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Engineering Note

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Project: AFE II
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Subject: AFE II Installation – Can an AFE II be put into an AFE I backplane?

Introduction

A basic assumption in the AFE II project schedule is that the AFE II boards can be installed "adiabatically" – an incorrect use of the word in that we are interested neither in the change in entropy nor whether heat is given out or received in the process. Presumably those using this term are confusing it with a *piecemeal* installation, and it is this that will be addressed in this document.

Those familiar with the AFE board installation in the Dzero central platform will recall that 13 power supplies are connected to 25 backplanes; eight AFE boards plug into each backplane. The obvious methods of replacement are thus at rates of one, eight or sixteen AFE boards per cycle. The connector pinout and positioning of the AFE II is identical to that of the AFE I so no changes of the backplane are necessary. We need only concentrate upon the voltage and current requirements of the AFE II to determine the minimal number of boards that must be installed at the same time.

Power Supply Differences

Unfortunate as it is, the AFE II is designed for different bulk power voltages than the AFE I. This is a direct consequence of replacing the SIFT and SVX chips by the TRIP chips; the former require +5 and +5.2 volt supplies, the latter +2.5V. In addition, eight +3.3V programmable logic chips have been replaced by eight +3.3V / +2.5V parts. Further, numerous +5V parts have been removed. Engineering note A991117A describes the estimated power requirements of the AFE I at the time of design. Table 1 copies the original estimate and shows how reality differs.

Voltage	Current Required	Current per backplane (estimated)	Actual measured current per backplane
+5 Volts	3.61 Amps	28.88 Amps	22-ish?
+5.5 Volts	1.2 Amps	9.6 Amps	17 Amps
±12 Volts	.45 Amps	3.6 Amps	4 Amps
+3.3 Volts	2.83 Amps	22.64 Amps	32 Amps

Table 1 (base data taken from note A991117A)

Actual power draw of the boards has turned out to be larger than anticipated, mostly due to the SIFT and SVX chips consuming quite a bit more power than expected, and growth in the complexity of the programmable logic. These lessons need be well remembered as AFE II progresses.

The AFE II bulk supply design will replace the +5.5V supply voltage by another +3.3V supply. This second +3.3V supply will be used to develop the +2.5V required for the TRIP chips. The extant +3.3V supply will be retained for the +3.3V digital logic of the board. Since the pinout of the connectors is left unchanged, the AFE II presents no *immediate* problem, but further analysis is required.

AFE II Current Draw Relative to AFE I

- +12V draw is expected to be unchanged.
- -12V draw is expected to be unchanged.
- The +5V draw is reduced by the elimination of the discrete FIFO parts and a few gates, but increased by the addition of the Flash RAM, some extra buffers and latches, and moving three CPLDs (1553, Helper and Clockgen) to the +5V rail. Net, the draw on the +5V supply is ***increased.*** The CPLDs are each locally regulated back down to +3.3V. This increases the heat load but is necessary because…
- The +3.3V draw is increased because eight CPLDs have been replaced by eight FPGAs. Efficiency arguments aside, the significantly increased logic requirements of the FPGAs relative to the CPLDs says they'll draw at least the same. In addition, thirty-two new 16-bit latches and sixteen new level-shifting buffers have been added to support the interface requirements of the TRIP chips. The draw on the +3.3V supply is, hopefully, about the same, but is probably ***slightly increased.***
- The new +3.3V (analog) supply – replacing the +5.5V supply – powers the TRIP chips, their associated A/D converters and some of the level translating buffer logic. The actual numbers of the TRIP aren't known by this author at this writing, but the guess is that the amperage here will be ***reduced.***

In terms of current draw – voltage levels aside – it looks like the AFE II can reasonably coexist with the AFE I.

AFE II Voltage Needs Relative to AFE I

Much remains the same between the boards, but if an AFE II is plugged into an AFE I backplane with AFE I power supplies the pins expected to be the +3.3V (analog) will have at least +5.5V on them. The +5.5V supply has been the subject of some scrutiny lately. The nominal condition is that the +5.5V supply is set to about +6.05V at the supply output; this presents +5.8V on the backplane pins and, once you get to the SVX chips, about +5.6V at the inputs of the regulators. This is necessary to allow for 300 mV of drop across the regulator to provide +5.2V for the SVX.

The regulators chosen for the AFE II (Texas Instruments tps79301) specify an ***absolute maximum*** input voltage of 6.0V and a ***recommended maximum*** input voltage of +5.5V. Neither sparks nor smoke are expected should an AFE II be plugged into that voltage, but operation may be degraded. Dialing the supply down by a few tenths of a volt would be preferred. The above discussion assumes use ***on the central platform only.*** Conditions on a test stand ***will be different because of the number of boards*** *installed* changing the total current draw (and, thus, drop in the wires). Care must be taken to insure that remote sensing is operational or significant variations may occur between AFE I and AFE II.

Operation of other components within the AFE II

The AFE II, like the AFE I, includes a voltage monitoring circuit to hold the board in reset should power supply levels be incorrect. The AFE I power supply monitor chip, the LT1396, only monitored the digital voltages and wasn't connected to the +5.5V supply. In the AFE II, the LT1296 has been replaced by the UC2903, which does monitor all the voltages. The UC2903 compares all of its inputs to a nominal 2.5V reference. Resistor dividers are used to divide each power supply input by the appropriate scale such that, at nominal voltage, 2.5V is applied to the comparator. If the +3.3V (analog) is connected to a +5.5V input, the UC2903 will tag this as a fault condition and hold the board in reset.

Another new feature in the AFE II is localized monitoring of its own power supplies. This is accomplished by using the same resistor divider that is used for the voltage monitor and feeding it to the analog multiplexer inputs of the local microprocessor. If +5.5V is applied to the input assumed to be +3.3V (analog), the voltage delivered to the micro's input will be about 4.18V; this is less than the power supply voltage of the micro and is therefore safe.

Replacing eight at a time

Easily done. The power supply modularity supports this and the only other change required is to remove one of the 'personality modules' of the AFE power supply and put in a different one so that the power supply is configured for the new output voltage mix.

Can a single AFE II be put into a backplane with a bunch of AFE Is?

Yes, but it won't work because of the reset threshold. It will be held in reset and will not respond to commands. Do the replacement one backplane at a time.

Can I build a one-backplane test stand that works with both AFE I and AFE II?

Sure. Just make sure you can adjust the supply so that it drives +5.5V when the AFE I is plugged in and +3.3V when you install an AFE II.

I'm not happy with that. I want it both ways.

This will require redesign of the AFE II power monitor circuit. Are you willing to pay the schedule time penalty?