Investigation Line 1
Jumper connection blowing due to HIGH Current

Loosing a power connection can be attributed to enough energy being dissipated locally on the power connection to fuse it.

The CDF Silicon Detector Power supplies are:

- Limited on the maximum current they can provide
- Equipped with a remotely programmable tripping limit

The first measurement described the amount of energy necessary to blow a jumper connection.
A simple 5 V power supply has been connected to the 2 sides of the jumper connection with a variable current limit. A current probe (Tektronix A6312) is used to measure the current through the connection itself (channel 1 of the Oscilloscope) while a normal voltage probe monitor the output voltage of the power supply (channel 3 of the Oscilloscope).
The first step was to check if the jumper connection can hold up to 1A in steady state conditions. As you can see in Figure 1 the connection complies with this limit without any sign of degradation. The 1 A current in steady state has been applied for 10 minutes in a row without any sign of connection degradation. Twelve connections from 4 different ladders built during the construction of SVX have been measured with this technique and none of them failed.

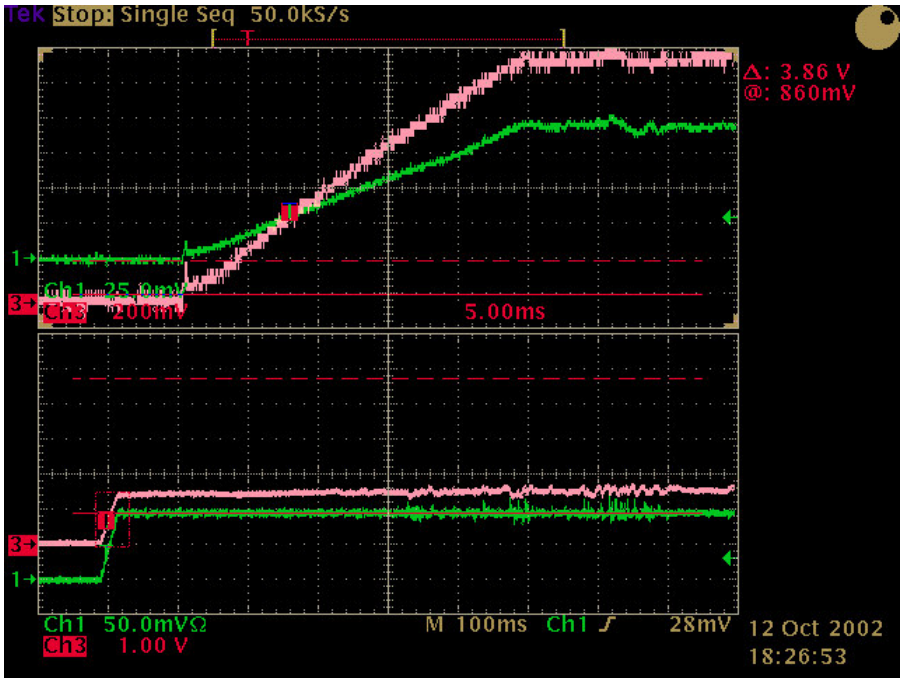

Figure 1 Current through (Channel 1 shown in GREEN) and Voltage across (Channel 3 shown in RED) the Jumper connection versus time. The current is measured through a current probe and each mV

correspond to 10 mA. The trigger represent the power supply being turned ON. It can clearly be seen how the connection hold 1 Ampere in a steady state condition.

The second and final measurement was achieved with exactly the same technique but with a 5 A current limit at the Power Supply. Figure 2 shows the results. The meaning of the various traces is the same as in Figure 1. On the top half of figure 2 the zoomed in view allows the calculation of the amount of energy necessary to break the connection. There are less than 50 ms with the current above 1A and during this time the voltage is always above 1.5V. So a total of 75mJ is the lowest amount of energy necessary to blow the connection.

Figure 2 Current and voltage across the Jumper connection (See Figure 1 for the meaning of the various traces). The amount of power released by the power supply was chosen to be enough to fuse the connection.

The calculated 75 mJ, that clearly under-estimate the necessary energy, should be compared with 2 quantities:

1. The amount of energy stored locally inside the detector for the DVDD line

   Whit no more than 150 μF on the DVDD line powered up with 5V the total amount of energy stored locally is in the order of 2 mJ that is a factor of 50 smaller than what is needed to fuse the bonds.

2. The amount of energy that the CAEN Power supply can release before tripping.

   Figure 3 shows that by inserting a short on the Z hybrid of a ladder powered up with the nominal 5V the total amount of energy released from the Power supply to the jumper is in the order of 10 mJ still an order of magnitude smaller than what is needed to fuse the connection.

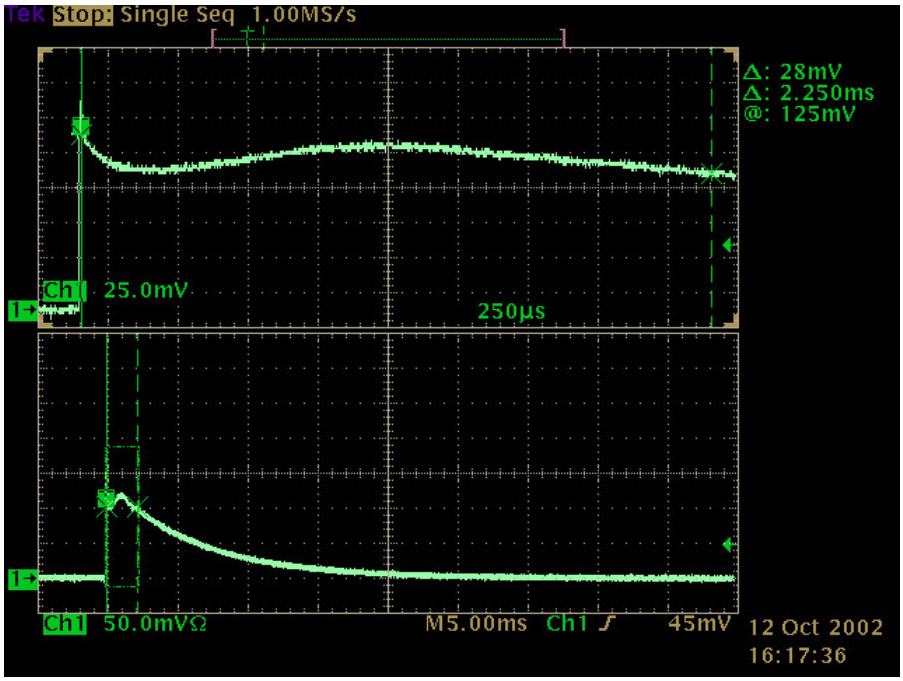

Figure 3 Current versus time measured on the Jumper DVDD connection (replaced by a discrete wire). When the Oscilloscope trigger a SHORT between DVDD and DGND is intentionally introduced on the Z hybrid. The CAEN Power Supply channel used for this measurement is channel 0 and the tripping limit is set to 250 mA (as in the CDF detector). As a result of the short the P.S. channel trips without breaking the jumper connection. As can be seen from the upper part of the picture the maximum current measured on the DVDD jumper connection is 1.4 A and the measured current stays above 1A for only 2.25 ms. This adds up to 11 mJ. It takes about 20 ms for the current to drop to zero.

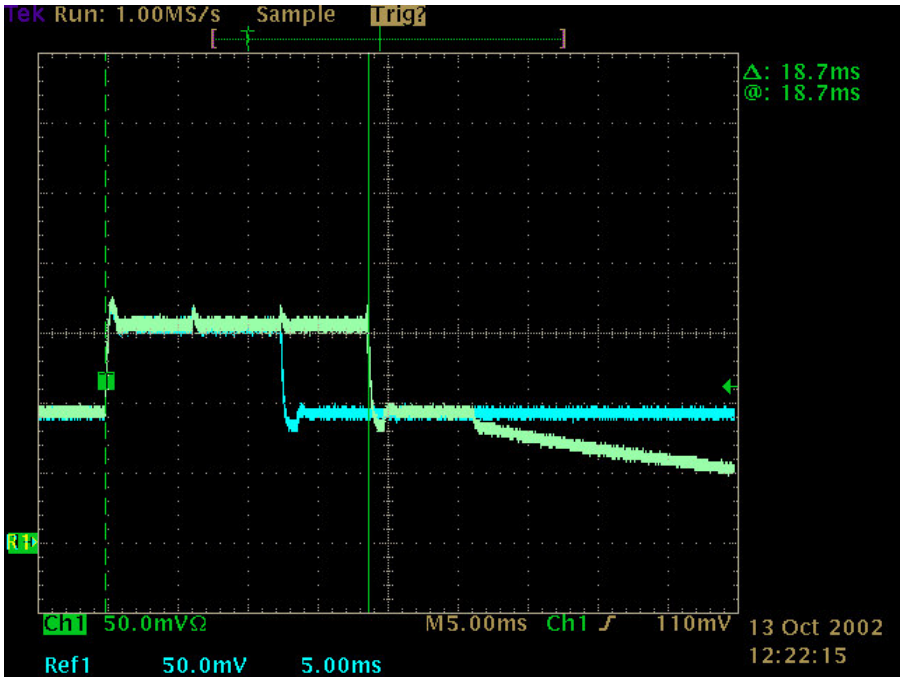

Figure 4 Current versus time measured at the output of the DVDD channel of the Power Supply. The tripping current limit was set to 110 mA. At the first cursor (dashed vertical line) a BURST of L1A (with consequent digitize and readout sequences) at 50 MHz is sent to the ladder. The current sharply increase from 90 mA (QUIET) to 150 mA (BURST). The 2 traces represent 2 BURSTs of different time duration. On the LIGHT BLUE trace the BURST is not long enough to trip the Power supply. From the GREEN trace it can be seen that a BURST of 19 ms is enough to trip the supply and have the current dropping to zero.