Introduction
Powering servers and memory cards requires the generation of low supply voltages at very high DC currents approaching 100 A or more. In addition to the high-current-supply requirements, dynamic load requirements are extremely demanding. The load may quickly go from an inactive low-current state to a fully processing high-current state while requiring precise voltage regulation.

Paralleling power modules
A stand-alone, dual-phase power module like the Texas Instruments (TI) PTH08T250W can supply up to 50 A of output load current. However, the PTH08T250W incorporates TI's TPS40140 stackable-controller feature that allows the outputs of multiple modules to be connected in parallel, thereby producing a reliable solution capable of supplying a load current of 100 A or more.

Configuring a PTH08T250W as a master and each additional module as a slave allows start-up and transient conditions to be controlled by a single module. Figure 1 shows a typical two-module solution where all of the features and inputs are controlled by the master device while the slave inputs are left open.

Figure 1. Typical two-module solution
Considerations for paralleling PTH08T250W modules

Input and output capacitors
When multiple PTH08T250W modules are paralleled, the amount of capacitance must be enough to filter the input and output and meet the transient requirements of the high-current application. The amount of capacitance must be calculated for a single module and then multiplied by the number of parallel modules.

Each device requires a 16-V, 1000-µF, OS-CON capacitor along with three to four 16-V, 22-µF, X5R ceramic capacitors directly at the input pins of the module. The ceramic capacitors are required to reduce any ripple and switching noise across the input bus.

The required output capacitance must be determined by the transient requirement of the application. The maximum current step required by the load must be divided by the number of modules being paralleled. The TurboTrans™ graphs in the datasheet should then be used to determine the amount of output capacitance per module. High-quality, low-ESR polymer-tantalum or OS-CON output capacitors are required for this application. A list of approved capacitors is included in the PTH08T250W datasheet.

TurboTrans technology
The PTH08T250W power module features TurboTrans technology, which allows a power-supply designer to adjust the module to meet a specific transient-load requirement. The TurboTrans feature is set only on the master module with a single resistor, RTT. The result is a high-current application with faster transient response, increased stability, and less output capacitance to meet tight requirements for output-voltage deviation. The benefits of TurboTrans are shown in Figure 2. The transient response to a load step is shown with and without the TurboTrans feature.

Parallel connections
When multiple modules are operated in parallel, the control of each device feature is set only on the master device. A device is configured as a master by connecting the Config pin to the power GND. All slave devices must connect the Config pin to VIN. The slave devices must leave all other control pins open (connect the SmartSync pin to the GND). See Table 1 for pin connections of the master and slave modules.

Table 1. Master and slave pin connections

<table>
<thead>
<tr>
<th>PIN NAME</th>
<th>MASTER</th>
<th>SLAVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Connect to the input bus.</td>
<td>Connect to the input bus.</td>
</tr>
<tr>
<td>VOUT</td>
<td>Connect to the output bus.</td>
<td>Connect to the output bus.</td>
</tr>
<tr>
<td>GND</td>
<td>Connect to the common power GND.</td>
<td>Connect to the common power GND.</td>
</tr>
<tr>
<td>INH/UVLO</td>
<td>Use for inhibit control and UVLO adjustment. If unused, leave open-circuit.</td>
<td>No connection. Leave open-circuit.</td>
</tr>
<tr>
<td>VOUT Adjust</td>
<td>Use to set the output voltage. Connect RSET resistor between this pin and AGND.</td>
<td>No connection. Leave open-circuit.</td>
</tr>
<tr>
<td>+Sense</td>
<td>Connect to the output voltage either at the load or at the module.</td>
<td>No connection. Leave open-circuit.</td>
</tr>
<tr>
<td>–Sense</td>
<td>Connect to the output GND either at the load or at the module.</td>
<td>No connection. Leave open-circuit.</td>
</tr>
<tr>
<td>Track</td>
<td>Connect to Track control. If unused, connect to VIN.</td>
<td>No connection. Leave open-circuit.</td>
</tr>
<tr>
<td>TurboTrans</td>
<td>Connect TurboTrans resistor, RTT, between this pin and +Sense pin.</td>
<td>No connection. Leave open-circuit.</td>
</tr>
<tr>
<td>SmartSync</td>
<td>Connect to an external clock. If unused, connect to GND.</td>
<td>Connect to the common power GND.</td>
</tr>
<tr>
<td>Config</td>
<td>Connect to the common power GND.</td>
<td>Connect to the input bus.</td>
</tr>
<tr>
<td>Share</td>
<td>Connect to pin 2 of the slave.</td>
<td>Connect to pin 2 of the master.</td>
</tr>
<tr>
<td>Comp</td>
<td>Connect to pin 3 of the slave.</td>
<td>Connect to pin 3 of the master.</td>
</tr>
<tr>
<td>AGND</td>
<td>Connect to pin 4 of the slave.</td>
<td>Connect to pin 4 of the master.</td>
</tr>
<tr>
<td>CLKIO</td>
<td>Connect to pin 5 of the slave.</td>
<td>Connect to pin 5 of the master.</td>
</tr>
</tbody>
</table>
Four-phase operation
When operated in parallel, the slave modules are synchronized to the frequency of the master. Each PTH08T250W is a two-phase device; each phase operates 180° out of phase. Placing two modules in parallel results in a four-phase operation by shifting the slave-module phases by 90° (see Figure 4). However, driving the master with an external frequency via SmartSync eliminates the 90° phase shift.

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Four-phase operation results in a reduction of input and output voltage ripple. Each phase draws current from the input source out of phase, minimizing source loading. Four-phase operation also adds to the already exceptional transient response of the module, responding more quickly and delivering current more evenly to the load.

When multiple PTH08T250W modules operate in parallel, all slave modules operate in phase with one another, 90° out of phase with the master. Once again, driving the master with an external frequency eliminates the 90° phase shift.

**PTH08T250W features**

The PTH08T250W operates over a wide 4.5- to 14-V input-voltage range and generates a positive output voltage of 0.7 to 3.6 V. Additionally, the PTH08T2xxW family of power modules is designed to meet a very tight 1.5% DC tolerance, deliver exceptional transient response, and have the ability to synchronize to an external frequency.

This article also applies to the PTH08T255W, a spin-off of the PTH08T250W designed to produce a 5-V, 40-A output. The PTH08T255W operates over an 8- to 14-V input-voltage range, and the output voltage can be set from 3.0 to 5.25 V.

**Related Web sites**

[power.ti.com](http://power.ti.com)
[www.ti.com/sc/device/PTH08T250W](http://www.ti.com/sc/device/PTH08T250W)
[www.ti.com/sc/device/PTH08T255W](http://www.ti.com/sc/device/PTH08T255W)
**TI Worldwide Technical Support**

**Internet**

TI Semiconductor Product Information Center Home Page
[support.ti.com]

TI Semiconductor KnowledgeBase Home Page
[support.ti.com/sc/knowledgebase]

**Product Information Centers**

**Americas**
- Phone: +1(972) 644-5580

**Brazil**
- Phone: 0800-891-2616

**Mexico**
- Phone: 0800-670-7544
- Fax: +1(972) 927-6377
- Internet/Email: [support.ti.com/sc/pic/americas.htm]

**Europe, Middle East, and Africa**

**Phone**
- European Free Call: 00800-ASK-TEXAS (00800 275 83927)
- International: +49 (0) 8161 80 2121
- Russian Support: +7 (4) 95 98 10 701

**Note:** The European Free Call (Toll Free) number is not active in all countries. If you have technical difficulty calling the free call number, please use the international number above.

**Fax**
- +49 (0) 8161 80 2045

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- [support.ti.com/sc/pic/euro.htm]

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  - Hong Kong: 800-96-5941
  - India: 1-800-425-7888
  - Indonesia: 001-803-8861-1006
  - Korea: 080-551-2804
  - Malaysia: 1-800-80-3973
  - New Zealand: 0800-446-934
  - Philippines: 1-800-765-7404
  - Singapore: 800-886-1028
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