Comparison and Selection of PC Card Power Controllers

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ABSTRACT

With so many PC Card power controller options available from Texas Instruments, it may be somewhat difficult for designers to select a particular device. This report summarizes all of the similarities and differences, such as features and options, between all of these PC Card power controllers to help eliminate any potential confusion. With the help of this report, the designer can select an exact controller for a specific application.

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1 Introduction

As the leading silicon manufacturer of the PC card power controllers, Texas Instruments provides various power controllers with different features to meet the different needs of our customers. These devices are ideal power managers to power PC cards, Smart cards, or multimedia cards. The goal is to give customers greater flexibility in design, minimize the components count, and reduce cost.

A family tree that includes all of the PC card power controllers from Texas Instruments is shown in Figure 1.

![Family Tree of All PC Card Power Controllers From Texas Instruments](image)

† Selected by MODE pin

Figure 1. Family Tree of All PC Card Power Controllers From Texas Instruments

This report explains the differences among all of these controllers so that the selection of controllers is easy and clear for customers.
2 Single-Slot PC Card Power Controllers

All the single-slot controllers support a parallel interface only. These devices have three different supply inputs and two outputs. The main features of these devices are listed in Table 1.

Table 1. Comparison of Single-Slot PC Card Power Controllers

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>INPUT SUPPLY (V)</th>
<th>AVCC or VCC</th>
<th>AVPP or Vpp or VPP/VCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OUTPUT VOLTAGE (V)</td>
<td>MAXIMUM DC CURRENT (A)</td>
<td>MAXIMUM RDS(on) (mΩ)</td>
</tr>
<tr>
<td>TPS2211</td>
<td>12 5 3.3</td>
<td>5 3.3</td>
<td>1 1</td>
</tr>
<tr>
<td>TPS2211A</td>
<td>12 5 3.3</td>
<td>5 3.3</td>
<td>1 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPS2212</td>
<td>12 5 3.3</td>
<td>5 3.3</td>
<td>0.25 0.25</td>
</tr>
<tr>
<td>TPS2221</td>
<td>5 3.3</td>
<td>1</td>
<td>160 120</td>
</tr>
</tbody>
</table>

All the devices in Table 1 have an over-current reporting pin (OC) and an active-low shutdown pin (SHDN or SHDN_RST).

2.1 TPS2211 and TPS2211A

The TPS2211 was the first single-slot PC Card power controller from Texas Instruments, and it is used in many applications in notebook PCs, set top boxes, and PDAs. The device uses a 4-pin parallel interface (VCC0, VCC1, VPP0, and VPP1) to control the switching from three input supplies (12 V, 5 V, and 3.3 V) to two outputs (AVCC and AVPP). The 12-V supply can be disabled if not required by its load, and either the 5-V (if 5 V is present) or 3.3-V (if 5 V is not present) supply provide chip power for the whole device, which provides greater design flexibility. With more customers using the TPS2211, new demands are encountered, such as cost reduction and new packages. The TPS2211A uses the latest fabrication process from Texas Instruments and has the same functionality as the TPS2211 but costs less. The TPS2211A also adds a new package HTSSOP-20 (PowerPAD™) that minimizes temperature rise caused by power dissipation.

2.2 TPS2212

The TPS2212 has lower current ratings on the AVCC switches and higher current ratings on the AVPP switches than those of the TPS2211 and TPS2211A as shown in Table 1. The functionality of the TPS2212 is the same as the TPS2211 and the TPS2211A. The device is suitable for low-power PC card applications.

PowerPAD is a trademark of Texas Instruments.
2.3 TPS2221

With Smart card and Multimedia cards becoming more popular, a lower voltage supply is demanded, and the TPS2221 is the result of this trend. The device supports 5-V, 3.3-V, and 1.8-V supplies, but no longer supports the 12-V supply input. In the TPS2221, a 3.3-V input is required for chip power, so this input must be present for proper operation of the device. Another major difference is the logic control. The control of the TPS2221 uses four digital logic inputs but has a different switching table from those of the TPS2211, TPS2211A, and TPS2212. This change provides more flexibility to the PCMCIA controller that generates the parallel interface data inputs. Refer to the data sheets of these devices for a more thorough explanation of the control logic differences.

Due to some confusion between pin names (SHDN_RST of the TPS2221 and SHDN of the other controllers), it is necessary to explain the difference between the functions of the shutdown and reset pins.

A shutdown pin, when activated (e.g., low voltage on SHDN), causes all the internal switches from inputs to outputs to be turned off and no internal discharge paths on the outputs to be activated. In other words, the outputs are Hi-Z after shutdown. But when a reset pin is activated, all of the internal switches from inputs to outputs are turned off and the outputs are discharged to ground through internal discharge paths. Therefore the voltages on the outputs are forced to 0 V during a reset. For the devices with both a shutdown pin and a reset pin, such as the dual-slot controllers described in the next section, the shutdown function overwrites the reset function if both are activated. However, when both the shutdown pin and the reset pin go back to inactive states from active states simultaneously, the device resets all outputs to 0 V during the transaction before switching to the projected states set by control logic inputs (e.g., CLOCK, LATCH, and DATA for the TPS2206A).

The SHDN_RST pin of the TPS2221 actually has the same functionality as the SHDN pin of the other controllers. In other words, SHDN_RST is only a shutdown pin and not a reset pin as its name might suggest.

3 Dual-Slot PC Card Power Controllers

As shown in Figure 1, two kinds of interfaces exist in the dual-slot PC card power controllers: parallel and serial. For the serial interface devices, they can be divided into three categories based on the format of their DATA input: 9-bit only serial data, 11-bit only serial data, or both. The main features of these devices are listed in Table 2.
### Table 2. Comparison of Dual-Slot PC Card Power Controllers

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>(V_i) (V)</th>
<th>(xV_{CC})</th>
<th>(xV_{PP}) or (xV_{PP}/V_{CORE})</th>
<th>SPECIAL PINS (see Note 1)</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(V_o) (V)</td>
<td>MAX (I_o) (A)</td>
<td>MAX (R_{DS(on)}) (mΩ)</td>
<td>(V_o) (V)</td>
<td>MAX (I_o) (A)</td>
</tr>
<tr>
<td>TPS2201</td>
<td>12 5 3.3</td>
<td>5 1 160 225</td>
<td>12 5 3.3</td>
<td>0.15 0.15 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2205</td>
<td>12 5 3.3</td>
<td>5 1 140 110</td>
<td>12 5 3.3</td>
<td>0.15 0.15 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2202</td>
<td>12 5 3.3</td>
<td>5 1 160 225</td>
<td>12 5 3.3</td>
<td>0.15 0.15 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2202A</td>
<td>12 5 3.3</td>
<td>5 1 160 225</td>
<td>12 5 3.3</td>
<td>0.15 0.15 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2206</td>
<td>12 5 3.3</td>
<td>5 1 140 110</td>
<td>12 5 3.3</td>
<td>0.15 0.15 1</td>
<td>Y</td>
</tr>
<tr>
<td>TPS2206A</td>
<td>12 5 3.3</td>
<td>5 1 160 140</td>
<td>12 5 3.3</td>
<td>0.1 0.1 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2214</td>
<td>12 5 3.3</td>
<td>5 1 140 140</td>
<td>12 5 3.3</td>
<td>0.2 0.2 2.5</td>
<td>Y</td>
</tr>
<tr>
<td>TPS2214A</td>
<td>12 5 3.3</td>
<td>0.75 0.75 200 140</td>
<td>12 5 3.3</td>
<td>0.2 0.2 2.5</td>
<td>Y</td>
</tr>
<tr>
<td>TPS2216</td>
<td>12 5 3.3</td>
<td>5 1 140 140</td>
<td>12 5 3.3</td>
<td>0.2 0.2 2.5</td>
<td>Y</td>
</tr>
<tr>
<td>TPS2216A</td>
<td>12 5 3.3</td>
<td>0.75 0.75 200 140</td>
<td>12 5 3.3</td>
<td>0.2 0.2 2.5</td>
<td>Y</td>
</tr>
<tr>
<td>TPS2223</td>
<td>5 3.3</td>
<td>5 1 160 140</td>
<td>5 3.3</td>
<td>0.1 0.1 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2223A</td>
<td>5 3.3</td>
<td>1</td>
<td>160 140</td>
<td>5 3.3</td>
<td>0.1 0.1 1</td>
</tr>
<tr>
<td>TPS2224</td>
<td>12 5 3.3</td>
<td>5 1 160 140</td>
<td>12 5 3.3</td>
<td>0.1 0.1 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2224A</td>
<td>12 5 3.3</td>
<td>5 1 160 140</td>
<td>12 5 3.3</td>
<td>0.1 0.1 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2226</td>
<td>12 5 3.3</td>
<td>5 1 160 140</td>
<td>12 5 3.3</td>
<td>0.1 0.1 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2226A</td>
<td>12 5 3.3</td>
<td>5 1 160 140</td>
<td>12 5 3.3</td>
<td>0.1 0.1 1</td>
<td>N</td>
</tr>
<tr>
<td>TPS2228</td>
<td>5 3.3</td>
<td>5 1 160 120</td>
<td>5 3.3 1.8</td>
<td>0.1 0.5 1.6 0.325 0.12</td>
<td>N</td>
</tr>
</tbody>
</table>

**NOTE 1:** Each controller listed in this table has an overcurrent reporting pin \(OC\).
3.1 TPS2201 and TPS2205

As one of the earliest PC card power controllers, the TPS2201, provides a complete dual-slot card power controller with a simple parallel interface. Compared to the TPS2201, the TPS2205 has lower switch turnon resistance. The TPS2205 no longer supports a power-good reporting function that is not needed in PC card applications. Both the TPS2201 and the TPS2205 have a shutdown pin (SHDN) but no reset pin. Therefore the reset function can only be performed through certain combinations of the parallel interface logic. Another notable difference between these two devices is that the TPS2201 has a designated supply pin VDD for chip power but the TPS2205 uses 3.3-V (if a 5-V input is not present) or 5-V (if a 5-V input is present) as its bias supply. The TPS2201 is only available in a SSOP-30 package, and the TPS2205 is available in both SSOP30 and TSSOP32 packages.

3.2 TPS2202 and TPS2202A

Among all the serial-interfaced dual-slot controllers, the TPS2202 was the first to provide a complete integrated power solution for dual PC cards. It provides a power-good reporting pin but does not have a reset or shutdown pin. The A version of this device, the TPS2202A, adds two reset pins to the device, an active-low RESET pin and an active-high RESET pin. Both reset pins serve the same function. A reset is performed as long as one of the two reset pins is activated. Both the TPS2202 and the TPS2202A, like the TPS2201, have a VDD input as their chip power source.

3.3 TPS2206 and TPS2206A

To meet the demands of some new applications, the TPS2206 has reduced switch turnon resistance and the power-good reporting pin is eliminated that is supported in the TPS2201 and the TPS2202A. The device is available in both SSOP30 and TSSOP32 packages. Like the TPS2205, the TPS2206 uses either the 5-V input or 3.3-V input as its bias power supply. Because of its simplicity and adequate parameters, the TPS2206 attracted much interest and soon became the most preferred PC card power controller before a newer version was released.

With a new fabrication process and additional design efforts, an A version of TPS2206, the TPS2206A, became available, which cost less than the TPS2206. Another major change from the TPS2206 to the TPS2206A is that an active-low shutdown pin (SHDN) was added to the TPS2206A, providing a shutdown function directly from a single pin. The active-high reset pin (RESET) is no longer supported in the TPS2206A because the active-low reset pin (RESET) provides the same function. Unlike the TPS2206, the TPS2206A only uses the 3.3-V input as the chip power supply.

3.4 TPS2214, TPS2216, TPS2214A, and TPS2216A

All of the previous serial controllers discussed integrate a 9-bit serial data interface that controls VPP outputs depending on VCC switching status. However, some new PCMCIA controllers with an 11-bit serial data interface emerged in the last few years which provide independent switching between VPP and VCC switches. To meet this new requirement, the TPS2214 and the TPS2216 were designed. They support both 9-bit serial data and 11-bit serial data, selected by a special MODE pin. Another special pin in the TPS2214 and the TPS2216, named STBY, is provided to select the current rating and the on-resistance of the power switches. With STBY, these devices can be used for normal PC card loads when STBY is high or can be used to power low-power loads when STBY is set low. The only difference between the TPS2214 and the TPS2216 is the package as listed in Table 2.
The TPS2214 was the first 24-pin dual-slot PC card power controller. For cost reduction reasons, the TPS2214A and the TPS2216A used the latest fabrication process and some newer design techniques to achieve the same functionality of the TPS2214 and the TPS2216. The on-resistance of the \( xV_{CC} \) switches had some changes from the non-A versions to A versions, but not much. The current ratings on the \( xV_{CC} \) switches were reduced to 0.75 A from 1 A to limit the voltage drop and power dissipation, but they still meet PCMCIA power requirements. The chip power of these four devices is supplied from either a 5-V or 3.3-V input, similar to the TPS2206.

3.5 TPS2223, TPS2224, and TPS2226

With more PCMCIA controllers using 11-bit serial data interfaces, an 11-bit only serial data interfaced power controller, the TPS2226, was designed. This device is pin compatible with the TPS2206A and has almost the same parameters as the TPS2206A. The major difference between them is that the TPS2226 has an integrated 11-bit serial data interface instead of the 9-bit data interface in the TPS2206A. The TPS2226 is available in both 30-pin SSOP and 32-pin TSSOP packages. The TPS2223 and the TPS2224 are the 24-pin versions of the TPS2226, both of which are available in 24-pin SSOP and 24-pin HTSSOP packages. The only difference between the TPS2223 and the TPS2224 is that the TPS2223 does not have a 12-V input so it does not support 12-V switching. The chip power for the TPS2223, TPS2224, and TPS2226 is only supplied from their 3.3-V inputs.

3.6 TPS2223A, TPS2224A, and TPS2226A

While the TPS2223, TPS2224, and TPS2226 meet all power requirements for PC card applications, they were found to not respond fast enough during a short circuit created by the removal of some Smart cards. Some Smart cards have a close-loop metal trace around the edge of the cards. When the cards are removed with power applied, the power connection may short to ground. This may cause the input supplies to droop and generate a system reset if the drop is big enough. To solve this issue, faster current limiting is required to limit the total power flow during the short-circuit period. To meet this demand, a faster current-limiting version of the TPS2223, TPS2224, and TPS2226 were released to the market. They are the TPS2223A, TPS2224A, and TPS2226A. These devices have the same pin configurations, packages, functions, and parameters as their non-A counterparts. The only difference is that the current-limiting response is faster for the A version devices than the non-A versions.

3.7 TPS2228

Another 11-bit serial data interfaced power controller is the TPS2228. The device supports 5-V, 3.3-V, and 1.8-V power switching and uses the 3.3-V input as the chip power supply. Like the TPS2221, this device supports both PC card and Smart card or Multimedia card applications. The TPS2228 is available in both 30-pin SSOP and 20-pin HTSSOP packages.

4 Typical PC Card Application

Using the TPS2206A as an example, a typical application diagram for dual-slot PC cards is shown in Figure 2.
The serial interface includes the CLOCK, LATCH, and DATA lines which are the same for all serial-interfaced PC card power controllers. The diagram also applies to single-slot controllers and dual-slot parallel-interfaced controllers with modification of the control interface.

5 Other Applications for PC Card Power Controllers

Although PC card power controllers are designed for PC card applications, due to the similarity between PC cards, Smart cards, and Multimedia cards, these controllers can also be used to power Smart cards and Multimedia cards as well. The TPS2228 and TPS2221 support 1.8-V power switching and meet the low-voltage requirements of many Smart cards and Multimedia cards. They are designed to be used in PC card, Smart card, or Multimedia card applications.
6 References of the Data Sheets

http://www-s.ti.com/sc/ds/tps2211.pdf Literature number: SLVS156E
http://www-s.ti.com/sc/ds/tps2211a.pdf Literature number: SLVS282A
http://www-s.ti.com/sc/ds/tps2212.pdf Literature number: SLVS193A
http://www-s.ti.com/sc/ds/tps2221.pdf Literature number: SLVS419A
http://www-s.ti.com/sc/ds/tps2201.pdf Literature number: SLVS094C
http://www-s.ti.com/sc/ds/tps2206.pdf Literature number: SLVS138D
http://www-s.ti.com/sc/ds/tps2206a.pdf Literature number: SLVS449A
http://www-s.ti.com/sc/ds/tps2214.pdf Literature number: SLVS206B
http://www-s.ti.com/sc/ds/tps2216.pdf Literature number: SLVS179D
http://www-s.ti.com/sc/ds/tps2214a.pdf Literature number: SLVS267B
http://www-s.ti.com/sc/ds/tps2223.pdf Literature number: SLVS317
http://www-s.ti.com/sc/ds/tps2224.pdf Literature number: SLVS317
http://www-s.ti.com/sc/ds/tps2226.pdf Literature number: SLVS317
http://www-s.ti.com/sc/ds/tps2223a.pdf Literature number: SLVS428
http://www-s.ti.com/sc/ds/tps2224a.pdf Literature number: SLVS428
http://www-s.ti.com/sc/ds/tps2226a.pdf Literature number: SLVS428
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