

# design Hot-Swapping And Digital Power Monitoring

# FAQs

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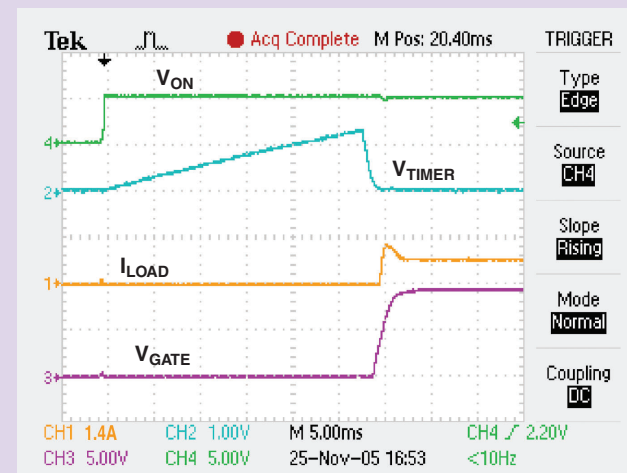
## FREQUENTLY ASKED QUESTIONS

### What is hot-swapping?

During hot-swapping, a module can be plugged into or unplugged from a live supply bus without affecting the overall system operation. The idea probably comes from telephone line cards, whose edge connectors were designed with fingers of different lengths. When the cards were inserted into the backplane, ground was always connected first, followed by the power bus and the I/O pins. That was sufficient for the simple and robust electronics of the public-switched telephone network. But today's routers, servers, and embedded systems often need a hot-swap controller, a sense resistor, and a FET pass transistor as well to provide a more robust and intelligent solution.

### What kind of module needs a hot-swap controller?

Modules with a significant amount of bypass capacitance across the input power line or a failure mode

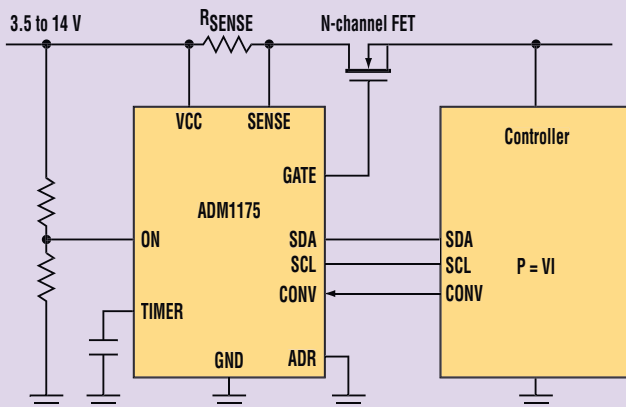


1. These typical power-up waveforms, which are associated with a linear current control loop, limit inrush current at startup as a hot-swappable module is plugged into a live backplane.

that could bring down the main power bus need a hot-swap controller. A closed-loop current-limiting capability that limits the initial charging current to the bypass capacitors keeps the main supply bus voltage from drooping when a new load is added (Fig. 1). It also prevents the connector power contacts from being overloaded by short-term excess currents.

Once the input caps have

charged up, the current-control loop can be used as a protection mechanism to limit any subsequent high currents beyond the design specs for the module, which can be presumed to indicate a short or other failure. So, it's relatively simple to make the controller shut the module down when it senses excess current demand, either permanently until there is a manual reset or in an auto-retry mode.



2. This integrated solution provides accurate closed-loop hot-swap control and digital power monitoring via an external controller.

### Where does power monitoring come in?

Knowing what voltages and currents are present at each point in the system lets designers calculate the power consumption for each power rail. A sense resistor, current sense amplifier, and analog-to-digital converter (ADC) are the key components required to capture and digitize current and voltage data. Digital power monitoring algorithms then can be implemented in the software domain. In a hot-swappable system, this

function is especially useful to monitor the performance of each pluggable subsystem.

### What can the system do with all that information?

This data can be used to make decisions that directly improve the system's efficiency and performance. Consider a server rack consisting of 10 boards, each with a 100-W limit. The 100-W limit per blade slot is enforced, as the power-supply unit for the rack can deliver 1000 W maximum. In a standard system, no blade can operate at above 100 W.

If digital power monitoring is introduced, more intelligent power decisions can be made dynamically as the system operates. If a board is unplugged from a fully populated rack board, there would be 100 W of "extra" unused power. In this case, 10 W of extra power could be delivered to each of the other boards in the system.

The power consumption of the populated boards must be monitored to ensure the overall power budget is not exceeded. This type of power-management scheme allows the system to make the best possible use of the available power budget, and monitoring the power consumption at the subsystem level is an integral part of achieving that aim.

### Why combine basic hot-swap current control and monitoring in one device?

Integrating the hot-swap controller and current sense circuitry means a single sense resistor can be used for both functions, saving components and minimizing power loss (Fig. 2). It also can be difficult to implement these functions separately using a single sense resistor. Lots of calibration may be needed to get two separate circuits working correctly for a given sense resistor. Some compromises may have to be made regarding the performance of each function. And, integrating a sense amplifier and an ADC on the same chip as the controller trims footprint and parts count, saves power, and eliminates noise problems.

# ANALOG DEVICES

## product Q&As

### New Hot-Swap Devices With Integrated Digital Power Monitor

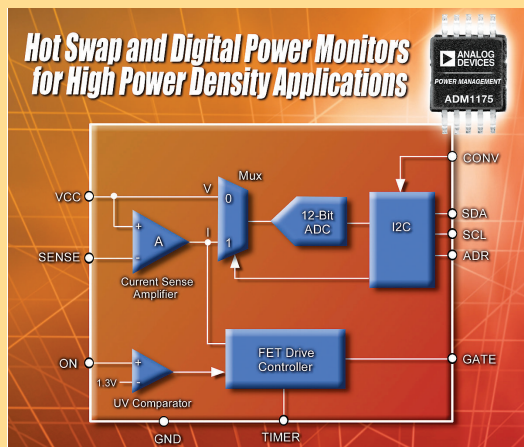
Protect your systems from damaging power and thermal transients.

As processing power density continues to climb in rack-mounted communications systems, so too does the risk of unpredictable and potentially damaging transient power spikes and/or excessive thermal conditions.

The ADM1175/ADM1176/ADM1177/ADM1178 family of products combines a hot-swap controller with an on-board, 12-bit ADC-based digital power monitor.

These devices are full-feature positive hot-swap controllers that allow boards to be safely inserted and removed from a live 2.7- to 16.5-V backplane. These parts also provide precise robust current limiting as well as protection against transient and nontransient short circuits and overcurrent and undervoltage conditions.

In addition to the standard hot-swap functionality, the onboard power monitor enables engineers and technicians to precisely monitor the power profile of each individual line card within a designated rack system. Communication to the power monitor is provided via an onboard I<sup>2</sup>C port.



Part number	Hot-swap control	Voltage/current readback via I <sup>2</sup> C	ON/ ONB pin	CONV pin	SS pin	ALERT/ ALERTB pin	Number of I <sup>2</sup> C addresses	Package	Price
ADM1175	Yes	Yes	Yes	Yes	—	—	4	10-lead MSOP	\$2.80
ADM1176	Yes	Yes	Yes	—	—	—	16	10-lead MSOP	\$2.85
ADM1177	Yes	Yes	Yes	—	Yes	—	4	10-lead MSOP	\$2.90
ADM1178	Yes	Yes	Yes	—	—	Yes	4	10-lead MSOP	\$2.95

Pricing shown is in USD for 1000-unit quantities or less. Alternative pricing is available for larger quantities.

For more information on the ADM1175-78 family and other hot-swap products offered by Analog Devices, please visit [www.analog.com/hotswapped](http://www.analog.com/hotswapped).

Visit [www.digikey.com](http://www.digikey.com) to get real-time pricing and availability on our wide selection of Analog Devices parts!