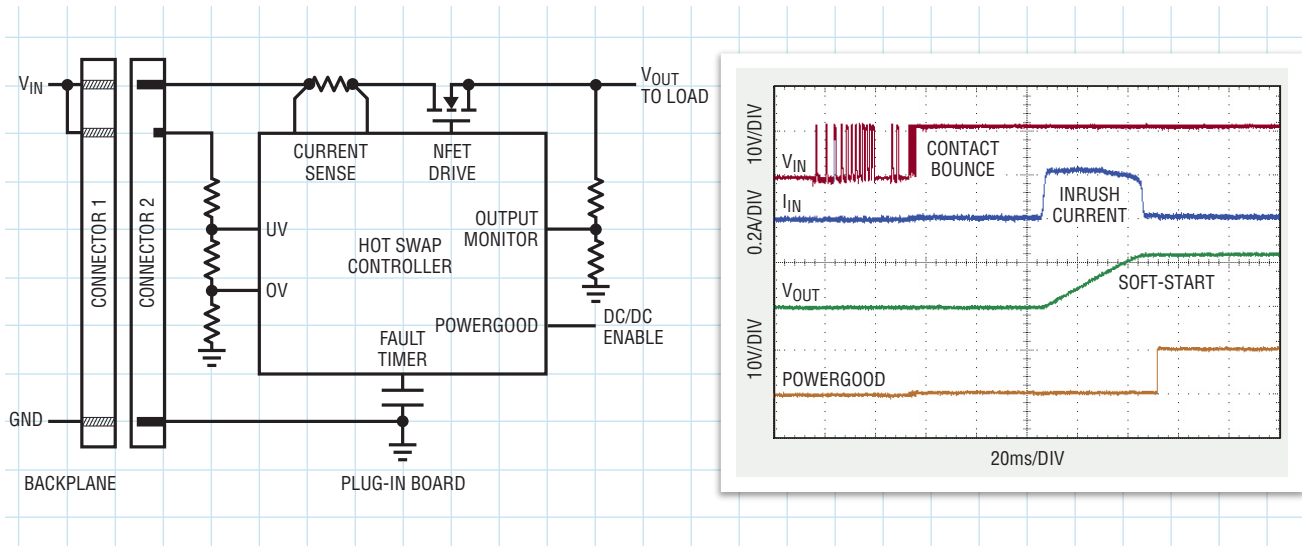


# Hot Swap Controllers



## Inrush Control

## Circuit Breaker

## Telemetry

## UV/OV Protection

Mission-critical servers and communication equipment must continue operating even as circuit boards and cards are plugged in or pulled out for maintenance and capacity adjustment. Hot swap controllers enable board insertion and removal from live systems by soft-starting the supply, avoiding connector sparks, backplane supply glitches and card resets. In addition to inrush current control, hot swap controllers provide fault isolation with a circuit breaker, undervoltage (UV) and overvoltage (OV) lockout, and digital telemetry of board electrical parameters. Linear Technology delivers leading-edge hot swap innovations and tough, dependable protection for high availability systems.

- Enables Safe Board Insertion and Removal from Live Systems
- Controls Up to  $\pm 80V$ , 200A Supply Rails
- Protects System from Overload and Short-Circuit at Board
- Validates Input Supply Against UV/OV Lockout Thresholds
- Provides Board Voltage, Current, Power and Energy Telemetry
- Over 200 Million Hot Swap Controllers Shipped

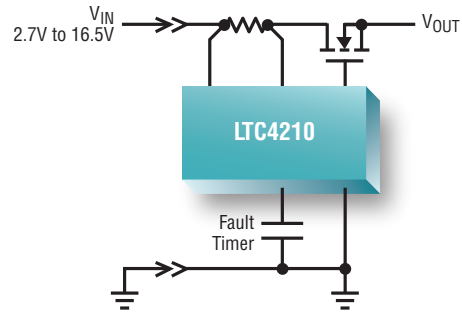
| Year | First-to-Market                       |
|------|---------------------------------------|
| 1996 | Dual Supply Controller                |
| 2001 | Triple Supply Controller              |
| 2004 | 48V Controller with Telemetry         |
| 2005 | -48V Controller with Telemetry        |
| 2006 | 12V Controller with Telemetry         |
| 2015 | Integrated Controller with Tested SOA |
| 2015 | SOA Sharing Controller with EEPROM    |



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## Single Positive Supply Hot Swap Controllers

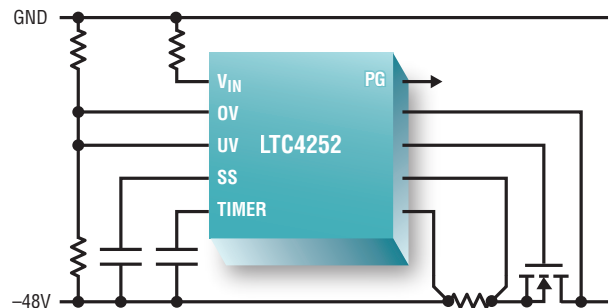
- Controls Supply in the 0V to 80V Range
- Load Soft-Start with Ramped Output or in Current Limit
- Circuit Breaker (CB) for Overcurrent Protection
- Adjustable Circuit Breaker Threshold and Delay
- Current Limiting (CL) Until CB Opens After Fault Timer Expires
- Adjustable Undervoltage/Overvoltage Thresholds



| Device                | V <sub>IN</sub> | I <sub>Q</sub> | UV | OV | CL | PG | Features   | Demo Board | Package-Pins (mm × mm) |
|-----------------------|-----------------|----------------|----|----|----|----|--|------------|------------------------|
| LTC <sup>®</sup> 4216 | 0V to 6V        | 1.68mA         | •  |    | •  | •  | Controls 0V, CL Above CB Level   | NA         | 4 × 3 DFN-12, MSOP-10  |
| LTC4210               | 2.7V to 16.5V   | 655μA          | •  |    | •  |    | Simple, Small, 6-Pin SOT-23  | DC628      | SOT23-6                |
| LTC4211               | 2.5V to 16.5V   | 1mA            | •  |    |    | •  | 2-Level Slow and Fast CB   | DC536      | SO-8, MSOP-8/10        |
| LTC4218               | 2.9V to 26.5V   | 1.68mA         | •  | •  | •  | •  | 15mV±5% CB, Current Monitoring   | DC1052     | 5 × 3 DFN-16, SSOP-16  |
| LTC4231               | 2.7V to 36V     | 4μA            | •  | •  | •  | •  | 4μA I <sub>Q</sub> , 0.3μA I <sub>SHDN</sub> , Survives ±40V <sub>IN</sub> | DC2161     | 3 × 3 QFN-12, MSOP-12  |
| LT <sup>®</sup> 4256  | 10.8V to 80V    | 1.84mA         | •  | •  | •  | •  | Survives 100V <sub>IN</sub> , Signals Light Load                           | DC1354     | SO-8, SSOP-16          |

## Negative Supply Hot Swap Controllers

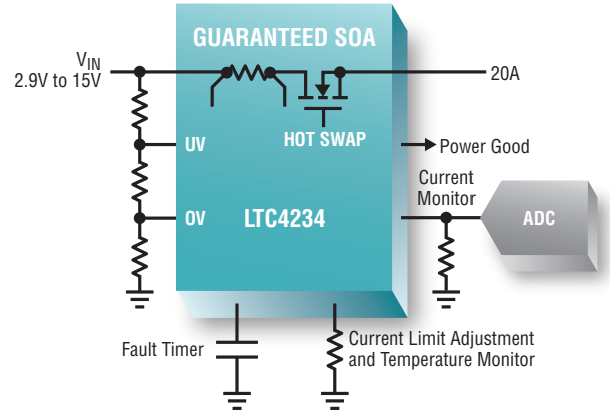
- Controls Supply in the 0V to Above -80V Range
- Floating Topology with Internal Shunt Regulator Enables Very High Voltage Operation
- 3-Stage Overcurrent Protection (OCP): Filtered Circuit Breaker, Current Limit, Fast Comparator
- Adjustable Circuit Breaker Threshold and Delay
- Soft-Started Current Limit
- Telecom-Compatible UV/OV Thresholds



| Device  | V <sub>IN</sub> | UV | OV | CL | PG | Features                                       | Demo Board | Package-Pins (mm × mm) |
|---------|-----------------|----|----|----|----|--|------------|------------------------|
| LTC4214 | 0V to -16V      | •  | •  | •  | •  | 3-Stage OCP, V <sub>DS</sub> Accelerated Timer | NA         | MSOP-10                |
| LT4250  | -18V to -80V    | •  | •  | •  | •  | 500μs Internal Fault Timer                     | DC429      | SO-8, PDIP-8           |
| LTC4251 | -15V to > -80V  | •  | •  | •  |    | 3-Stage OCP, Simple, Small, 6-Pin SOT-23       | NA         | SOT23-6                |
| LTC4252 | -15V to > -80V  | •  | •  | •  | •  | 3-Stage OCP, V <sub>DS</sub> Accelerated Timer | DC787      | MSOP-8/10              |
| LTC4253 | -15V to > -80V  | •  | •  | •  | •  | LTC4252 Features + 3 Sequenced PG              | NA         | SSOP-16                |

## Hot Swap Controllers with Integrated MOSFET

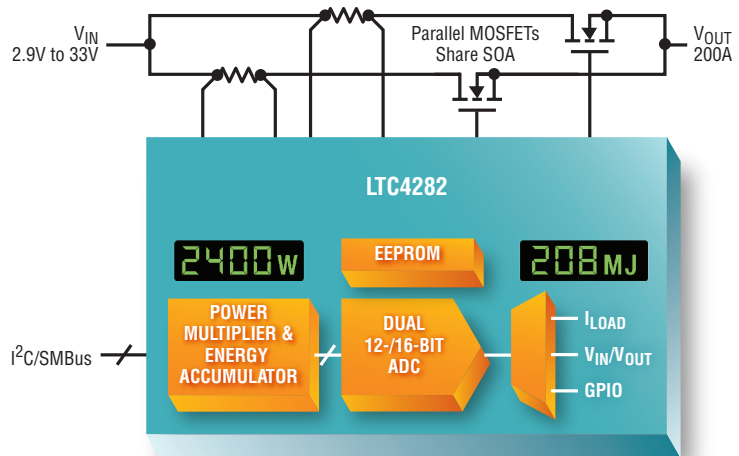
- Internal Power MOSFET and Current Sense Resistor
- Controllers for 2A to 20A Applications
- Output Voltage Soft-Start
- Foldback Current-Limited Circuit Breaker with Adjustable Delay
- Resistor-Adjustable Circuit Breaker Threshold
- Current & Temperature Monitor, Power Good and Fault Outputs
- UV, OV and Overtemperature Protection
- Production Tested and Guaranteed SOA
- Pin-Compatible Controllers



| Device  | V <sub>IN</sub> | Max I <sub>LOAD</sub> | R <sub>ON</sub> | UV | OV | CL | PG | Tested SOA | Pin Compatible | Temp Grades | Demo Board | Package-Pins (mm × mm) |
|---------|-----------------|-----------------------|-----------------|----|----|----|----|------------|----------------|-------------|------------|------------------------|
| LTC4217 | 2.9V to 26.5V   | 1.85A                 | 33mΩ            | •  | •  | •  | •  |            | LTC4232        | C, I, H     | DC1051     | 5 × 3 DFN-16, TSSOP-20 |
| LTC4219 | 5V or 12V       | 5A                    | 33mΩ            |    | •  | •  | •  |            | NA             | C, I        | DC1594     | 5 × 3 DFN-16           |
| LTC4232 | 2.9V to 15V     | 5A                    | 33mΩ            | •  | •  | •  | •  |            | LTC4217        | C, I        | DC1886     | 5 × 3 DFN-16           |
| LTC4233 | 2.9V to 15V     | 10A                   | 10mΩ            | •  | •  | •  | •  | •          | LTC4234        | C, I, H     | DC2116     | 5 × 9 QFN-38           |
| LTC4234 | 2.9V to 15V     | 20A                   | 4mΩ             | •  | •  | •  | •  | •          | LTC4233        | C, I, H     | DC2116     | 5 × 9 DFN-38           |

## Hot Swap Controllers with Digital Telemetry

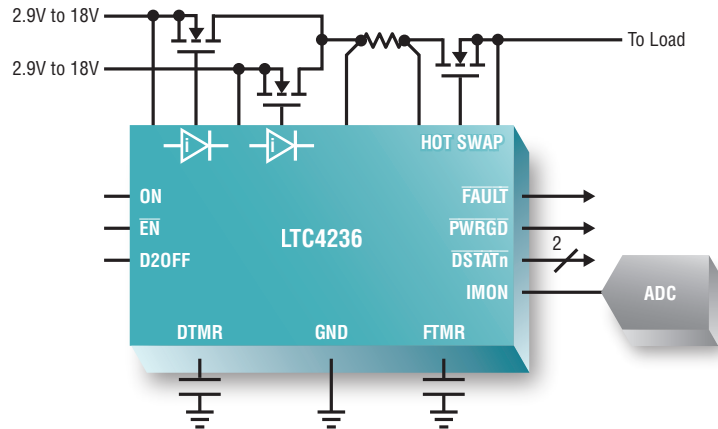
- Monitors Supply Voltage, Current, Power and Energy
- I<sup>2</sup>C/SMBus Digital Interface for Configuration and Data Readback
- ADC with Low Total Unadjusted Error (TUE)
- Internal EEPROM for Nonvolatile Configuration and Fault Log
- Resistor- or Digitally Adjustable Circuit Breaker and UV/OV Thresholds



| Device  | Supplies | V <sub>IN</sub> | ADC   |      | Monitor |   |   |   | EEPROM | Features                    | Demo Board | Package-Pins (mm × mm)   |
|---------|----------|-----------------|-------|------|---------|---|---|---|--------|-----------------------------|------------|--------------------------|
|         |          |                 | Bits  | TUE  | V       | I | P | E |        |                             |            |                          |
| LTC4215 | 1        | 2.9V to 15V     | 8     | 2%   | •       | • |   |   |        | dl/dt Controlled Inrush     | DC874      | 4 × 5 QFN-24, SSOP-16    |
| LTC4281 | 1        | 2.9V to 33V     | 12/16 | 0.7% | •       | • | • | • | •      | Adjust Thresholds Digitally | DC2278     | 4 × 5 QFN-28             |
| LTC4282 | 1        | 2.9V to 33V     | 12/16 | 0.7% | •       | • | • | • | •      | LTC4281 + SOA Sharing       | DC2024     | 5 × 5 QFN-32             |
| LTC4260 | 1        | 8.5V to 80V     | 8     | 2%   | •       | • |   |   |        | Survives 100V <sub>IN</sub> | DC786      | 5 × 5 QFN-32, SO/SSOP-24 |
| LTC4261 | 1        | -12V to >-80V   | 10    | 1.8% | •       | • |   |   |        | Floating Topology           | DC998      | 4 × 5 QFN-24, SSOP-28    |
| LTC4222 | 2        | 2.9V to 29V     | 10    | 1%   | •       | • |   |   |        | dl/dt Controlled Inrush     | DC1134     | 5 × 5 QFN-32, SSOP-36    |
| LTC4245 | 4        | ±12V, 5V, 3.3V  | 8     | 2%   | •       | • |   |   |        | For cPCI/PCIe, Sequencing   | DC985      | 5 × 7 QFN-38, SSOP-36    |

## Hot Swap Controllers with Ideal Diode

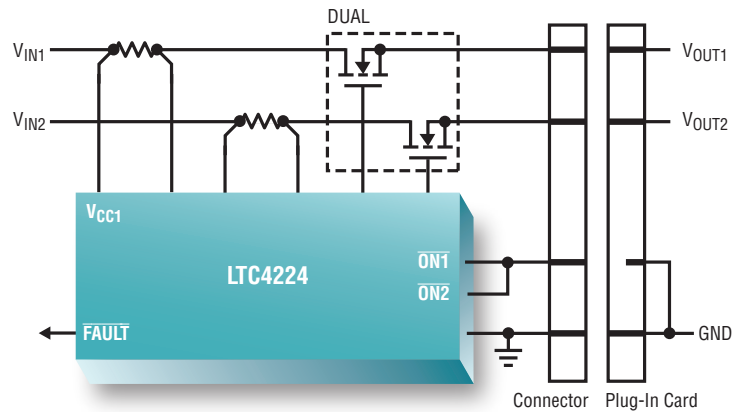
- Ideal Diode (ID) for Low Loss Redundant Supply Active ORing, Reverse Current Blocking and Supply Holdup
- Eliminates Power Schottky Diodes and Heat Sinks
- Fast 0.5 $\mu$ s Ideal Diode Turn-On and Turn-Off Time
- Current-Limited Circuit Breaker with Adjustable Delay
- Current Monitoring (CM), Power Good, CB Fault, and Diode Status (DS) Outputs



| Device  | Configuration | V <sub>IN</sub> | UV | OV | Output |    | Features                            | Demo Board | Package-Pins (mm × mm) |
|---------|---------------|-----------------|----|----|--------|----|-------------------------------------|------------|------------------------|
|         |               |                 |    |    | CM     | DS |                                     |            |                        |
| LTC4229 | ID + HS       | 2.9V to 18V     | •  | •  |        | •  | Prioritizer, Adj Debounce Delay     | DC2060     | 4 × 5 QFN-24, SSOP-24  |
| LTC4227 | 2 • ID + HS   | 2.9V to 18V     | •  |    |        |    | 100ms/1.6ms Debounce Options        | DC1625     | 4 × 5 QFN-20, SSOP-16  |
| LTC4235 | 2 • ID + HS   | 9V to 14V       | •  |    | •      |    | Preset 12V Power Good Threshold     | DC2315     | 4 × 5 QFN-20           |
| LTC4236 | 2 • ID + HS   | 2.9V to 18V     | •  |    | •      | •  | Prioritizer, Adj Debounce Delay     | DC2314     | 4 × 5 QFN-28           |
| LTC4228 | 2 • [ID + HS] | 2.9V to 18V     | •  |    |        | •  | Complete Dual for $\mu$ TCA Systems | DC1899     | 4 × 5 QFN-28, SSOP-28  |

## Multiple Supply Hot Swap Controllers

- Compact Solution for Multiple Supplies
- Supports Advanced Mezzanine Card (AMC), MicroTCA ( $\mu$ TCA), PCI Express (PCIe), CompactPCI (cPCI), and PCI Standards
- Internal MOSFET for Low Current Supply Rails
- Circuit Breaker for Each Supply with Coupled or Independent Turn-Offs on Fault



| Device  | Supplies | V <sub>IN</sub> | UV | OV | CL | PG | Independent | Features   | Demo Board | Package-Pins (mm × mm) |
|---------|----------|-----------------|----|----|----|----|-------------|--|------------|------------------------|
|         |          |                 |    |    |    |    |             |  |            |                        |
| LTC4221 | 2        | 1V to 13.5V     | •  | •  |    | 2  |             | Sequencing, 2-Level Slow/Fast CB                 | DC1355     | SSOP-16                |
| LTC4223 | 2        | 12V, 3.3V       | •  |    | •  | 2  |             | AMC, Internal Aux FET, I <sub>12V</sub> Monitor  | DC1162     | 5 × 4 DFN-16, SSOP-16  |
| LT4220  | 2        | ±2.7V to ±16.5V | •  | •  |    | 1  |             | Supply Tracking Mode                             | DC665      | SSOP-16                |
| LTC4226 | 2        | 4.5V to 44V     | •  |    | •  | 0  | •           | 3-Selectable CL:CB Ratio                         | DC1627     | 3 × 3 QFN-16, MSOP-16  |
| LTC4230 | 3        | 1.7V to 16.5V   |    |    |    | 3  |             | 2-Level Slow/Fast CB                             | DC537      | SSOP-20                |
| LTC4244 | 4        | ±12V, 5V, 3.3V  | •  |    | •  | 1  |             | For cPCI, Internal ±12V FETs                     | NA         | SSOP-20                |
| LTC4241 | 5        | ±12V, 5V, 3.3V  | •  |    | •  | 1  |             | PCI with 3.3V <sub>AUX</sub> , Internal ±12V FET | NA         | SSOP-20                |
| LTC4242 | 6        | 12V, 3.3V       | •  |    | •  | 4  | •           | For 2 PCIe Slots, Internal Aux FETs              | DC1054     | 5 × 7 QFN-38, SSOP-36  |