatic, and begins with a soft-start power-up. It occurs when the the sensed temperature decreases by about 10°C below the trip point.

Note: The overtemperature protection is a last resort mechanism to prevent thermal stress to the regulator. Operation at or close to the thermal shutdown temperature is not recommended and will reduce the long-term reliability of the module. Always operate the regulator within the specified Safe Operating Area (SOA) limits for the worst-case conditions of ambient temperature and airflow.

6.2 Overcurrent Protection
For protection against load faults, all modules incorporate output overcurrent protection. Applying a load that exceeds the regulator's overcurrent threshold will cause the regulated output to shut down. Following shutdown a module will periodically attempt to recover by initiating a soft-start power-up. This is described as a "hiccup" mode of operation, whereby the module continues in the cycle of successive shutdown and power-up until the load fault is removed. During this period, the average current flowing into the fault is significantly reduced. Once the fault is removed, the module automatically recovers and returns to normal operation.

6.3 Soft-start Power-up
The Auto-Track feature allows the power-up of multiple PTH modules to be directly controlled from the Track pin. However in a stand-alone configuration, or when the Auto-Track feature is not being used, the Track pin should be directly connected to the input voltage, Vin (see Figure 6).

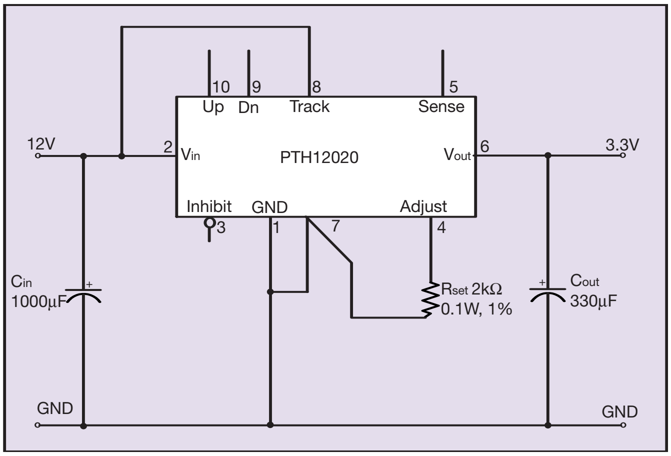
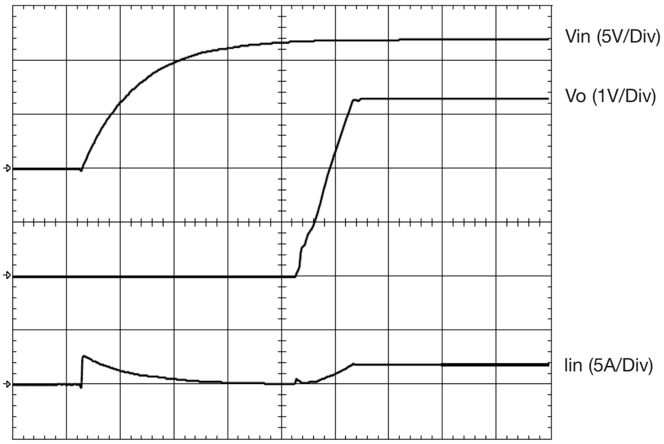


Figure 6 - Soft-start Power-up

When the Track pin is connected to the input voltage the Auto-Track function is permanently disengaged. This allows the module to power-up entirely under the control of its internal soft-start circuitry. When power-up is under soft-start control, the output voltage rises to the set-point at a quicker and more linear rate.



HORIZ SCALE: 5 ms/Div

Figure 7 - Power-up Characteristic

From the moment a valid input voltage is applied, the soft-start control introduces a short time delay (typically 5ms to 10ms) before allowing the output voltage to rise. The output then progressively rises to the module's set-point voltage. Figure 7 shows the soft-start power-up characteristic of the 18A output product (PTH12020W), operating from a 12V input bus and configured for a 3.3V output. The waveforms were measured with a 5A resistive load, with Auto-Track disabled. The initial rise in input current when the input voltage first starts to rise is the charge current drawn by the input capacitors. Power-up is complete within 25ms.

7. Feature Set

7.1 Adjusting the Output Voltage

The Vo adjust control (pin 5) sets the output voltage of the PTH12050 product. The adjustment range is from 1.2V to 5.5V for '-W' Suffix model and 0.8V to 1.8V for '-L' Suffix model. The adjustment method requires the addition of a single external resistor, Rset, that must be connected directly between the Vo Adjust and GND pins[1]. Table 4 gives the preferred value for 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 equations, or simply selected from the range of values given in Tables 5A and 5B. Figure 8 shows the placement of the required resistor.

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

Equation 3 - For the '-W' Suffix Models

$$R_{set} = 10K \times \frac{0.8V}{V_{out} - 0.8V} - 7.87\,K$$

Equation 4 - For the '-L' Suffix Models

V_{out} Standard	R_{set} (Preferred Value)	V_{out} (Actual)
5.0V	280Ω	5.009V
3.3V	2kΩ	3.294V
2.5V	4.32kΩ	2.503V
2.0V	8.06kΩ	2.010V
1.8V	11.5kΩ	1.801V
1.5V	24.3kΩ	1.506V
1.2V	Open	1.200V

Table 4A - Preferred Values of R_{set} for Standard Output Voltages '-W' Suffix Models

V_{out} Standard	R_{set} (Pref'd Value)	V_{out} (Actual)
1.8V	130Ω	1.800V
1.5V	3.57kΩ	1.499V
1.2V	12.1kΩ	1.201V
1.1V	18.7kΩ	1.101V
1.0V	32.4kΩ	0.999V
0.9V	71.5kΩ	0.901V
0.8V	Open	0.800V

Table 4B - Preferred Values of R_{set} for Standard Output Voltages '-L' Suffix Models

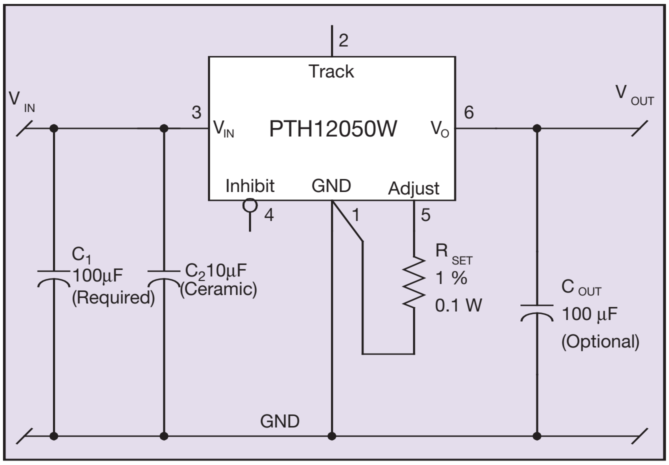


Figure 8 - Adjust Resistor Placement

OUTPUT VOLTAGE SET-POINT RESISTOR VALUES					
Va Req'd	Rset	Va Req'd	Rset	Va Req'd	Rset
1.200	Open	2.15	6.6kΩ	3.40	1.82kΩ
1.225	318kΩ	2.20	6.18kΩ	3.45	1.74kΩ
1.250	158kΩ	2.25	5.8kΩ	3.50	1.66kΩ
1.275	105kΩ	2.30	5.45kΩ	3.55	1.58kΩ
1.300	78.2kΩ	2.35	5.14kΩ	3.60	1.51kΩ
1.325	62.2kΩ	2.40	4.85kΩ	3.70	1.38kΩ
1.350	51.5kΩ	2.45	4.85kΩ	3.80	1.26kΩ
1.375	43.9kΩ	2.50	4.33kΩ	3.90	1.14kΩ
1.400	38.2kΩ	2.55	4.11kΩ	4.00	1.04kΩ
1.425	33.7kΩ	2.60	3.89kΩ	4.10	939Ω
1.450	30.2kΩ	2.65	3.70kΩ	4.20	847Ω
1.475	27.3kΩ	2.70	3.51kΩ	4.30	761Ω
1.50	24.8kΩ	2.75	3.34kΩ	4.40	680Ω
1.55	21.0kΩ	2.80	3.18kΩ	4.50	604Ω
1.60	18.2kΩ	2.85	3.03kΩ	4.60	533Ω
1.65	16.0kΩ	2.90	2.89kΩ	4.70	466Ω
1.70	14.2kΩ	2.95	2.75kΩ	4.80	402Ω
1.75	12.7kΩ	3.00	2.62kΩ	4.90	342Ω
1.80	11.5kΩ	3.05	2.50kΩ	5.00	285Ω
1.85	10.5kΩ	3.10	2.39kΩ	5.10	231Ω
1.90	9.61kΩ	3.15	2.28kΩ	5.20	180Ω
1.95	8.85kΩ	3.20	2.18kΩ	5.30	131Ω
2.00	8.18kΩ	3.25	2.08kΩ	5.40	85Ω
2.05	7.59kΩ	3.30	1.99kΩ	5.50	41Ω
2.10	7.07kΩ	3.35	1.90kΩ		

Table 5A - Output Voltage Set-point Resistor Values for Suffix '-W Model

OUTPUT VOLTAGE SET-POINT RESISTOR VALUES					
V_a Req'd	R_{set}	V_a Req'd	R_{set}	V_a Req'd	R_{set}
0.800	Open	1.100	18.8kΩ	1.400	5.46kΩ
0.825	312kΩ	1.125	16.7kΩ	1.425	4.93kΩ
0.850	152kΩ	1.150	15kΩ	1.450	4.44kΩ
0.875	98.8kΩ	1.175	13.5kΩ	1.475	3.98kΩ
0.900	72.1kΩ	1.200	12.1kΩ	1.500	3.56kΩ
0.925	56.1kΩ	1.225	11kΩ	1.550	2.80kΩ
0.950	45.5kΩ	1.250	9.91kΩ	1.600	2.13kΩ
0.975	37.8kΩ	1.275	8.97kΩ	1.650	1.54kΩ
1.000	32.1kΩ	1.300	8.13kΩ	1.700	1.02kΩ
1.025	27.7kΩ	1.325	7.37kΩ	1.750	0.551kΩ
1.050	24.1kΩ	1.350	6.68kΩ	1.800	0.130kΩ
1.075	21.2kΩ	1.375	6.04kΩ		

Table 5B - Output Voltage Set-point Resistor Values for Suffix '-L' Model

Notes:

1 Use a resistor with a tolerance of 1% (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.

2 Never connect capacitors from Vo Adjust to either GND or Vout. Any capacitance added to the Vo Adjust pin will affect the stability of the regulator.

7.2 Output ON/OFF Inhibit

For applications requiring output voltage ON/OFF control,each series of the PTH family incorporates an output Inhibit control pin. The inhibit feature can be used wherever there is a requirement for the output voltage from the regulator to be turned OFF.

The power modules function normally when the Inhibit pin is left open-circuit, providing a regulated output whenever a valid source voltage is connected to Vin with respect to GND.

Figure 9 shows the typical application of the inhibit function. Note the discrete transistor (Q1). The Inhibit control has its own internal pull-up to +Vin potential. An open-collector or open-drain device is recommended to
control this input.

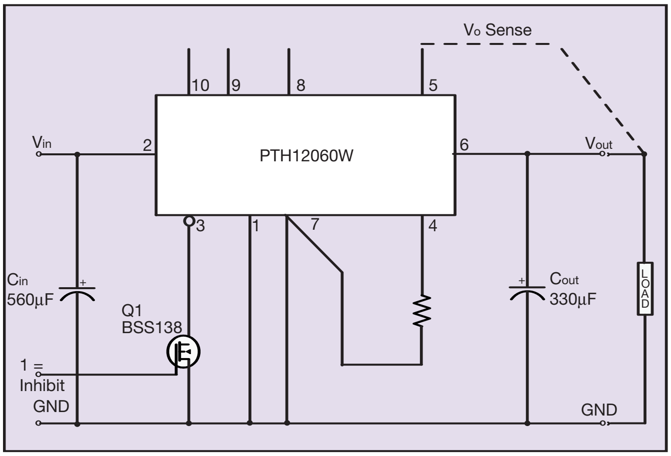


Figure 9 - Typical Application of the Inhibit Function

Turning Q1 on applies a low voltage to the Inhibit control pin and disables the output of the module. If Q1 is then turned off, the module will execute a soft-start power-up sequence. A regulated output voltage is produced within 20ms. Figure 10 shows the typical rise in both the output voltage and input current, following the turn-off of Q1. The turn off of Q1 corresponds to the rise in the waveform, Q1 V_{DS}. The waveforms were measured with a 5A load.

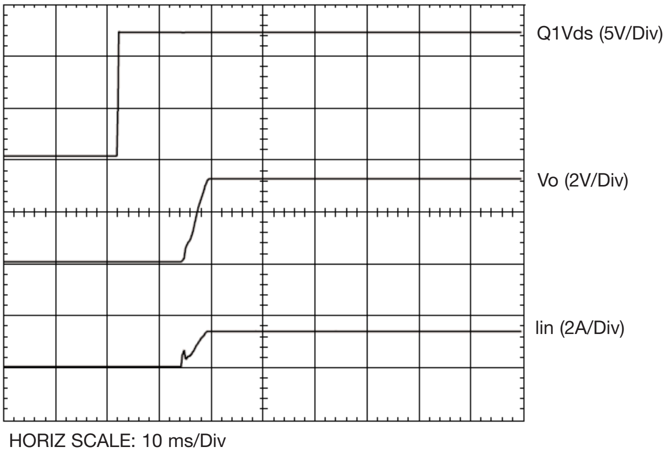


Figure 10 - Typical Rise in Output Voltage and Input Current

8. Thermal Information

8.1 Thermal Reference Points

The electrical operating conditions namely:

- Input voltage, V_{in}
- Output voltage, V_o
- Output current, I_o

determine how much power is dissipated within the converter. The following parameters further influence the thermal stresses experienced by the converter:

- Ambient temperature
- Air velocity
- Thermal efficiency of the end system application
- Parts mounted on system PCB that may block airflow
- Real airflow characteristics at the converter location

8.2 Safe Operating Area Curve

Thermal characterisation data is presented in the datasheet in a safe operating area curve format which is repeated here in Figure 11. This SOA curve shows the load current versus the ambient air temperature and velocity.

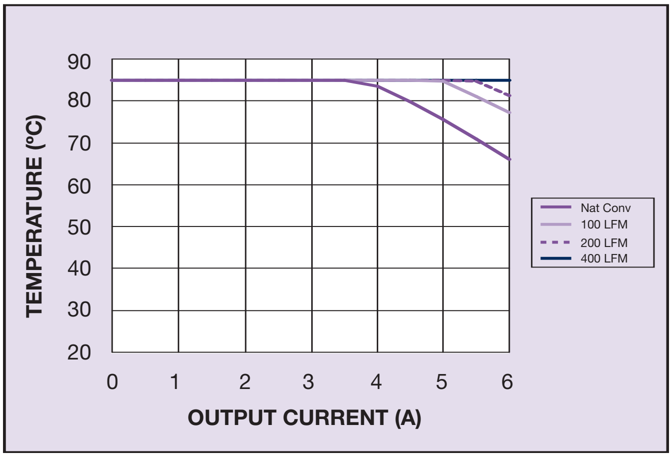


Figure 11 - Safe Operating Curve
PTH12050W V_{out} = 3.3V

8.3 Thermal Test Set-up

All of the data was taken with the converter soldered to a test board which closely represents a typical application. The test board is a 1.6mm, eight layer FR4 PCB with the inner layers consisting of 2oz power and ground planes. The top and bottom layers contain a minimal amount of metalisation. A board to board spacing of 1 inch was used. The data represented by the 0m/s curve indicate a natural convection condition i.e. no forced air. However, since the thermal performance is heavily dependent upon the final system application, the user needs to ensure the thermal reference point temperatures are kept within the recommended temperature rating. It is recommended that the thermal reference point temperatures are measured using either AWG #36 or #40 gauge thermocouples or an IR camera. In order to comply with stringent Artesyn derating criteria, the ambient temperature should never exceed 85°C. Please contact Artesyn Technologies for further support.

9. Use in a Manufacturing Environment

9.1 Recommended Land Pattern

It is recommended that the customer uses a solder mask defined land pattern similar to that shown in Figures 12 and 13.

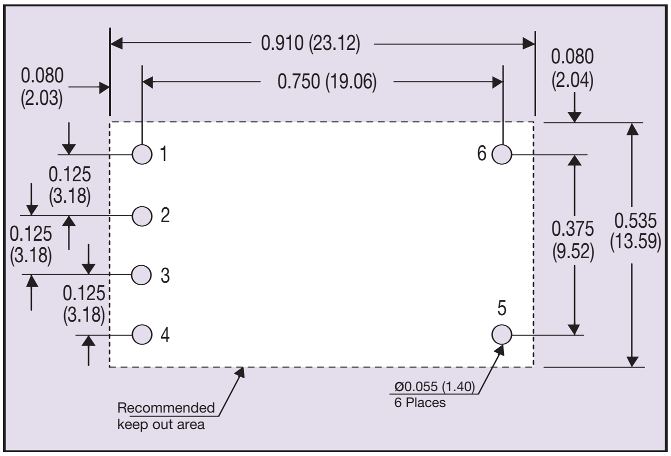


Figure 12 - Recommended Land Pattern (Through-Hole Model)

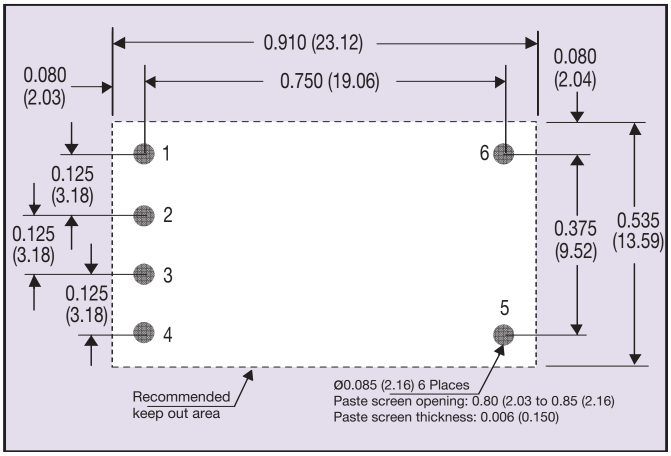


Figure 13 - Recommended Land Pattern (Surface Mount Model)

Power pin connection should utilize four or more vias to the interior power plane of 0.025 (0.63) I.D. per input, ground an doutput pin (or the electrical equivalent.

As a surface-mount power component, interconnection to internal power planes will typically be required. This is accomplished by placing a number of vias between the SMT pad and the relevant plane. the number and exact location of these vias should be determined based on electrical resistivity, current flow and thermal requirements.

10. Auto-Track™

10.1 Auto-Track™ Function

The Auto-Track function is unique to the PTH family, and is available with the all "Point-of-Load Alliance" (POLA) products. Auto-Track was designed to simplify the amount of circuitry required to make the output voltage from each module power-up and power-down in sequence. The sequencing of two or more supply voltages during power-up is a common requirement for complex mixed-signal applications, that use dual-voltage VLSI ICs such as DSPs, micro-processors, and ASICs.

10.2 How Auto-Track™ Works

Auto-Track works by forcing the module's output voltage to follow a voltage presented at the Track control pin. This control range is limited to between 0V and the module's set-point voltage. Once the track-pin voltage is raised above the set-point voltage, the module's output remains at its set-point[1]. As an example, if the Track pin of a 2.5V regulator is at 1V, the regulated output will be 1V. But if the voltage at the Track pin rises to 3V, the regulated output will not go higher than 2.5V.

When under track control, the regulated output from the module follows the voltage at its Track pin on a voltfor- volt basis. By connecting the Track pin of a number of these modules together, the output voltages will follow a common signal during power-up and power-down. The control signal can be an externally generated master ramp waveform, or the output voltage from another power supply circuit[3]. For convenience the Track control incorporates an internal RC charge circuit. This operates off the module's input voltage to produce a suitable rising waveform at power-up.

10.3 Typical Application

The basic implementation of Auto-Track allows for simultaneous voltage sequencing of a number of Auto-Track compliant modules. Connecting the Track control pins of two or more modules forces the Track control of all modules to follow the same collective RC ramp waveform, and allows them to be controlled through a single transistor or switch; Q1 in Figure 14.

To initiate a power-up sequence, it is recommended that the Track control be first pulled to ground potential. This should be done at or before input power is applied to the modules, and then held for at least 10ms thereafter. This brief period gives the modules time to complete their internal soft-start initialization. Applying a logiclevel high signal to the circuit's On/Off Control turns Q1 on and applies a ground signal to the Track pins. After completing their internal soft-start intialization, the output of all modules will remain at zero volts while Q1 is on.

10ms after a valid input voltage has been applied to the modules, Q1 may be turned off. This allows the track control voltage to automatically rise toward to the modules' input voltage. During this period the output voltage of each module will rise in unison with other modules, to its respective set-point voltage.

Figure 16 shows the output voltage waveforms from the circuit of Figure 14 after the On/Off Control is set from a high to a low-level voltage. The waveforms, Vo1 and Vo2 represent the output voltages from the two power modules, U1 (3.3V) and U2 (2V) respectively. Vo1 and Vo2 are shown rising together to produce the desired simultaneous power-up characteristic.

The same circuit also provides a power-down sequence. Power-down is the reverse of power-up, and is accomplished by lowering the track control voltage back to zero volts. The important constraint is that a valid input voltage must be maintained until the power-down is complete. It also requires that Q1 be turned off relatively slowly. This is so that the Track control voltage does not fall faster than Auto-Track's slew rate capability, which is 1V/ms. The components R1 and C1 in Figure 14 limit the rate at which Q1 can pull down the Track control voltage. The values of 100 kΩ and 0.1µF correlate to a decay rate of about 0.17V/ms.

The power-down sequence is initiated with a low-to-high transition at the ON/OFF Control input to the circuit. Figure 15 shows the power-down waveforms. As the Track control voltage falls below the nominal set-point voltage of each power module, then its output voltage decays with all the other modules under Auto-Track™ control.

Notes on the Use Of Auto-Track™

1. The Track pin voltage must be allowed to rise above the module's set-point voltage before the module can regulate at its adjusted set-point voltage.
2. The Auto-Track function will track almost any voltage ramp during power-up, and is compatible with ramp speeds of up to 1V/ms.
3. The absolute maximum voltage that may be applied to the Track pin is the input voltage V_{in}.
4. The module will not follow a voltage at its Track control input until it has completed its soft-start initialization. This takes about 10ms from the time that the module has sensed that a valid voltage has been applied its input. During this period, it is recommended that the Track pin be held at ground potential
5. The module is capable of both sinking and sourcing current when following a voltage at its Track pin. Therefore start-up into an output prebias cannot be supported when a module is under Auto-Track control.
   Note: A pre-bias holdoff is not necessary when all supply voltages rise simultaneously under the control of Auto-Track.
6. The Auto-Track function can be disabled by connecting the Track pin to the input voltage (Vin). When Auto-Track is disabled, the output voltage will rise at a quicker and more linear rate after input power is applied.

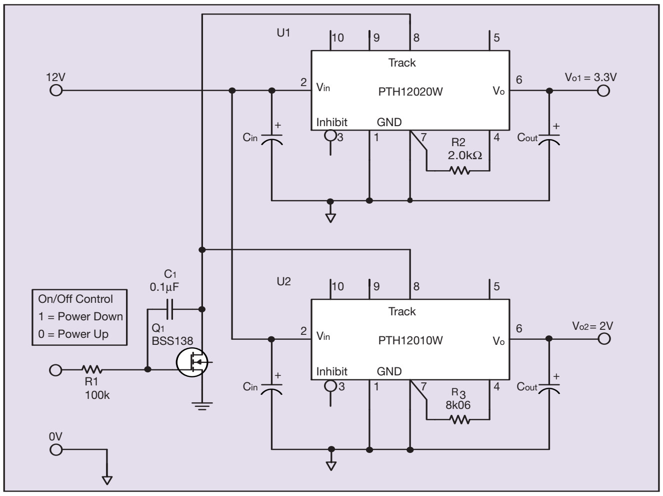


Figure 14 - Sequenced Power-up and Power-down Using Auto-Track™

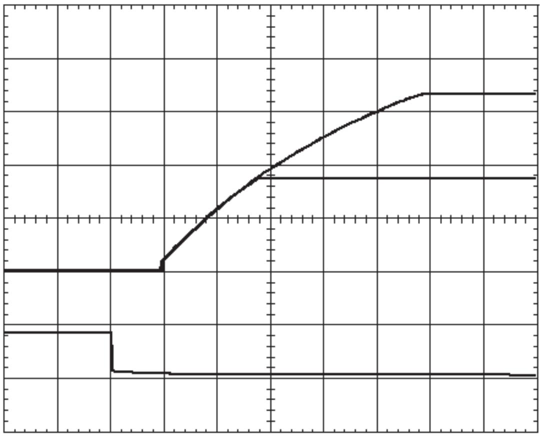


Figure 15 - Power-up Waveforms

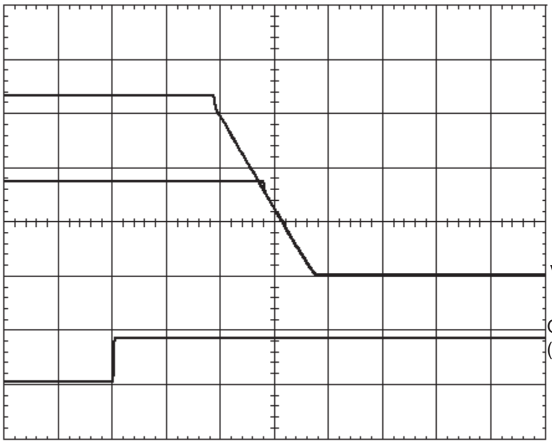


Figure 16 - Power-down Waveforms