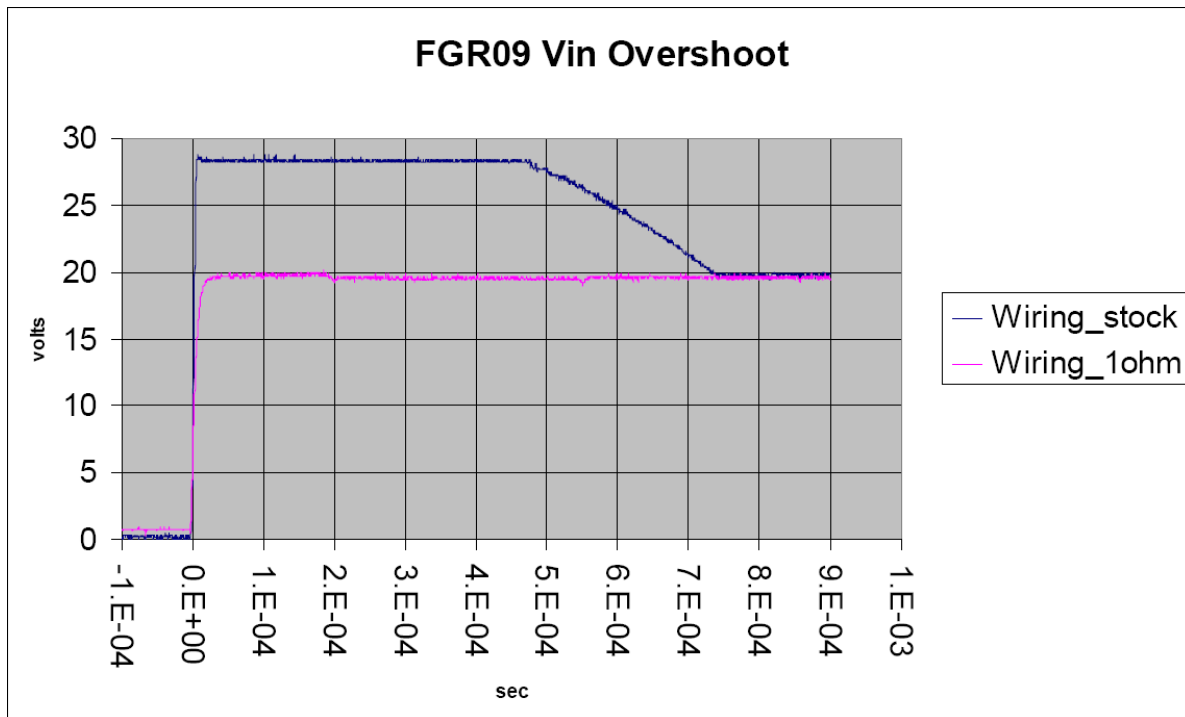


Application Note #5467

Power Wiring Precaution for FGR-Series at High Supply January 11, 2007

Instances have occurred wherein a radio has sustained damage to the switching voltage regulator on connection to a supply within the upper half of the 6-30V rating. Undamped inductance of the supply leads can result in a transient over-voltage of the regulator too brief for detection by slow instruments such as DMM's. The result can be damage leading to immediate or delayed regulator failure. As will be seen, the hazard can be remedied by proper connection sequencing or addition of a damping resistor. Below is an image comparing voltage delivered to the FGR09CSU switching voltage regulator with and without adding 1 Ohm of series resistance in the "B+" (positive supply) line. Supply voltage was set to 20V





Explanation of features of the traces is as follows:

The “stock” trace with unmodified wiring shows the regulator input overshooting past the 19.6V expected to about 28.4V, due to stored energy in the wiring inductance. The sustained character of the 28.4V is due to the input capacitor and regulator placement on the cathode side of a reverse-protection series diode, so that the inductive energy is “caught” on the cap, and also because the regulator initially draws no power. After about 470µsec, the regulator begins switching, drawing off the “extra” capacitor voltage until the diode conducts at about 720µsec.

The power supply was not set greater than 20V to protect the regulator input, rated at 30V. From data for an example battery, worst case output voltage of two in series and fully charged would be 25.6V at room temperature, increasing to 27.4V at -40degC. By proportional extrapolation of the measured result, we can predict 38.9V peak regulator input voltage, clearly above the 30V rating.

The “1ohm” trace shows no significant overshoot and is expected to perform so at higher voltages as well.

It is recommended that a damping resistor be placed in series with the radio positive supply lead under the following conditions:

- An unloaded open circuit supply voltage of greater than 15V AND total supply wire length greater than 1 foot.
- UNLESS connection of the supply is while unpowered AND the supply has a controlled ramp rate (less than 1V/µsec in this example, slower for longer wiring) while powering up.

Such a resistor should be non-inductive (not wire-wound types) and rated for both the steady-state dissipation and high transient surges. At 1 ohm and 30V input, the steady-state worst-case dissipation is only .03Watts, but initial peak current in the resistance approaches 30Amps, the peak power approaches 900Watts and the total energy nearly instantaneously dissipated is .002 Joule. Some film-type resistors, easily able to handle the steady-state power, may not be robust against the transients.