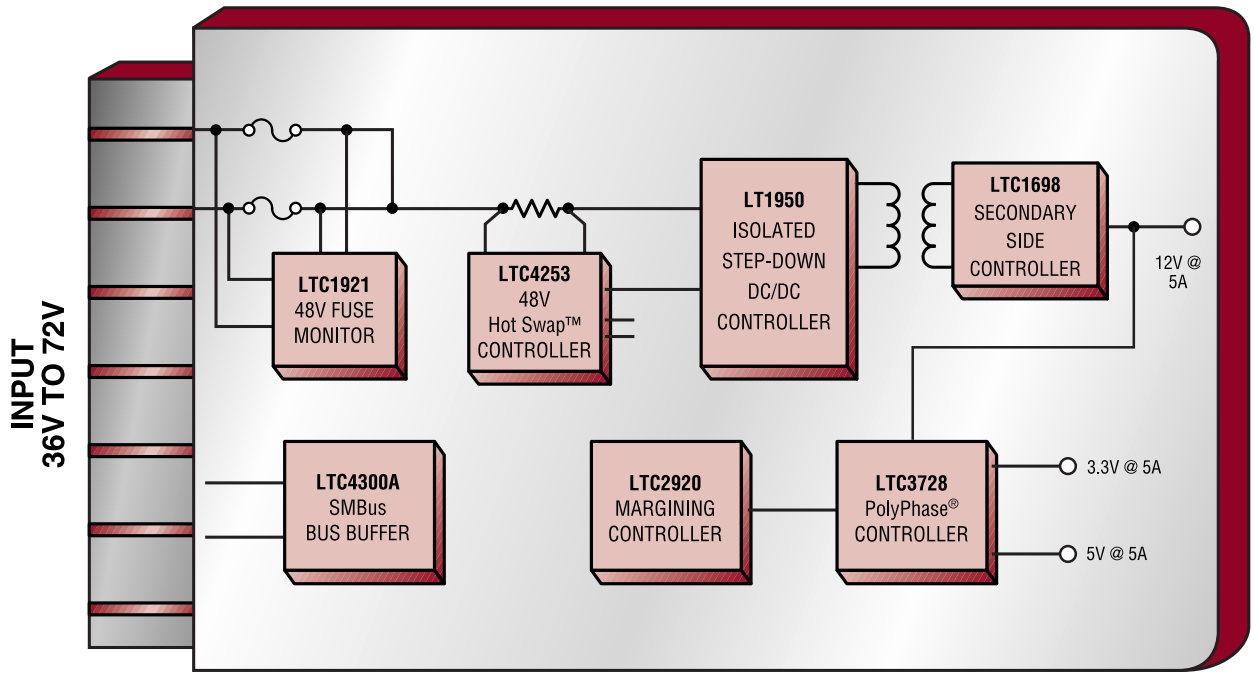
Linear Technology Chronicle

High Performance Analog Solutions from Linear Technology Vol. 12 No. 4

Focus...

Backplane Distributed Power



Inside This Issue:

As supply voltages for PC boards continue to drop, designers face the difficult task of minimizing the voltage drops through distributed power systems. At operating voltages of 3.3V or lower, the voltage drops across power busses, connector pins and inrush control circuitry can cause a supply voltage to drop out of tolerance. A solution to this problem is to distribute power at a high voltage, typically 24V to 48V and then step the voltage down to the lower voltage desired on each board.

These enterprise systems typically place a premium on reliability. Live insertion or removal of boards from the backplane can cause large inrush currents (on the order of 10A to 100A). This can cause the backplane voltage to dip temporarily, resulting in a system wide reset or damaging connectors and traces. System voltages and currents must be continually monitored to ensure system performance.

Linear Technology designs and manufactures the high performance analog components that enable today's high reliability distributed power systems, including high voltage, high efficiency isolated DC/DC converters, Hot Swap controllers and supply monitors.

48V Hot Swap Controllers

When a circuit board is inserted into a live backplane, the large bypass capacitors on the board can draw huge inrush currents from the backplane power bus as they charge. This high current can cause the backplane voltage to dip temporarily, causing a system-wide reset. The inrush current, on the order of 10 amps to 100 amps, can also destroy the board's bypass capacitors, metal traces or connector pins. Hot Swap controllers prevent these problems by controlling the current into the card, allowing boards to be safely inserted and removed from the live backplane. They also provide a myriad of protection features, including over-voltage, undervoltage and short circuit protection.

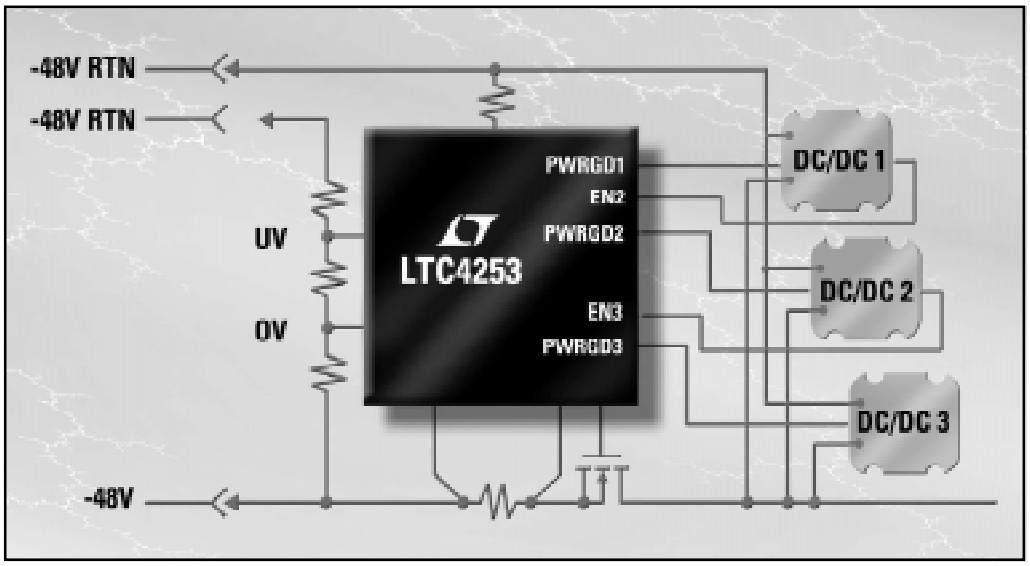
The LTC®4253 is the latest member of Linear Technology's family of –48V Hot Swap controllers. Like the rest of the family, the LTC4253 controls inrush current through a 3-level analog circuit breaker, riding out temporary voltage transients while limiting large inrush currents. Unique to this part, the LTC4253 adds a sequencing function that can turn on up to three separate power supplies in a programmable timed sequence. Features of the part include:

- **Safe board insertion and removal from live –48V backplane**
- **Wide supply range: –15V min.**
- **3- level analog current limit**
- **Sequence up to 3 power supplies with programmable delay**

High Voltage Hot Swap Controllers

Part Number	Voltage Range	Features	Package
LT®1640A	–10V to –80V	Power good output	SO-8
LT1641	9V to 80V	Active current limit, power good output	SO-8
LT4250	–20V to –80V	Active current limit, power good output	SO-8
LTC4251	–15V min	Active current limit	ThinSOT™
LTC4252	–15V min	Active current limit, power good output	MS8, MS10
LTC4253	–15V min	Sequenced power good outputs, active current limit	SSOP-16
LT4254	10.8V to 36V	Open circuit detect, active current limit, power good output	SSOP-16

–48V Hot Swap Controller with Sequencing



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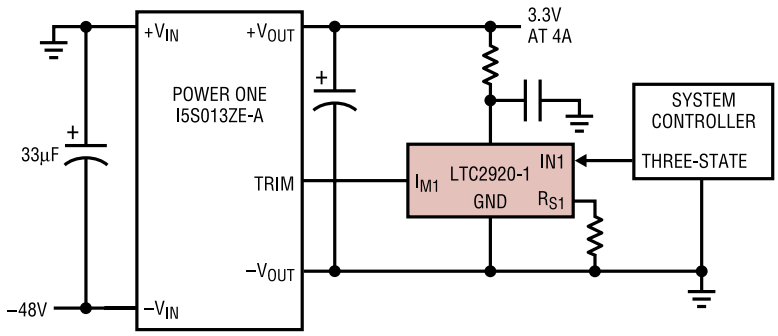
Power Supply Margining Controller

Precisely adjusting a power supply up or down during automated PCB testing (known as power supply margining) is a valuable way to confirm system performance at the upper and lower extremes of supply voltage. The LTC2920 margining controller adjusts power supply voltage by sourcing or sinking current into the feedback node of a DC/DC converter or the voltage adjust pin of a regulator module. Features of the part include:

- **Adjusts power supply modules or switching regulators**
- **0.4% margining voltage accuracy**
- **Margining current set by a single resistor**
- **Single LTC2920-1 in SOT-23**
- **Dual LTC2920-2 in MSOP-8 allows asymmetric high/low margining**

3.3V Quarter Brick with ±5% Voltage Margining Using the LTC2920

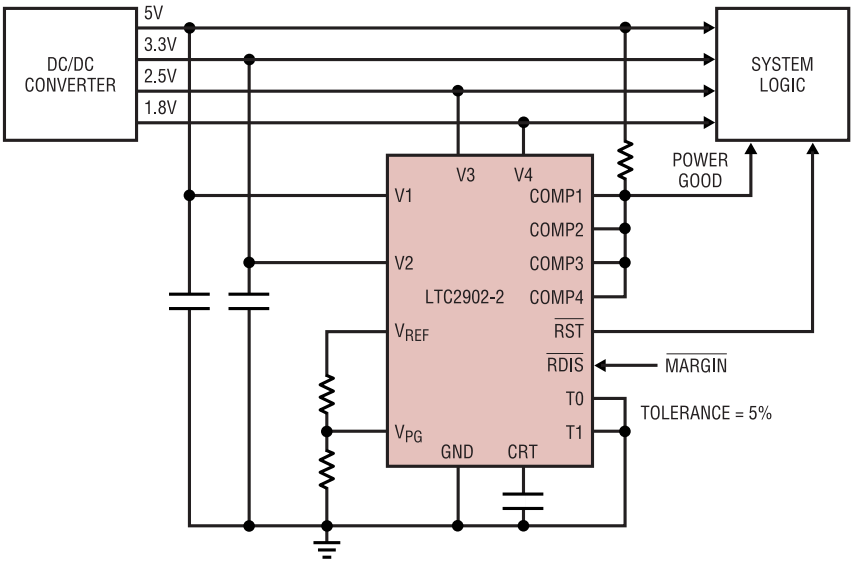


Quad Supply Monitor with Adjustable Tolerance

Margining during test can generate erroneous fault signals from any supply monitor ICs on the board. The LTC2902 quad supply monitor offers adjustable voltage tolerances that can be temporarily increased during margining. The user can select tolerances of 5%, 7.5%, 10% or 12.5%, allowing the board to undergo automatic margining testing without triggering the board's fault circuitry. Alternatively, a RESET disable function allows the supply monitor to be easily disabled during margining. Features of this part include:

- **Monitor up to four voltages with a single IC**
- **Resistor divider programs the part for any of 16 voltage threshold combinations**
- **Threshold adjustable by 5%, 7.5%, 10% or 12.5% for margining testing**
- **Separate comparator outputs can be used for sequencing**

LTC2902 Quad Supply Monitor with Adjustable Tolerance (5V, 3.3V, 2.5V, 1.8V)



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48V Isolated Power Supply: Primary Side Controller

Enterprise systems distribute power via a high voltage backplane, usually in the range of 24V to 48V. Each card in the system then regulates this supply down to a lower voltage. Isolating the bus supply from the board supply is usually required for board level protection and intrinsic safety. Bulky and expensive power supply modules or "bricks" have been the de facto standard for this function. However, these modules can present multiple problems, including high cost, thermal and heat sinking issues and a large fixed footprint that impacts board layout.

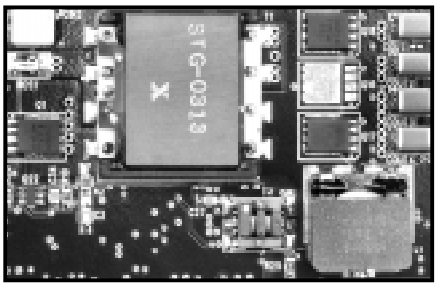
Linear Technology has developed a family of products that provide a cost effective, highly efficient solution for replacing "brick" power supply modules ranging from 10W to more than 400W. A primary side controller operates the main FET to drive power across a transformer to provide isolated step-down voltages. A secondary side controller can be added on the isolated side to implement a synchronous design, improving the efficiency to greater than 90%.

The LT®1950 PWM controller is a primary side controller in a single transistor forward converter. Compared to power supply modules, the LT1950's solution is smaller, lighter, lower profile, offers better thermal characteristics and costs up 50% less. The LT1950 features an adaptive maximum duty cycle clamp circuit that protects the MOSFET from catastrophic failure and reduces transformer size by as much as 50%. Features of this part include:

- **Isolated 48V step-down solutions from 10W to 400W at half the cost of "bricks"**
- **Programmable duty cycle clamp, leading edge blanking, slope compensation and UVLO**
- **Can be combined with a secondary side controller to create a highly efficient synchronous solution**
- **Small SSOP-16 package**

Linear Technology offers a range of alternatives to expensive power supply modules. Solutions include two transistor forward, single transistor forward and isolated flyback topologies.

LT1950 48V to 3.3V, 25A Isolated Converter (Actual Size)



Isolated Step-Down Controllers

Part Number	V_{IN} Max	Freq	Output Max Power	Features	Package
LT1681	72V	350kHz	250W	Dual transistor forward controller	SSOP-16
LT1725	72V	250kHz	60W	Isolated flyback controller	SSOP-16
LT1950	72V	500kHz	250W	PWM controller	SSOP-16
LT3781	72V	350kHz	250W	Dual transistor forward controller	SSOP-20
LTC3722	72V	1MHz	2kW	Synchronous full-bridge controller	SSOP-24

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48V Isolated Power Supply: Secondary Side Synchronous Control

In any transformer-based switching topology (forward or flyback, isolated or non-isolated), controlling the energy in the transformer has traditionally been left to diodes. While simple to design, diodes have large forward voltage drop and are not as efficient as low on resistance FETs. Replacing the diodes on the secondary side with FETs can greatly improve the efficiency of the system. However, controlling FETs on the secondary side in an isolated topology is quite challenging.

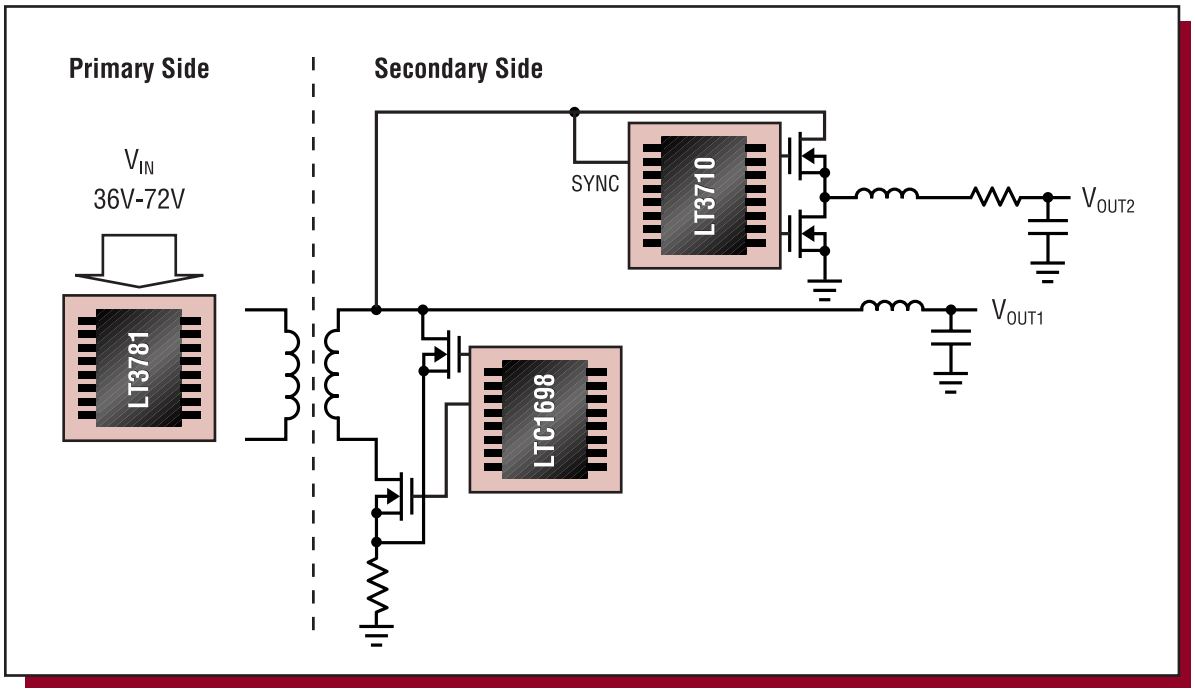
Linear Technology has developed several devices to solve this technical challenge. The LTC1698 is a secondary side synchronous controller used to provide a highly efficient fully isolated supply. The primary side controller communicates with the LTC1698 via a small pulse transformer to control the synchronous FETs. The LTC1698 also senses the output supply and communicates this information to the primary side controller via an external optoisolator. Features of the part include:

- **Dual N-channel MOSFET drivers for high efficiency synchronous control**
- **Programmable current limit**
- **±5% margining control**
- **Power good flag**

To generate multiple isolated outputs, most systems use either multiple windings or cascade regulators from the main output. However, multiple secondary windings sacrifice the regulation of the auxiliary outputs. Cascaded regulators require a larger transformer for the main output. The LT3710 allows system designers to generate a regulated secondary supply directly from a single secondary winding of the main output in flyback or forward topologies. This allows the designer to minimize the main output inductor size and directly regulate the secondary supply. Features of the part include:

- **A regulated secondary output generated from a single secondary winding**
- **Drives dual N-channel MOSFETs for high efficiency**
- **Switching frequency up to 500kHz**
- **Programmable current limit**
- **0.8V reference**

Multiple Output Isolated Supply Using LT3781, LT3710 and LTC1698



PolyPhase Controllers for High Power, Low Voltage Supplies

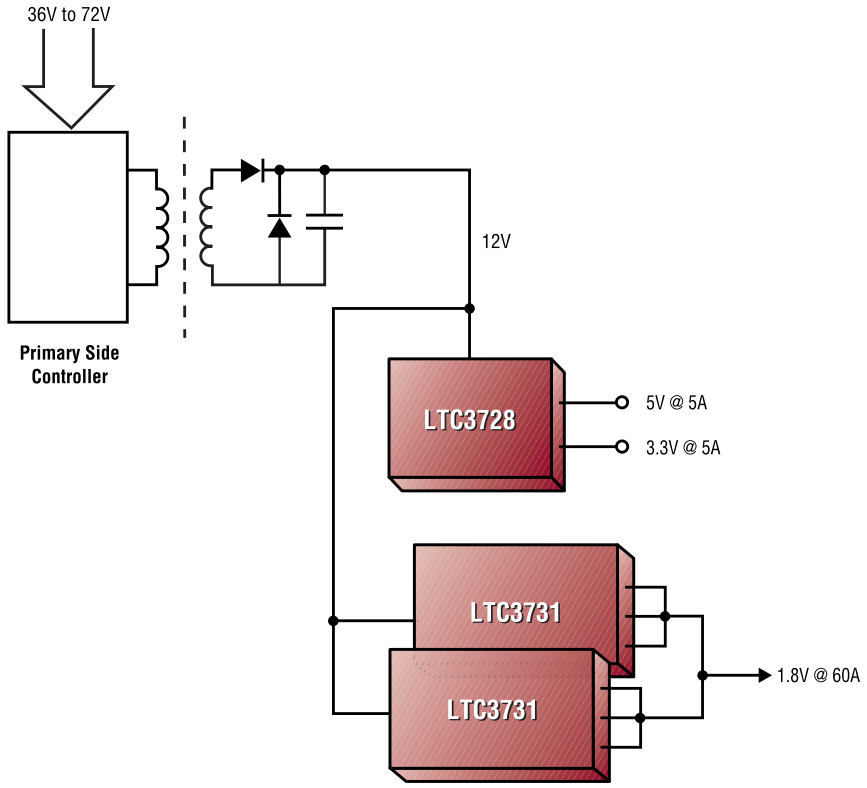
After stepping down from the high voltage backplane with an isolated DC/DC converter, another DC/DC converter is typically needed to provide the low voltage, high current supplies required by today's microprocessors, DSPs and ASICs. Digital ICs demand supply voltages down to 1V and supply currents of 20A or more. With several ICs on a card, requirements for DC/DC converters providing 40A or more, are common place.

Linear Technology's PolyPhase family is specifically designed to meet the needs of low voltage, high current supplies. These current mode synchronous controllers use external FETs to provide anywhere from 20A to 120A. By operating two or more outputs out of phase, input ripple current and required input capacitance are greatly reduced.

The LTC3728 is a dual output, 2-phase, synchronous step-down controller that provides up to 20A of output current per channel. Its 550kHz switching frequency allows the use of small and inexpensive capacitors and inductors. Available in the space saving 5mm x 5mm QFN package, the LTC3728 provides a small, efficient solution for high power, low voltage supplies. Features of the part include:

- **Synchronous current mode step-down controllers provide 20A or more per channel**
- **PolyPhase operation reduces input ripple current and cuts the required input capacitance in half**
- **High 550kHz switching frequency allows small, inexpensive external components**
- **Available in 5mm x 5mm QFN package**

High Power PolyPhase Controllers



PolyPhase Controllers

Part Number	V_{IN} Max	I_{OUT}	No. of Phases	No. of Outputs	Freq.	Package
LTC1628	36V	20A	2	2	300kHz	QFN, SSOP-28
LTC1629	36V	40A to 240A	Up to 12	1	300kHz	SSOP-28
LTC3728	36V	25A	2	2	550kHz	QFN, SSOP-28
LTC3729	36V	40A to 240A	Up to 12	1	550kHz	QFN, SSOP-28
LTC3731	36V	60A to 240A	Up to 12	1	600kHz	QFN, SSOP-36

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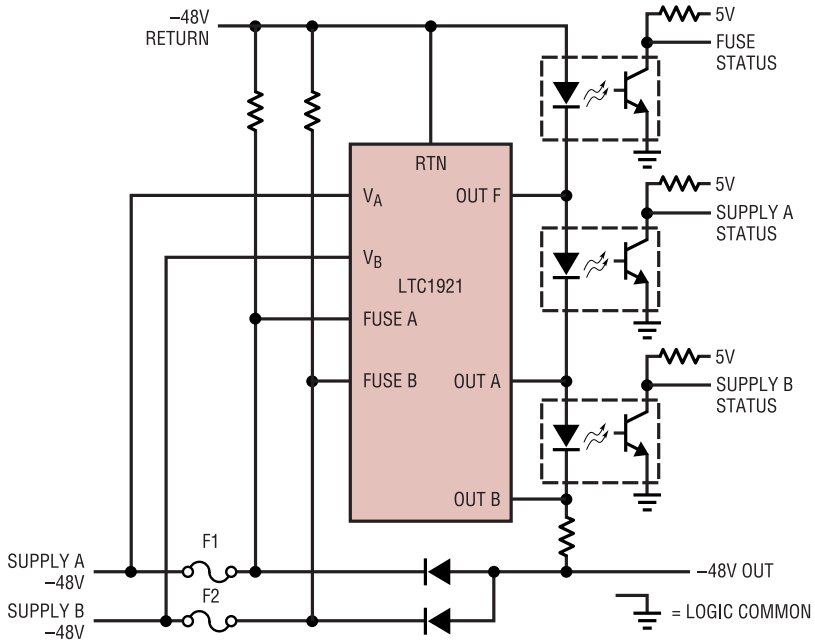
Dual 48V Supply and Fuse Monitor

Reliability is a top priority for the designers of modern telephone and communications equipment. Designers take extra care to protect circuitry from failure-causing temperature and voltage changes, employing redundancy whenever possible. Typical systems will employ a pair of 48V supply lines and a pair of fuses, each of which must be monitored to ensure maximum reliability. Even with precision discrete components, it's no trivial task to meet the Telcordia and AT&T specifications for supply and fuse monitoring over all supply conditions and temperature variations.

The LTC1921 provides a fully compliant solution by monitoring the dual –48V supply lines and the dual fuses used in high reliability 48V telecom supplies. The LTC1921 provides a significant savings in board space and design complexity, implementing a complex precision monitoring system in a single MSOP-8 package. Features of the part include:

- **Monitors two –48V supplies for under- or overvoltage**
- **Monitors two fuses for both blown fuse and high resistivity**
- **Operates on –10V to –80V and can withstand 200V transients**
- **Small MSOP-8 package–entire solution smaller than 20mm^2**

LTC1921 Dual 48V Supply and Fuse Monitor



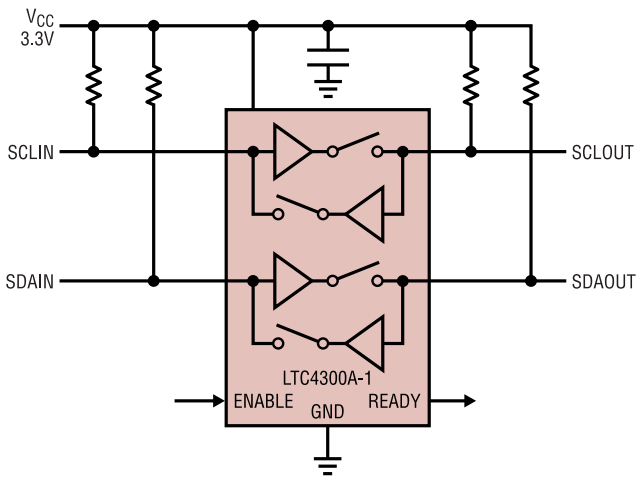
SMBus/I²C Bus Buffers

SMBus and I²C™ are 2-wire bus interfaces commonly used to communicate between boards and across the backplane. Each added component on the bus adds capacitance that slows the rise time of the signals. Adding stronger pull-up resistors makes it difficult to meet the low logic level voltage requirement. Live insertion or removal of a card is even more difficult because these added components corrupt the data when connected or removed.

The LTC4300A is an I²C hot swappable bus buffer that allows insertion or removal of devices from the bus without corrupting data. The LTC4300A includes rise time accelerators in combination with weak pull-up resistors, meeting both the rise time requirement and low logic level voltage requirement. It is compatible with the I²C, I²C Fast Mode™ and SMBus Standards. Features of the part include:

- **Bidirectional buffer for SDA and SCL lines prevents corruption of data during live insertion and removal**
- **Rise time accelerators on all SDA and SCL lines**
- **5V to 3.3V level translation with the LTC4300A-2**
- **MSOP-8 package**

LTC4300A Bus Buffer



SMBus/I²C Products

Part Number	Description	Package
LTC1623	SMBus dual high-side switch controller	MS8, SO-8
LTC1663	Micropower 10-bit DAC with I²C	ThinSOT, MS8
LTC1694	SMBus/I²C accelerator	ThinSOT
LTC1695	SMBus fan speed controller in ThinSOT	ThinSOT
LTC1699	SMBus VID voltage programmer	MS8, SSOP-16
LTC1710	SMBus dual high side switch	MS8, SO-8
LTC1840	SMBus dual fan speed controller	SSOP-16
LTC1909	SMBus programmable step down DC/DC controller	SSOP-28
LTC4300A	SMBus/I²C bus buffer and accelerator	MS8

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