



# Fermi National Accelerator Laboratory

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## **Engineering Note**

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**Project: D0 Tracking Electronics**

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**Subject: Trim Resistors on Vicor PFC-Mini Power Supplies (+5V)**

Due to the voltage drop across the cable, connectors, and shunts, the Vicor power supplies' output voltage must be trimmed to provide the proper voltage at the Sequencer and Sequencer Controller. In addition, the Sequencers run at about 1% higher voltage than the Sequencer Controller (due to the voltage drop across the boards' fuses) so when adjusting the voltage, a compromise must be made. The voltage typically strived for is to keep the Sequencer voltage under 5.1 Volts, so that the voltage at the output of the Vicor supply is not higher than 5.5 Volts. It is also desirable to run the Sequencer Controller higher than 4.92 Volts for proper operation of the logic. Changing the value of **R1** on the Vicor circuit board changes the power supply output.

Measurement is taken by probing pin 4 of the 10-pin JTAG connector. The ground reference is preferably one of the LEMO or Twin-ax shields on the front panel. Care must be taken to only touch pin 4 of the JTAG connector since shorting this to another pin with your probe could cause the card's fuse to blow. A special cable fixture has been made by the D0 Operations group to make measurement of this voltage easy. This fixture plugs into pins 2 and 4 of the JTAG connector.

### **Power Supply Sensing**

Before describing trim values being used, it is important to describe the different remote sense configurations being used, since they affect the output voltage of the supply. All eight Vicor supplies in the Platform have remote sense connections to their respective backplanes. Some crates have fuses to protect the sense wires (both supply and return) located at the backplane end of the wire. Other crates have 5-ohm resistors protecting these wires. As of this date, the North Platform's sense wires all have fuse protection in the sense lines. In the South Platform, slots 1 & 2 (PC20 top and bottom) have 5-ohm resistors in the sense lines. Slots 3&4 (PC19 top and bottom) have fuses in the sense lines. To determine if there are fuses or resistors, turn off power for that supply and disconnect the power and sense lines from the supply. Then measure from a power lead to one of the four pins in the sense (Burndy) connector to find the lowest value. The lowest value will be six ohms if resistors are used, and it will be close to zero if fuses are used.

Since Vicor supplies seem to have a tendency to oscillate when driving a capacitive load like our crates at the end of our 12' power leads, a 1-ohm resistor is installed on the negative local sense terminals in order to provide a small amount (5%) of local sensing. This correction proved to be insufficient on the South Platform so during an access on 2/21/02 slots 1-3 on the South had an additional 1-ohm resistor added to the positive local sense terminal. This seemed to make the oscillations there vanish. On 3/7/02, 1-ohm resistors were put across the positive sense terminals for the first three North supplies.

## Power Supply Voltage Trimming

The presence of one or two local sense resistors will change the output of the supply, as will the choice of using fuses or 5-ohm resistors to protect the sense wires.

On the North Platform, Vicor supplies for full crates (slots 1-3) are being fitted with a 81k-ohm trim resistor equivalent. This value should produce acceptable if not nearly ideal voltages. If a different voltage is desired, a resistor value of about 75k-ohm will raise the voltage by about 0.05 Volts. Raising the resistor value to about 91k-ohm will lower the output voltage by about 0.05 Volts. Other values may be tried to adjust further. For slot 4, the CFT supply, a value of 90.9k-ohms is used. Local sense resistors will probably be added to the positive leg of the supplies for the North Platform in an upcoming access.

On the South Platform, the full crates with resistors protecting their sense leads (slots 1 & 2) have about 37k-ohm as a voltage trim resistor. Slot 3 has a fuse protecting its sense leads so this Vicor has a value of 81k-ohm as R1. Slot 4 (fused sense leads) has less cards, has less of a voltage drop, and therefore has a value of 100k-ohm for R1. The chart below sums it up:

| Crate       | Sense Protection | Local Sense  | # Seqs | Trim   |
|-------------|------------------|--------------|--------|--------|
| PC20 Top    | 5Ω               | 1Ω both legs | 20     | 37kΩ   |
| PC20 Bottom | 5Ω               | 1Ω both legs | 20     | 37kΩ   |
| PC19 Top    | Fuse             | 1Ω both legs | 20     | 81kΩ   |
| PC19 Bottom | Fuse             | 1Ω Neg. leg  | 13     | 100kΩ  |
| PC03 Top    | Fuse             | 1Ω both legs | 20     | 81kΩ   |
| PC03 Bottom | Fuse             | 1Ω both legs | 20     | 81kΩ   |
| PC04 Top    | Fuse             | 1Ω both legs | 20     | 81kΩ   |
| PC04 Bottom | Fuse             | 1Ω both legs | 14     | 90.9kΩ |

The above table is based on the general Trim Resistor (R1) Recommendations:

| Sense Configuration               | Full Crate | 15 Cards |
|-----------------------------------|------------|----------|
| Fuse protection, single 1Ω local  | 91kΩ       | 100kΩ    |
| Fuse protection, double 1 Ω local | 81kΩ       | 91kΩ     |
| 5 Ω protection, single 1 Ω local  | 75kΩ       | 81kΩ     |
| 5 Ω protection, double 1 Ω local  | 37kΩ       | 43kΩ     |

Some further adjustment may be desirable since some crates will have different loads. Different loads are due the fact that some crates have different numbers of cards, and also because some Sequencers draw more current than others. SMT crates are fully populated with 20 Sequencers per crate, while CFT crates have about 15 Sequencers per crate. The two types of Sequencers are distinguished by the Hewlett-Packard G-link chips. Older cards have ECL versions along with TTL-ECL translators, while newer cards have TTL versions without the translators. As a result the new Sequencers will have more current draw from the +5V supply. The following table shows approximate current for the cards taken at the test stand (platform currents are measured to be slightly higher):

| Card                 | I (+5V)     | I (-5.2V) |
|----------------------|-------------|-----------|
| Sequencer Controller | 2.6 A       | 0.54 A    |
| Old (ECL) Sequencer  | 5.55-5.98 A | 3.0 A     |
| New (TTL) Sequencer  | 6.72-7.1 A  | 0.1A      |

## Future Plans

It is hoped that all sense wire protection will be changed to fuses, and 1Ω local sense resistors will be installed on both legs of all +5V power supplies.