Application Report
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Hot Plug PCIExpress Server Input Output Module (SIOM)

Robert Kando *PMP - Systems Power (MAN)*

1 Introduction

This application note outlines an approach to SIOM hot plug using TI's general purpose hot plug controllers, TPS2491 and TPS2041/2. SIOM uses 12 V and 3.3 V for module power. Components that perform the hot plug function are located on the plug in module. SIOM modules can be singlewide or doublewide, each with different current specifications. The schematic drawing and parts list in this application note are for the singlewide module. There are schematic notes for two component changes for doublewide.

SIOM is used for high avability and requires hot swap modules so that the computer system can be repaired while in operation. The operating characteristics of hot plug modules are:

- Limit inrush currents to less than maximum continuous current for the module to prevent a voltage drop and failure to the plug-in module, other bus modules, or the system itself.
- Power the module on and off under control of the computer system which is also controlling the module clock and other bus signal connections.
- Circuit breaker like turn-off on over-current or under voltage events.

2 Supporting Documentation

- PCI Express Server / workstation module electromechanical specification, revision 0.9RD, November 15, 2004
- TPS2041/2 datasheet
- TPS2490/1 datasheet
- TPS2490/1 design tool

3 Singlewide

Two Texas Instrumentssingle channel hot plug controllers were selected, one for each module power supply. The 3.3-V auxiliary supply requirement is 475 mA for singlewide slots. The TPS2041 hot plug controller can support up to 900 mA continuous current using an internal power switch. It requires only a few support components.

The 12-V primary power at 2.08 A require a controller with an external FET. The TPS2490/1 was selected for its small size and intelligent control of the FET switch. The TPS2490 latches off on power fault and the TPS2341 retries at low current over a fixed interval until the fault is cleared. TPS2490/1 need some additional support components.

The TPS2041/2 and TPS2490/1 hot plug controllers have enable inputs and return either power good or fault status to the controlling processor.

4 Doublewide

The doublewide modules have twice the current capacity of the singlewide module. The 3.3-V auxiliary channel is changed to the TPS2042 which has a 1.5-A capacity. The 12-V primary power channel still uses the TPS2491 but has a sense resistor change to accommodate the 4.17-A output.

5 Power Consumption

Singlewide module = Up to 25 W

Doublewide module = Up to 50 W

The singlewide module connector supports the doublewide maximum power (50 W) to allow a doublewide module to draw all its power from a single connector.

Table 1. Table 1 SIOM Power Supply Requirements

POWER RAIL	SINGLE WIDE	DOUBLEWIDE
12 V Bulk		
Voltage tolerance	+/- 15% (max)	+/- 15% (max)
Continuous current	2.08 A (max)	4.17 A (max)
Initial hot-plug capacitance	5000 pF (max)	5000 pF (max)
Input capacitance	500 µF (max)	500 µF (max
3.3 V Aux		
Voltage tolerance	+/- 10% (max)	+/- 10% (max)
Continuous current	475 mA (max)	950 mA (max)
Peak precharge current	475 mA (max)	950 mA (max)
Input capacitance	150 µF (max)	300 µF (max)
Pre-charge pin timing	3 ms (max)	3 ms (max)

6 Power Supply Sequencing

The auxiliary power supply must be applied to the module before or at the same time as the primary power. The module slot connector applies both auxiliary and primary power when the system is turned on. During hot-plug events, the system does not remove power from the module slot connector. The system must drive the module reset (MRST#) signal active (logic 0) any time the primary or auxiliary power goes out of tolerance

7 Power Supply Decoupling

Supply noise may interfere with the recovery of data from a remote upstream PCI Express device. Some basic guidelines to help ensure a quiet power supply are provided below.

The add-in adapter module device decouple value should average 0.01 µF per device VCC pin

For all devices on the add-in card, the trace length between a decoupling capacitor and the power supply or ground via should be less then 0.2 inches (5.08 mm) and be a minimum of 0.02 inches (0.508 mm) in width.

8 Precharge

A precharge resistor is placed between the long and short pin for each voltage. When the connector long pin makes contact with the plug in module, the current through the pre-charge resistor will start to charge the bulk capacitors connected to the short pins.

Peak pre-charge current during hot insertion is determined by the value of the pre-charge resistor. Single wide example: Pre-charge resistor = 3.3 V/475 mA = 7 Ω. 3.3 V_{AUX} pre-charge pin timing is the maximum time ensured during hot insertion from the 3.3 V_{AUX} pre-charge pin mating to the main power pins mating. The time constant with the maximum input capacitance and pre-charge resistor shall not exceed 1/3 of the pre-charge pin timing.

Example: 150 µF x 7 Ω = 1 ms (which is 1/3 of the maximum pre-charge pin timing of 3 ms)

9 System Interconnect

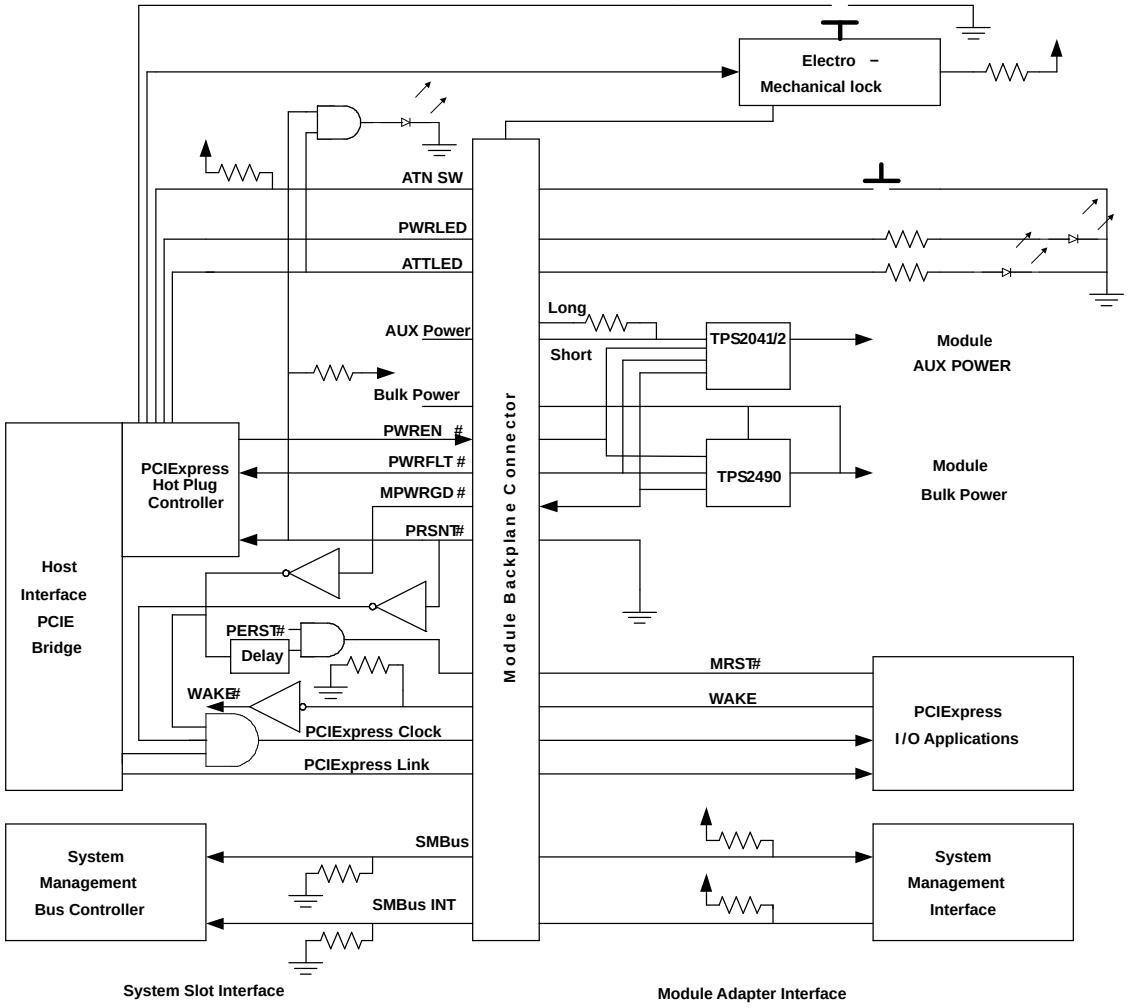


Figure 1. System Interface

Figure 1, shows the module/system interface for hot swap. Note that only the interface signals directly effecting power control are addressed in this application note. The designer needs to consider signals PRSNT#, MRST#, etc. as shown in Figure 1.

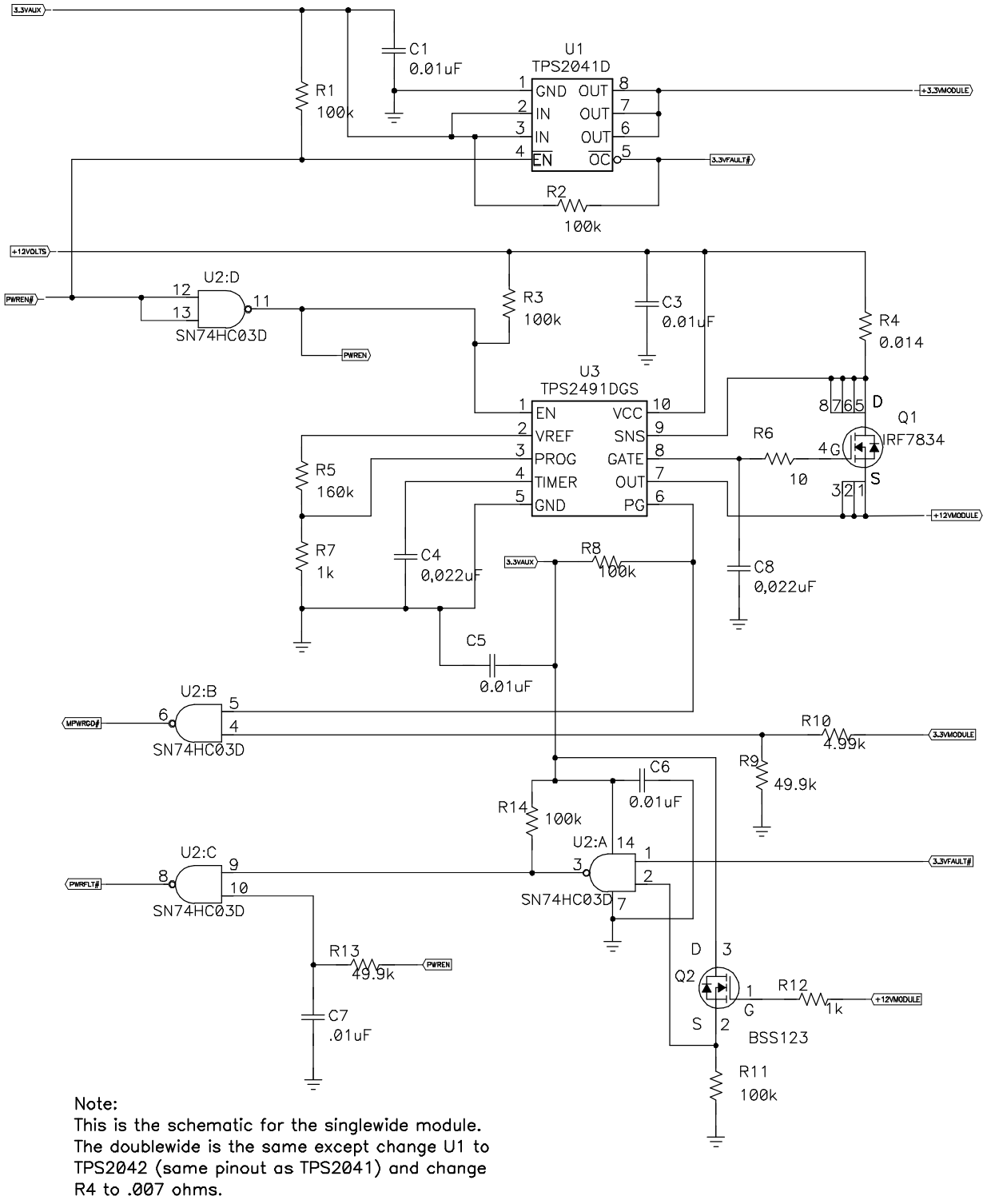
10 Design

Each channel of power control design is taken directly from the Applications Section of the TPS2041/2 and TPS2490/1 datasheets. The TPS2490 has a calculation tool to help select design components. The calculation tool can be downloaded from www.ti.com, Part Number Search TPS2490. The external FET is an N-channel device selected for low $R_{DS(on)}$, good I_{DSS} after de-rating for temperature, and margin on V_{DS}.

Module power is turned on when the module is inserted in its slot and POWEREN# is asserted. Reference the design schematic, Figure 2. A fault on either channel is read by the processor which de-asserts the enable to the module turning both channels off. A power good signal is returned to the processor.

The TPS2041 output status is a fault signal, $\overline{OC}$, and the TPS2491 output status is a power good signal, PG. Additional logic is needed to detect a fault on TPS2491 and power good on TPS2041.

11 Design Schematic



Note:
This is the schematic for the singlewide module. The doublewide is the same except change U1 to TPS2042 (same pinout as TPS2041) and change R4 to .007 ohms.

Figure 2. Design Schematic

12 Power Good

PG from the TPS2491 is used directly at U2B. For the 3.3-V power Good, the 3.3 -V is connected to resistor divider R9, R10. The divider is set for a 2.4-V output at 2.7-V input. If 3.3-V module power drops below approximately 2.7 V, MPWRGD# is de-asserted. The circuit also keeps power good from asserting just after EN is asserted and power is increasing.

Power good is available to the module designer to signal on-board DC-to-DC converters. If other module power supplies receive input from bus power, it may be necessary to provide a power good signal from these supplies and return it to MPWRGD# instead of the circuit shown here.

13 Power Fault

The 3.3-V fault is taken directly from the TPS2041/2. A PWRFLT signal was made from the TPS2490 output voltage. When 12-V module power drops below 2 V max, the FET Q2 turns off and Fault is asserted.

When enable first turns on, a 1-ms delay set by R13 and C7 keeps the PWRFLT from asserting before the 12-V output reaches 2 V. Other module power such as DC-to-DC converters may indicate a system Fault on PWRFLT# if necessary.

14 List of Materials

RefDes	COUNT	Description	MFR	Part Number
C1	1	Capacitor, ceramic, 0.01 μF, 16 V	std	
C3, C5, C6	3	Capacitor, ceramic, 0.01 μF, 16 V	std	
C4, C8	2	Capacitor, ceramic, 0.022 μF	std	
C7	1	Capacitor, ceramic, 0.01 μF, 16 V	std	
Q1	1	MOSFET, N-channel	std	
Q2	1	MOSFET, N-channel, 100 V, 0.17 A, 6 Ω	std	
R1, R2, R3, R8, R11	5	Resistor, chip, 100 kΩ, 1/10 W, 5%	std	
R10	1	Resistor, chip, 31.1 kΩ, 1/10 W, 1%	std	
R12	1	Resistor, chip, 100 kΩ, 1/10 W, 5%	std	
R13	1	Resistor, chip, 1/10 W, 1%	std	
R14	1	Resistor, chip, 1/10 W, 5%	std	
R4	1	Resistor, chip, 0.020 Ω, 1/10 W, 5%	std	
R5	1	Resistor, chip, 69.9 kΩ, 1/10 W, 5%	std	
R6	1	Resistor, chip, 10 Ω, 1/10 W, 5%	std	
R7	1	Resistor, chip, 10 kΩ, 1/10 W, 5%	std	
R9	1	Resistor, chip, 49.9 kΩ, 1/10 W, 1%	std	
U1	1	Power Distribution Switch, 33 mΩ	Texas Instruments	TPS2041D
U2	1	QUAD, NAND GATE, CMOS	Texas Instruments	SN74HC03D
U3	1		Texas Instruments	TPS2491DGS

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