Application Note - Minimum Load and Wiring Resistance

Any electronic load has a minimum operating resistance or minimum operating voltage specification. Older load designs, such as the Hewlett-Packard/Agilent 6060B, used a minimum voltage specification because they could pass little or no current below about 2.0 V. Newer load designs such as Scribner Associates 850/890 products use a load design that can operate down to near zero voltage and the load's performance is best described by a minimum resistance specification.

The 850e 50/25/5 A model, for instance, has a minimum resistance specification of less than 2.0 milliohms (<2 mΩ). This means that at an operating current of 50 A, the voltage measured at the 850e's main load terminals can be driven by the 850e's load to as low as 100mV (0.1 V). Using typical 1 meter 4 gauge (4 AWG) cell cables as an example, there is a resistance introduced of 0.8 milliohms (0.8 mΩ) per cable. This will cause a voltage drop of 40 mV at 50 A in each cable. The resulting total voltage drop in the system is 100 + 40 + 40 = 180 mV. If your fuel cell is not capable of producing 50A at a cell voltage of at least 180 mV (at the cell terminals), then you will not be able to get the system to 50 A. If you double the cell cables (connect two in parallel from each side of the fuel cell to the 850e), you will reduce the voltage drop in each cable at 50 A by half. This will result in a total voltage drop of 100 + 20 + 20 = 140 mV. If your cell can produce 50 A at a cell voltage of at least 140 mV, then you will be able to get to 50 A using paralleled cables. If your fuel cell will not produce 50 A at a cell voltage of at least 100 mV, then it will not be possible to get 50 A with the 850e even with perfect (zero resistance) cell cables.

The *FuelCell* software will display the following alarm message if the load is operating at its minimum resistance but the operating condition set point (voltage or current) cannot be achieved due to the above problem:

> *Desired current/voltage cannot be applied, the total current is being limited by the lead resistance or low cell voltage*

Using a lower resistance cables as short as possible will minimize the resistance. If you make your own cables, pay special attention to attaching low-resistance lug terminals on the ends so the whole cable assembly has low resistance. The lug set screws (if used) and bolts used to attach the leads to the cell and 890/850 terminals need to be tightened securely for best results.

The above calculations and guidelines also apply to higher current 890e models with up to 1000A current ratings and the large cables used with these systems.