

Crowbar circuit on split power supplies. Jan 2002

Talking points:

- 1) In order to reliably open the fuses we must approach the manufacturer recommended current of 400% of the rated current with a recommended minimum of 200%. The fuse should not open at 100% of the rated current. The smallest fuse we can get is 2 milliamps. Therefore we need to apply more than 4 milliamps to reliably open the fuse.
- 2) The power supply can provide 5 milliamps.
- 3) A split output power supply is not two power supplies sharing a common reference wire but instead, a single supply with a "pseudo ground" created by a resistor divider network connected between the two output wires. This "pseudo ground" is connected to the center bulk silicon of a double-sided sensor.
- 4) The layer 00 crowbar circuit design could be used on a split supply but, after the fuse opened in the positive high voltage lead, the negative high voltage lead could continue to bias half of the sensor because of the return path through the "pseudo ground".
- 5) Two of the layer 00 crowbars could be added to a split supply, one from the positive high voltage lead to the reference and one from the reference to the negative high voltage lead. However the fuses might not open because the reference output will not support the currents necessary to open the fuses. The "pseudo ground" path is created with high value resistors that will not allow currents of more than a few milliamps. The resistors could be lowered to support more current but then they would continuously shunt some extra current out of the supply. The limit to this with a balanced (50/50) voltage output is 2.5-ma shunt and 2.5-ma fuse current. This is probably not reliable or practical. Unbalanced output voltage examples left as an exercise for the reader.
- 6) If two crowbar circuits are cross connected on either side of two fuses as shown below, the sensors can be protected from over voltage without regard to the reference connection between the power supply and the ladders. Each crowbar circuit will open one of the two fuses without regard to the condition of the other fuse. The disadvantage of this design is the cost (double the layer 00 design) and the larger circuit board required. This necessitates a different packaging and connection to the back of the power supply. Also the thresholds for the two circuits are not necessarily matched well. However the expected fault condition is so far over the operating voltage that the exact threshold is not a primary issue.
- 7) A secondary discovery with the cross-connected crowbars is the current path remaining through the crowbars after the fuses have opened. The positive high-voltage can flow through crowbar 2, reverse bias the sensor and flow back through crowbar 1 to the negative power supply output. A pair of signal diodes in the output leads blocks this path. They need a reverse voltage rating equal to the full output voltage.

