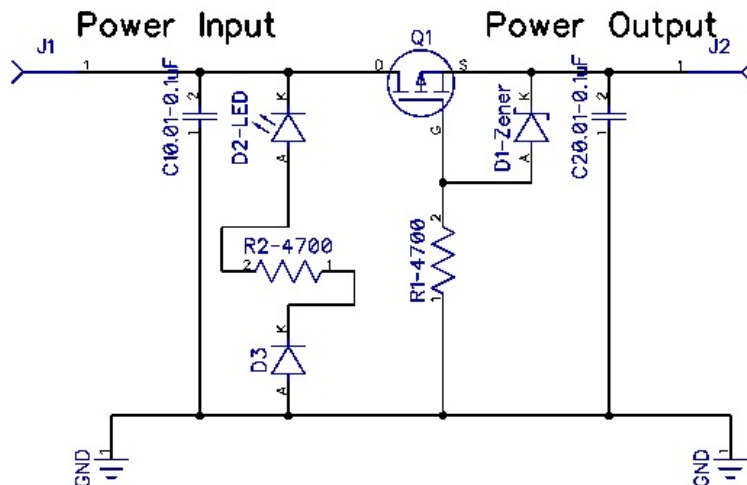


## Club Project: Protecting Your Transceiver from Accidental Reverse Polarity Damage PART ONE

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Accidentally connecting up a battery backwards can have devastating effects on an expensive or crucial radio transceiver. This is a real concern for volunteers who deploy into chaotic circumstances in disaster response, potentially using unusual power sources. It can also occur if jumping a dead battery in car accidentally reverses the jumper cables. As a result many techniques have been developed to help avoid a sad outcome, some involving high power Shottky diodes, other using diode-energized relays, others shunt diodes and series fuses designed to blow quickly before the shunt diode is vaporized.



In recent years, high-power P-Channel enhancement-mode MOSFETs with series ON resistances as low as 3-5 milliohms (similar to a foot of power cable) have become affordably available in the \$3 range. These devices can be inserted in the positive line and only require their insulated gate to be pulled down toward negative (ground, if the polarity is correct) by 10V in order to fully turn ON.<sup>1</sup> The Figure shows the basic schematic, including the pass-MOSFET [**which may be 1-4 identical devices paralleled for higher power**], some RF-bypass capacitors, and a simple LED to illuminate when reverse polarity power is attempted. When correct polarity power is connected, the gate of the MOSFET(s) is pulled down as much as the voltage rating of the Zener (chosen to be 11-12 Volts) and the MOSFET conducts heavily with a series resistance (per device) of about 0.005 ohms. If the input polarity is reversed, that gate ends up *positive* with respect to the source -- and the MOSFET simply doesn't conduct. Instant protection! The only complication is that the gate insulation usually can't stand more than 15-20V offset in voltage from the source (or the incredibly thin silicon dioxide insulator will be destroyed), so a zener diode of about 10-12V is employed to limit the excursion of the gate voltage from the source. [A few MOSFETs come with a built-in protective zener diode for this reason.] Because of the BODY DIODE (an inescapable part of MOSFET construction), the device has to be inserted with the *drain* toward to the battery and the *source* terminal toward the load, or the body diode will defeat the polarity protection.

### Thermal & Voltage Drop Considerations

A 50 watt VHF transmitter will typically draw 8 or more amperes from a 12V source, while a 100-watt HF rig may draw 15-20 Amps. To keep voltage drop  $\leq 200$  mV, a series resistance of 10 milli-ohm is desirable, but MOSFETs tend to dramatically INCREASE their series resistance if their channel temperature rises....so a considerable "over-design" is required to avoid the need for a large heatsink on the MOSFET. Since power =  $V^2 / R$ , reducing the voltage drop by adding additional MOSFETs in parallel makes a *very* significant improvement: Doubling the number of MOSFETs carrying the current will reduce the power dissipated by a factor of FOUR. In practice, with 5 milli-ohm

<sup>1</sup> Circuit description can be found here: <https://components101.com/articles/design-guide-pmos-mosfet-for-reverse-voltage-polarity-protection>

MOSFETS, 2 in parallel will handle most VHF transceivers, and 3 or 4 in parallel will handle a 100-watt HF transceiver. The voltage losses will be negligible and no heatsink will be required on the MOSFETs.

There are several of these same- type protection systems available from small manufacturers, but they typically only include *one* MOSFET. In order to provide for adequate power handling, it would be advisable to parallel 2-4 of these commercially available systems<sup>2</sup>

**PART TWO** in next month's newsletter will go over construction / parts purchase on a simple printed circuit board that can be fabricated inexpensively by international suppliers.

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2 Examples include: "Reverse Polarity Protection Kit" [https://www.skyvisiony.com/index.php?main\\_page=product\\_info&products\\_id=124576](https://www.skyvisiony.com/index.php?main_page=product_info&products_id=124576); "RPP Reverse Polarity Protection" by kc9on, <https://kc9on.com/product/rpp-reverse-polarity-protection/> and "Reverse Polarity Protection Switch for Power Supply" Ebay, <https://www.ebay.com/itm/153333961289>