

Simple and Efficient Reverse Polarity Protection for -48V Communication Systems

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INTRODUCTION

Reverse polarity protection is required in many -48V wired and wireless communication infrastructure systems, with or without two-feed redundancy. Reverse polarity protection protects against accidental swap of ground and -48V feeds during system installation that could damage the system or bring down multiple systems in a central office. The reverse polarity protection can be implemented either on-board, or at the input of a custom, multiple-output redundant power supply.

REVERSE POLARITY PROTECTION USING SCHOTTKY DIODE

Figure 1 shows a typical card-type power system employing a single -48V feed, diode reverse polarity protection, hot swap control, DC bus converter, and multiple point-of-load converters (POL). Power levels for a system like this ranges between ~ 30W and ~ 300W, depending whether the solution is powering just one board or multiple boards on the shelf.

The main advantages of the reverse polarity protection using diodes for low power boards are simplicity and low cost. For example, for 30W boards, a D-Pak Schottky diode such as 12CWQ10G can be used, with ~0.5V forward voltage drop during conduction. For worst-case operating conditions ($40V_{IN}$), this device will conduct about 1A and dissipate 0.5W. This represents about 1.7% throughput efficiency loss. While this is a significant percentage increase in power dissipation, this surface-mounted D-Pak device can easily handle the power thermally.

For 300W of output power, a higher power surface-mounted diode such as 16CTQ100 would be needed, but thermally would not be able to handle worst-case power dissipation of about 4.7W, as the PCB temperature would exceed rated limits. Thus, a TO-220 packaged version of the device with a heat sink would be needed, significantly increasing the cost and manufacturing complexity of the solution.

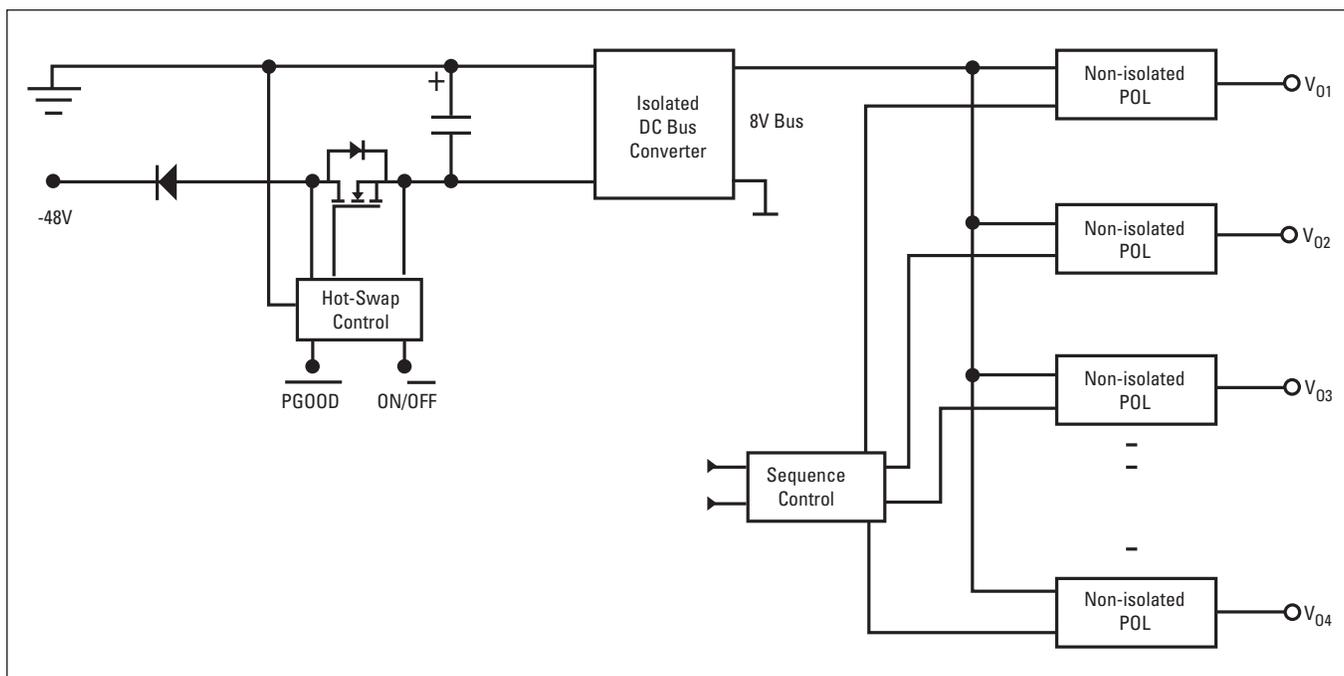


Figure 1: Typical On-Board Power Distribution with Reverse Polarity Protection.

SIMPLE AND EFFICIENT REVERSE POLARITY PROTECTION FOR -48V COMMUNICATION SYSTEMS

REVERSE POLARITY PROTECTION USING ELECTRONIC CIRCUIT BREAKERS

In higher power custom power supplies (500W to several kW), Schottky diodes are not practical for reverse polarity protection due to very high power dissipation. Instead, electronic circuit breakers are used in conjunction with a high power shunt diode as shown in Figure 2. If the polarity is correct and circuit breaker is on, the current will flow from GND terminal to -48V terminal. If the polarity was reversed, the shunt diode will immediately turn on, and the resulting short-circuit current will quickly trip the circuit breaker off.

While this scheme is lossless, the associated cost is very high and the accuracy of the circuit breakers is not adequate for precise current limiting. Required manual reset of the circuit breaker is also not suitable for installation in remote facilities potentially reducing critical up-time requirements.

REVERSE POLARITY PROTECTION USING ACTIVE ORING CONTROLLERS.

A much more elegant solution for reverse polarity protection is shown in Figure 3. In this scheme, IR5001S Active ORing controller is used in conjunction with a power MOSFET to achieve very efficient and simple reverse polarity protection (the circuit breaker function, if needed, can be achieved with various industry-standard hot-swap controllers).

IR5001S operation is automatic; if the polarity at the input terminals is right, the IC will be properly biased and will turn the reverse polarity FET on. If the polarity is reversed, the IC itself

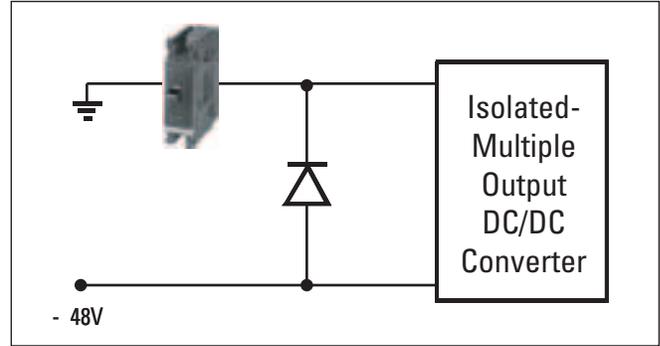


Figure 2: Reverse Polarity Protection using Electronic Circuit Breaker and a Diode.

will not have the proper bias and it will remain off, thus preventing the reverse polarity MOSFET from turning on.

IR5001S requires only a small bias capacitor for proper operation, but does offer several interesting features (including a system diagnostics capability). The details are described at <http://www.irf.com/product-info/datasheets/data/IR5001S.pdf>.

Compared to the scheme shown in Figure 2, IR5001S used in conjunction with the IRF6644 100V DirectFET™ MOSFET, reduces power dissipation from ~4.7W to only 0.7W. This is more than six-fold power loss reduction. For a 200W boards, power loss reduction with the same MOSFET would be tenfold!

For multiple-output power supplies in 1kW range, IR5001S can be used in conjunction with two D2-Pak IRFS4310PbF in parallel to reduce power dissipation of the reverse polarity protection function to less than 0.3% of the output power. This is significantly lower than 1.7% with diode ORing, and much less expensive than using traditional circuit breakers.

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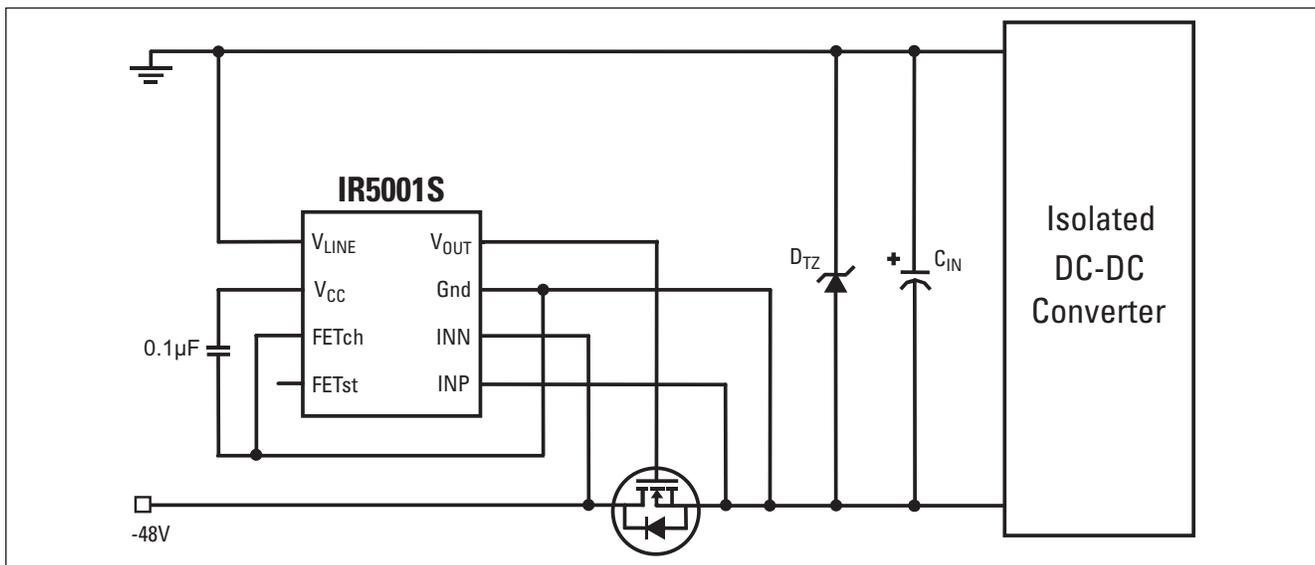


Figure 3: Reverse Polarity Protection Using IR5001S Active ORing Controller and Power MOSFET.