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 or capacity adjustment. Hot swap controllers enable board insertion and removal from live systems by soft starting the supply, which avoids 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. Analog Devices delivers leading-edge hot swap innovations and tough, dependable protection for high availability systems.

Electronic Circuit Breakers

**Key Features:**
- Fast disconnection of loads during overcurrent or short circuits
- Accurate fixed or adjustable ECB thresholds
- Minimal channel resistance increases power efficiency
- Protect against inrush current, overvoltage (OV), undervoltage (UV), reverse input (RI), and reverse current (RC)
- Compact solution for one or more multiple loads

<table>
<thead>
<tr>
<th>Device</th>
<th># Loads</th>
<th>Load Voltage (V)</th>
<th>Load Current Threshold</th>
<th>$R_{on}$ (mΩ)</th>
<th>Inrush</th>
<th>OV</th>
<th>UV</th>
<th>RI</th>
<th>RC</th>
<th>Temp Range (°C)</th>
<th>Demo Board</th>
<th>Package (mm × mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC4213</td>
<td>1</td>
<td>0 to 6</td>
<td>+3 selectable</td>
<td>Ext FET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-40 to +85</td>
<td>DC872</td>
<td>3 × 2, 8-lead DFN</td>
</tr>
<tr>
<td>LTC4381</td>
<td>1</td>
<td>2.5 to 5.5</td>
<td>Ext $R_F$ + ext FET</td>
<td>Ext C</td>
<td>5.8 V</td>
<td>Ext FET</td>
<td>-40 to +125</td>
<td>DC1506</td>
<td>2 × 2, 8-lead DFN, 8-lead TSOT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTC4382</td>
<td>1</td>
<td>2.5 to 5.5</td>
<td>Ext $R_F$ + ext FET</td>
<td>Ext C</td>
<td>5.8 V</td>
<td>Ext FET</td>
<td>-40 to +125</td>
<td>DC1575</td>
<td>3 × 2, 8-lead DFN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTC4358</td>
<td>1</td>
<td>2.5 to 60</td>
<td>Ext $R_F$ + ext FET</td>
<td>Ext C Ext R</td>
<td>-40 V</td>
<td>Ext FET</td>
<td>-40 to +125</td>
<td>DC2498</td>
<td>3 × 3, 10-lead DFN, 10-lead MSOP</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>LTC4347</td>
<td>2</td>
<td>2.7 to 16.5</td>
<td>Ext R + ext FET</td>
<td>Ext C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-40 to +85</td>
<td>DC3358</td>
<td>8-lead SO, 16-lead SSDP</td>
</tr>
<tr>
<td>LTC4246</td>
<td>2</td>
<td>15 to 65</td>
<td>230 mA to 1.2 A</td>
<td>75</td>
<td>1 A</td>
<td>Ext R Ext R</td>
<td>2 ECBs</td>
<td>-40 to +125</td>
<td>DC2733</td>
<td>3 × 3, 16-lead DFN, 16-lead MSOP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTC4246</td>
<td>8</td>
<td>0 to 15.2</td>
<td>50 mA to 1.5 A</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 ECBs</td>
<td>DC2945</td>
<td>3 × 5, 24-lead DFN</td>
</tr>
</tbody>
</table>
Single Positive Supply Hot Swap Controllers

**Key Features:**
- Controls supply in the 0 V to 80 V 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

<table>
<thead>
<tr>
<th>Device</th>
<th>$V_{IN} (V)$</th>
<th>$I_{in}$</th>
<th>UV</th>
<th>OV</th>
<th>CL</th>
<th>PG</th>
<th>Features</th>
<th>Demo Board</th>
<th>Package (mm × mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC4216</td>
<td>0 to 6</td>
<td>1.68 mA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>Controls OV, CL above CB level</td>
<td>—</td>
<td>4 × 3, 12-lead DFN, 10-lead MSOP</td>
</tr>
<tr>
<td>LTC4210</td>
<td>2.7 to 16.5</td>
<td>655 μA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>Simple, small, 6-lead SOT-23</td>
<td>DC628</td>
<td>6-lead TSOT-23</td>
</tr>
<tr>
<td>ADM1177/ADM177/ADM172</td>
<td>1.6 to 16.5</td>
<td>670 μA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>Separate $V_{in}$/current monitor/aux comp</td>
<td>EVAL-ADMxxxx</td>
<td>8-lead TSOT</td>
</tr>
<tr>
<td>LTC4211</td>
<td>2.5 to 16.5</td>
<td>1 mA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>Start-up CL, 2-level slow, and fast CB</td>
<td>DC536</td>
<td>8-lead SO, 8-lead MSOP, 10-lead MSOP</td>
</tr>
<tr>
<td>LTC4219</td>
<td>2.9 to 26.5</td>
<td>1.68 mA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>16 mV, ±5% CB, current monitoring</td>
<td>DC1052</td>
<td>5 × 3, 16-lead DFN, 16-lead SSOP</td>
</tr>
<tr>
<td>LTC4231</td>
<td>2.7 to 38</td>
<td>4 μA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>4 μA, 0.3 μA $I_{in}$, survives ±40 $V_{in}$</td>
<td>DC2181</td>
<td>3 × 3, 12-lead DFN, 12-lead MSOP</td>
</tr>
<tr>
<td>LTC4266</td>
<td>10.8 to 80</td>
<td>1.84 mA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>Survives 100 $V_{in}$ signals light load</td>
<td>DC1354</td>
<td>8-lead SO, 16-lead SSOP</td>
</tr>
<tr>
<td>LTC4237/ LTC4238</td>
<td>6.5 to 80</td>
<td>3 mA</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>SOA sharing (LTC4238) parallelable</td>
<td>DC2982/DC2914</td>
<td>4 × 5, 20-lead DFN, 2 × 5, 24-lead QFN</td>
</tr>
</tbody>
</table>

Hot Swap Controllers with Digital Telemetry

**Key Features:**
- Monitors supply voltage, current, power, energy, and temperature
- PC/SMBus/PMBus 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 undervoltage/overvoltage thresholds

<table>
<thead>
<tr>
<th>Device</th>
<th>Supplies</th>
<th>$V_{IN} (V)$</th>
<th>ADC</th>
<th>Monitor</th>
<th>EEPROM PMBus</th>
<th>Features</th>
<th>Demo Board</th>
<th>Package (mm × mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC4215/LTC4280</td>
<td>1</td>
<td>2.9 to 15</td>
<td>8</td>
<td>2</td>
<td>•</td>
<td>$d/dt$ controlled inrush</td>
<td>DC974</td>
<td>4 × 5, 24-lead DFN, 16-lead SSDP</td>
</tr>
<tr>
<td>ADM1278</td>
<td>1</td>
<td>4.5 to 20</td>
<td>12</td>
<td>0.35</td>
<td>•</td>
<td>•</td>
<td>EVAL-ADM1278</td>
<td>5 × 5, 32-lead LFCSIP</td>
</tr>
<tr>
<td>LTC4280/LTC4282</td>
<td>1</td>
<td>2.9 to 33</td>
<td>12/16</td>
<td>0.7</td>
<td>•</td>
<td>•</td>
<td>DC2278/DC2024</td>
<td>4 × 5, 28-lead DFN, 5 × 5, 32-lead OFN</td>
</tr>
<tr>
<td>ADM1272</td>
<td>1</td>
<td>16 to 80</td>
<td>12</td>
<td>0.4</td>
<td>•</td>
<td>Survives 120 $V_{in}$</td>
<td>EVAL-ADM1272</td>
<td>7 × 8, 48-lead LFCSIP</td>
</tr>
<tr>
<td>LTC4260</td>
<td>8.5 to 80</td>
<td>8</td>
<td>2</td>
<td>•</td>
<td>Survives 100 $V_{in}$</td>
<td>DC786</td>
<td>5 × 5, 32-lead DFN, 24-lead SO, 24-lead SSOP</td>
<td></td>
</tr>
<tr>
<td>ADM1075</td>
<td>1</td>
<td>–35 to &gt;80</td>
<td>12</td>
<td>0.8</td>
<td>•</td>
<td>•</td>
<td>EVAL-ADM1075</td>
<td>5 × 5, 28-lead LFCSIP, 28-lead TSSOP</td>
</tr>
<tr>
<td>LTC4261</td>
<td>1</td>
<td>–12 to &gt;80</td>
<td>10</td>
<td>1.8</td>
<td>•</td>
<td>Floating topology</td>
<td>DC998</td>
<td>4 × 5, 24-lead DFN, 29-lead SSOP</td>
</tr>
<tr>
<td>LTC4283/LTC4284</td>
<td>1</td>
<td>–9 to &gt;80</td>
<td>16</td>
<td>0.7</td>
<td>•</td>
<td>•</td>
<td>DC2490/DC2470</td>
<td>5 × 7, 38-lead DFN, 5 × 8, 44-lead OFN</td>
</tr>
<tr>
<td>LT81010</td>
<td>1</td>
<td>–1000 to +1000</td>
<td>10</td>
<td>1.8</td>
<td>•</td>
<td>5 kW rms isolation</td>
<td>DC243</td>
<td>22 × 9 × 5.16 BGA</td>
</tr>
<tr>
<td>LTC4222</td>
<td>2</td>
<td>2.9 to 29</td>
<td>10</td>
<td>1</td>
<td>•</td>
<td>$d/dt$ controlled inrush</td>
<td>DC134</td>
<td>5 × 5, 32-lead OFN, 36-lead SSDP</td>
</tr>
<tr>
<td>LTC4245</td>
<td>4</td>
<td>±12, 5, 3.3</td>
<td>8</td>
<td>2</td>
<td>•</td>
<td>For cPCI/PCIe sequencing</td>
<td>DC885</td>
<td>5 × 7, 38-lead OFN, 36-lead SSDP</td>
</tr>
</tbody>
</table>
Key Features:
► Internal power MOSFET and current sense resistor
► Controllers for up to 50 A applications
► Foldback current-limited circuit breaker with adjustable delay
► Current and temperature monitor, power-good, and fault outputs
► Undervoltage, overvoltage, and overtemperature protection
► Production tested and guaranteed SOA
► Pin-compatible controllers

Hot Swap Controllers with Integrated MOSFET

<table>
<thead>
<tr>
<th>Device</th>
<th>VIN (V)</th>
<th>Max ILOAD (A)</th>
<th>RDS (mΩ)</th>
<th>UV</th>
<th>OV</th>
<th>CL</th>
<th>PG</th>
<th>Tested SOA</th>
<th>Pin Comp</th>
<th>Temp Range (°C)</th>
<th>Demo Board</th>
<th>Package (mm × mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC4217</td>
<td>2.9 to 26.5</td>
<td>1.85</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>LTC4232</td>
<td>-40 to +125</td>
<td>DC1051</td>
<td>5 × 3, 16-lead DFN, 20-lead TSSOP</td>
</tr>
<tr>
<td>LTC4219</td>
<td>5 or 12</td>
<td>5</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>–</td>
<td>-40 to +85</td>
<td>DC1594</td>
<td>5 × 3, 16-lead DFN</td>
</tr>
<tr>
<td>LTC4232</td>
<td>2.9 to 15</td>
<td>5</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>LTC4277</td>
<td>-40 to +85</td>
<td>DC1888</td>
<td>5 × 3, 16-lead DFN</td>
</tr>
<tr>
<td>LTC4233</td>
<td>2.9 to 15</td>
<td>10</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>LTC4234</td>
<td>-40 to +125</td>
<td>DC2716</td>
<td>5 × 9, 38-lead QFN</td>
</tr>
<tr>
<td>LTC4234</td>
<td>2.9 to 15</td>
<td>20</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>LTC4233</td>
<td>-40 to +125</td>
<td>DC2716</td>
<td>5 × 9, 38-lead QFN</td>
</tr>
<tr>
<td>LTC4290</td>
<td>2.9 to 15</td>
<td>50</td>
<td>1.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>–</td>
<td>-40 to +125</td>
<td>DC3024</td>
<td>5 × 8, 36-lead QFN</td>
</tr>
</tbody>
</table>

Negative Supply Hot Swap Controllers

Key Features:
► Controls supply in the 0 V to above −80 V range
► Floating topology with internal shunt regulator enables very high voltage operation
► 3-stage overcurrent protection (OCP): filtered circuit breaker, current limit, fast comparator
► Telecom-compatible undervoltage/overvoltage thresholds

<table>
<thead>
<tr>
<th>Device</th>
<th>VIN (V)</th>
<th>UV</th>
<th>OV</th>
<th>CL</th>
<th>PG</th>
<th>Features</th>
<th>Demo Board</th>
<th>Package (mm × mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC4244</td>
<td>0 to −16</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>3-stage OCP, $V_{in}$ accelerated timer</td>
<td>–</td>
<td>10-lead MSOP</td>
</tr>
<tr>
<td>LTC4250</td>
<td>−18 to −80</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>500 µs internal fault timer</td>
<td>DC429</td>
<td>8-lead SO, 8-lead PDIP</td>
</tr>
<tr>
<td>LTC4251</td>
<td>−15 to &gt; −80</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>3-stage OCP, simple, small, 6-lead SDT-23</td>
<td>–</td>
<td>6-lead TSO1-23</td>
</tr>
<tr>
<td>LTC4252</td>
<td>−15 to &gt; −80</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>3-stage OCP, $V_{in}$ accelerated timer</td>
<td>DC787</td>
<td>8-lead MSOP, 10-lead MSOP</td>
</tr>
<tr>
<td>LTC4253</td>
<td>−15 to &gt; −80</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>LTC4252 features plus 3 sequenced PG</td>
<td>–</td>
<td>16-lead SSOP</td>
</tr>
</tbody>
</table>
Hot Swap Controllers with Ideal Diode

Key Features:
► Ideal diode (ID) for low loss redundant supply active OR’ing, reverse current blocking, and supply holdup
► Eliminates power Schottky diodes and heat sinks
► Fast 0.5 µs ideal diode turn-on and turn-off time
► Current-limited circuit breaker with adjustable delay
► Current monitoring (CM), power-good, circuit breaker fault, and diode status (DS) outputs

<table>
<thead>
<tr>
<th>Device</th>
<th>Configuration</th>
<th>VIN (V)</th>
<th>UV</th>
<th>OV</th>
<th>CM</th>
<th>DS</th>
<th>Features</th>
<th>Demo Board</th>
<th>Package (mm x mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC4229</td>
<td>ID + HS</td>
<td>2.9 to 18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prioritizer, adj debounce delay</td>
<td>DC2060</td>
<td>4 x 5, 24-lead QFN, 24-lead SSOP</td>
</tr>
<tr>
<td>LTC4227</td>
<td>2 x ID + HS</td>
<td>2.9 to 18</td>
<td></td>
<td></td>
<td></td>
<td>100 ms/1.6 ms debounce options</td>
<td>DC1625</td>
<td>4 x 5, 20-lead QFN, 16-lead SOP</td>
<td></td>
</tr>
<tr>
<td>LTC4235</td>
<td>2 x ID + HS</td>
<td>9 to 14</td>
<td></td>
<td></td>
<td></td>
<td>Preset 12 V power-good threshold</td>
<td>DC2305</td>
<td>4 x 5, 20-lead QFN</td>
<td></td>
</tr>
<tr>
<td>LTC4236</td>
<td>2 x ID + HS</td>
<td>2.9 to 18</td>
<td></td>
<td></td>
<td></td>
<td>Prioritizer, adj debounce delay</td>
<td>DC2334</td>
<td>4 x 5, 28-lead QFN</td>
<td></td>
</tr>
<tr>
<td>LTC4228</td>
<td>2 x [ID + HS]</td>
<td>2.9 to 18</td>
<td></td>
<td></td>
<td></td>
<td>Complete dual for µTCA systems</td>
<td>DC1899</td>
<td>4 x 5, 28-lead QFN, 28-lead SOP</td>
<td></td>
</tr>
</tbody>
</table>

Multiple Supply Hot Swap Controllers

Key Features:
► Compact solution for multiple supplies
► Supports Advanced Mezzanine Card (AMC), MicroTCA (µTCA), 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

<table>
<thead>
<tr>
<th>Device</th>
<th>Supplies</th>
<th>VIN (V)</th>
<th>UV</th>
<th>OV</th>
<th>CL</th>
<th>PG</th>
<th>Independent</th>
<th>Features</th>
<th>Demo Board</th>
<th>Package (mm x mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC4224</td>
<td>2</td>
<td>1 to 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Simple, small, internal timers</td>
<td>DC1364</td>
<td>3 x 2, 10-lead QFN, 10-lead SSOP</td>
<td></td>
</tr>
<tr>
<td>LTC4221</td>
<td>2</td>
<td>1 to 13.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sequencing, 2-level slow/fast CB</td>
<td>DC1355</td>
<td>16-lead SSOP</td>
<td></td>
</tr>
<tr>
<td>LTC4223</td>
<td>2</td>
<td>12, 3.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AMC, internal aux FET, Ivo monitor</td>
<td>DC1822</td>
<td>5 x 4, 16-lead QFN, 16-lead SSOP</td>
<td></td>
</tr>
<tr>
<td>LTC4220</td>
<td>2</td>
<td>±2.7 to ±16.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Supply tracking mode</td>
<td>DC686</td>
<td>16-lead SSOP</td>
<td></td>
</tr>
<tr>
<td>LTC4226</td>
<td>2</td>
<td>4.5 to 44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-selectable CL:CB ratio</td>
<td>DC1627</td>
<td>3 x 3, 18-lead QFN, 18-lead SSOP</td>
<td></td>
</tr>
<tr>
<td>LTC4230</td>
<td>3</td>
<td>1.7 to 18.5</td>
<td></td>
<td></td>
<td></td>
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<td>2-level slow/fast circuit breaker</td>
<td>DC537</td>
<td>20-lead SOP</td>
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<td>±12, 5, 3.3</td>
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<td>For cPCI, internal ±12 V FETs</td>
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<td>PCI with 3.3 Vaux, internal ±12 V FET</td>
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<td>20-lead SSOP</td>
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<td>12, 3.3</td>
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<td>For two PCIe slots, internal aux FETs</td>
<td>DC1054</td>
<td>5 x 7, 38-lead QFN, 38-lead SSOP</td>
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