

Power Distribution System for the Central Tracker Digital Front End Components

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Abstract

The SVX Sequencer boards reside in the detector platform and are designed to control eight SVX chip strings for data acquisition and convert the eight resulting parallel data streams into four optical signals, guided by optical fiber to VRB cards located in the movable counting house. A total of about 150 boards will reside in eight custom 9U euro-style crates; each crate will also hold one Sequencer Controller. Current draw per crate is expected to be about 100 A for the +5V supply and about 58 A for the -5.2 V supply.

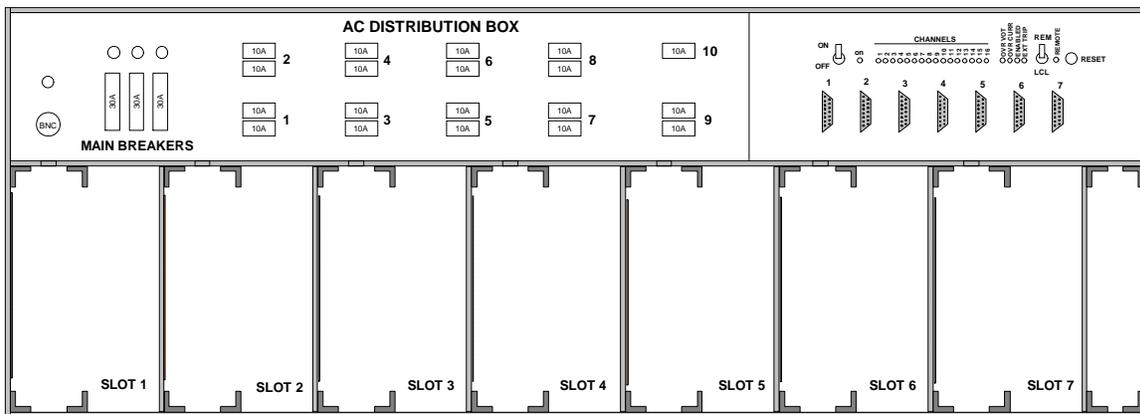
Scope of this Document

This document deals with the hardware needed to supply power to the eight Sequencer subracks.

Power Supply Chassis

The Sequencer power supplies are located in a large aluminum chassis box located on the wall behind racks PC03/PC04 and PC19/PC20 on the center platform. DFE power supplies, which are similar to the Sequencer power supplies, also reside in these two chassis boxes.

The chassis box is constructed out of 1/8" anodized aluminum. A good ground connection is assured by connecting aluminum pieces together using star washers. Furthermore, the chassis is electrically connected to a good electrical ground with a tin plated copper braid.



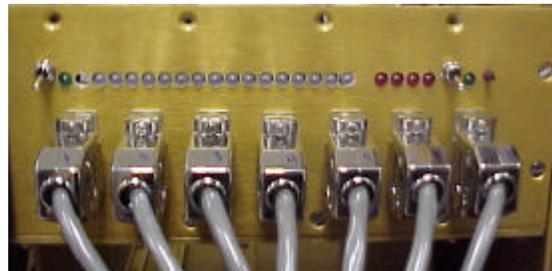
J0019

Up to seven power supplies can be slid into bays located in the chassis box. The front of each bay is open, allowing power cabling to exit the chassis box. The open front also allows the power supply assembly to be disconnected and easily removed for maintenance.

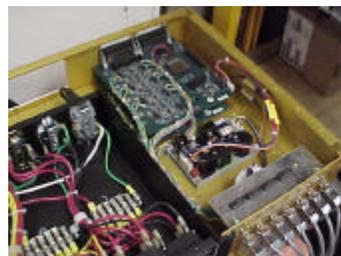
Above the bays there is an enclosed area that is used for the AC distribution box and the monitoring interface boards. A small panel contains LEDs and switches that can be used to control the power supplies locally.



ABOVE: chassis front view with power supply assembly in slot 2.



UPPER RIGHT: Detail of chassis control panel.

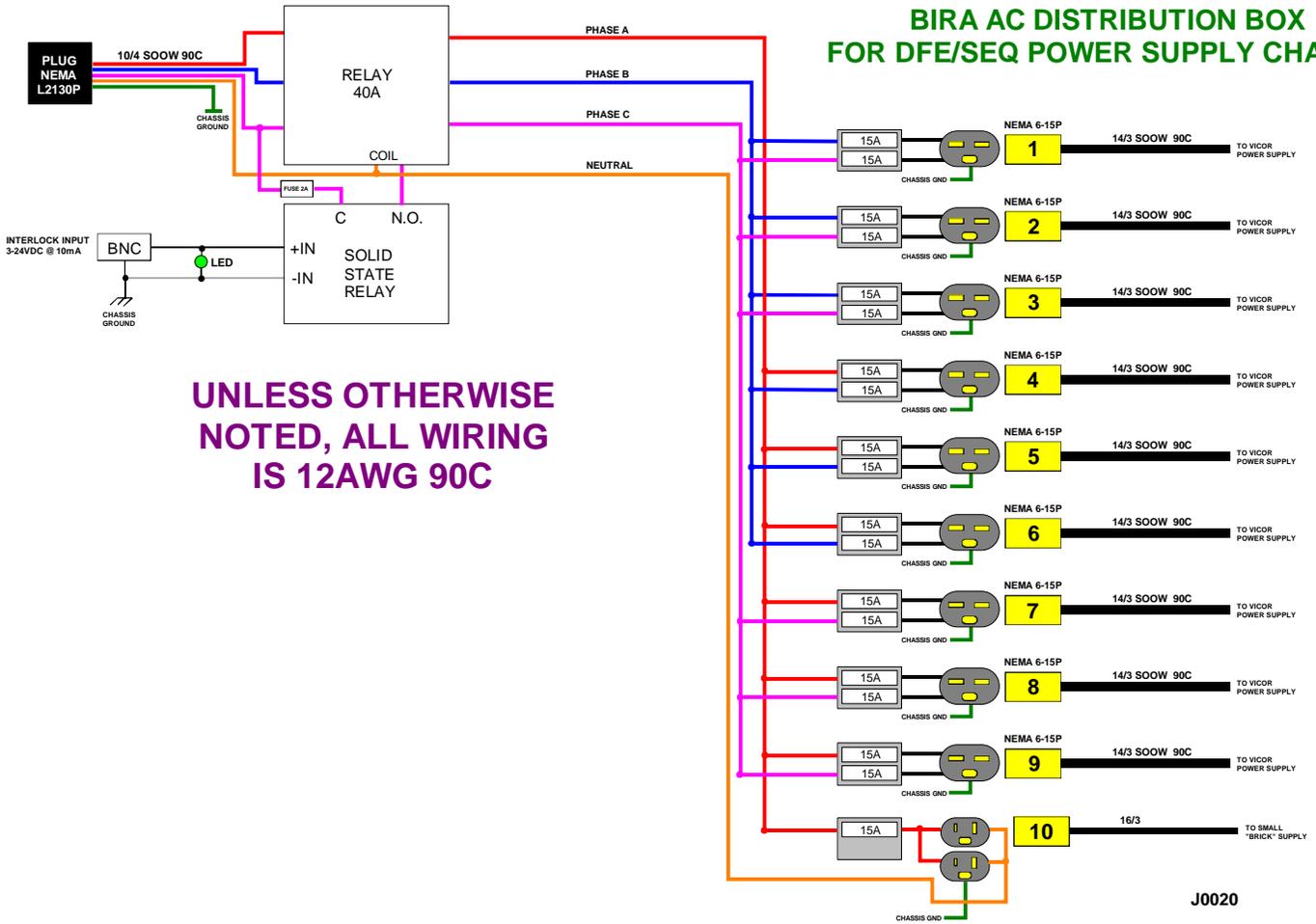


LOWER RIGHT: chassis with top lid removed. AC distribution box also has its lid removed.

AC Distribution

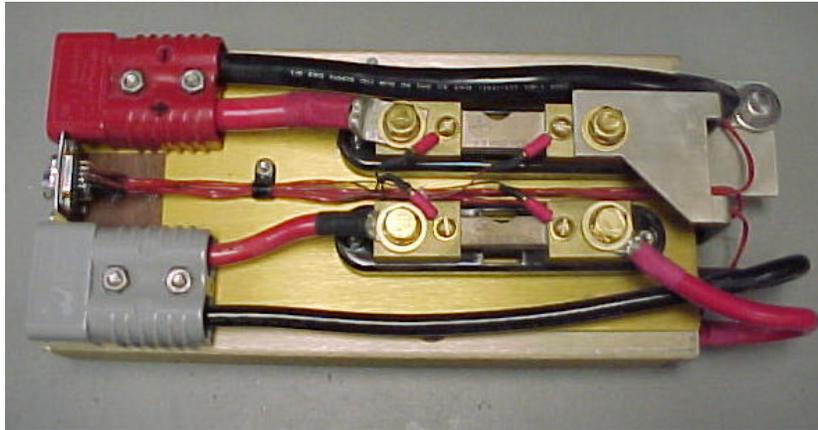
BiRa Systems built the AC distribution box to our specifications. It is a 3U x 19" rack mount unit with circuit breakers on the front panel and AC sockets on the back side. Three phase AC is supplied to the box, and is then distributed as two phase AC to the power supplies. A dual receptacle single phase AC connection is also available. Each AC receptacle is individually controlled with a circuit breaker. Additionally, the distribution box contains a relay to control all of the AC outputs; this relay is connected to the interlock system and requires 3-24 VDC @ 10mA to enable the AC outputs. The three phases are evenly distributed to nine two-phase outlets to allow for load balancing.

The schematic diagram of the AC distribution box is shown below:



PFC Mini Power Supply

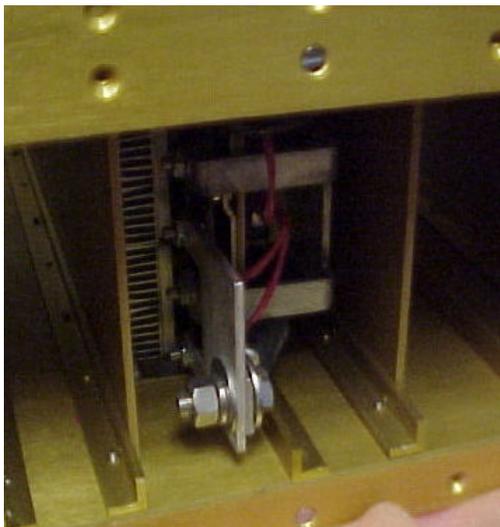
The power supply selected for the Sequencer subracks must be capable of delivering +5V @ 160A and +-5.2V @ 80A to the Sequencer backplane. The Vicor PFC Mini supply meets these criteria and does so in a very low profile form factor. The supply consists of three modules: two +5.0V outputs each rated for 80A, and a -5.2V module rated for 80A. Two +5.0V modules (master and slave) are ganged together at the supply; internally these modules communicate with each other to support dynamic load sharing. All module outputs are fully isolated and feature automatic over-current and over-voltage shutdown.



Since the PFC mini supply does not report output current, external shunts were added to the back side of the supply. The +5.0V and -5.2V shunts are rated for 200A and 100A respectively. Current limiting resistors are used on the connections to the shunt terminals to protect the small wires connecting the shunt to the monitor connector.

Remote sensing is used to compensate for the voltage drop across the shunts and cables. A 1.8 ohm feed-forward resistor is connected between the minus power terminal and the minus sense at the output of the supply to aid in proper Vicor regulation. Each PFC mini is air cooled using two very small high velocity fans. To facilitate airflow through the supply the front and back of the chassis box have been left open.

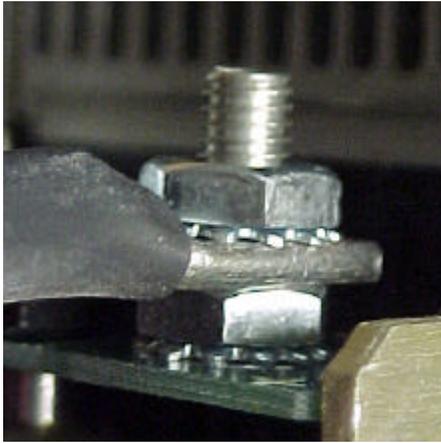
The bus connecting the master and slave outputs is constructed of 1/8" tin plated copper, 1.25" wide.



LEFT: back view of chassis showing airflow opening.



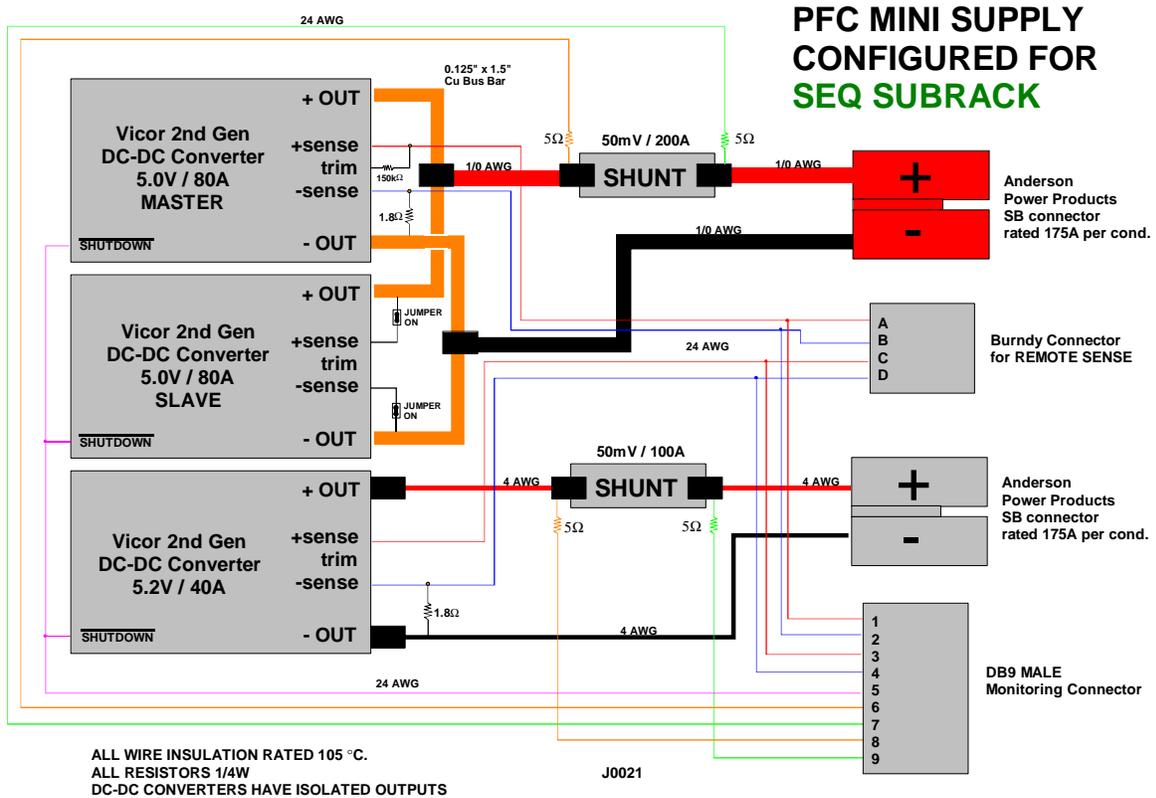
RIGHT: power supply rear view showing bus bars connecting the master and slave +3.3V modules. The +5V module is wired directly with 8 AWG.



ABOVE: detail of +5V lug to the output of the power supply module.



RIGHT: front view of power supply assembly showing power output, remote sense, and monitoring connectors.

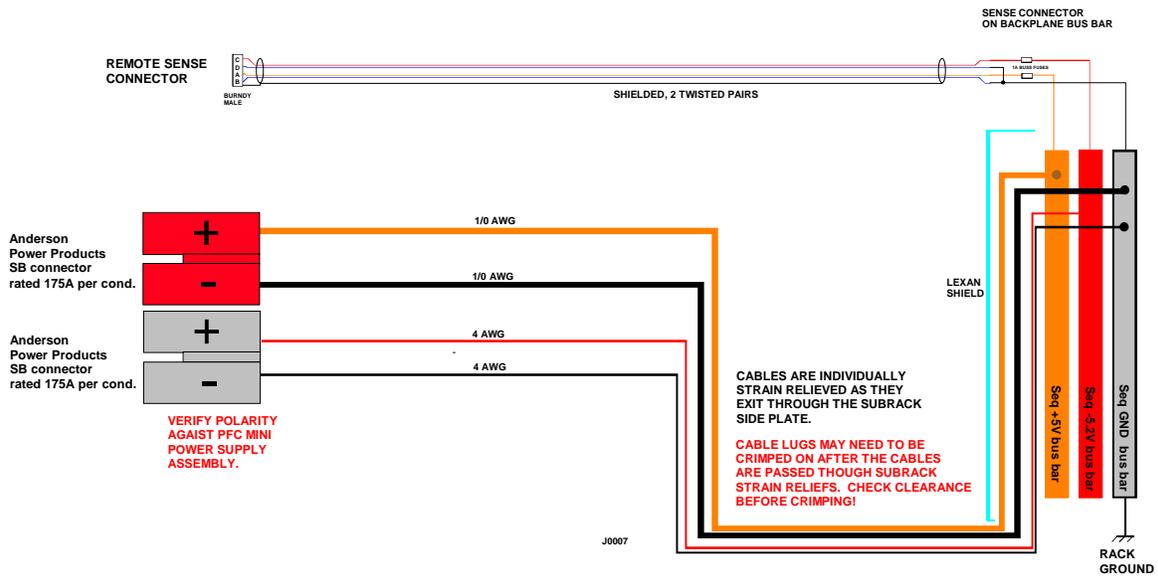


DC Distribution

Since the power supplies are located on the wall behind the racks, the power cables must drop down, go under the aisleway, and back up inside the rack to the backplanes. Worst case distance is approximately 12 feet. To protect against shorts at the backplane, a lexan shield is placed over the bus bars. Additionally, the sense leads are protected with 1A slow blow fuses.

Power and remote sense cables are shown below.

SEQUENCER BACKPLANE POWER HARNESS



RIGHT: Burdny remote sense connector
 ABOVE: 1/0 cable and lugs used for +5.0V supply/return

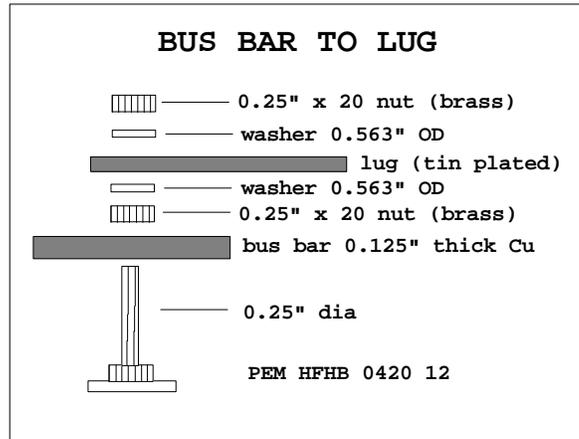


Sequencer Backplane Bus Bars

Three bus bars are used to distribute power on the Sequencer backplane. Each bus bar is 1.5" x 0.0625" tin plated copper. Because the current feed point is in the middle of the busbar, maximum current density in the busbar is $80A / (.0625" \times 1.5") = 853A/sq. in.$



LEFT: DFE backplane bus bars and studs
 ABOVE: DFE backplane installed in subrack.
 Note lexan shield protecting the bus bars.



$$\text{Area of washer} = (3.14)(0.282")^2 - (3.14)(0.125")^2 = 0.200 \text{ in}^2$$

$$\text{Current Density} = 160A / (0.200 \text{ in}^2) = 800 \text{ A} / \text{in}^2$$

Sequencer Backplane

For a discussion of the backplane current density and temperature rise measurements, please refer to Engineering note U010128A.

Monitoring

Each PFC mini assembly has two outputs: +5.0V and -5.2V. For the purposes of monitoring, these outputs are considered separate entities— thus each chassis box can contain up to 14 outputs that must be monitored. A monitor board supports up to 8 supplies; therefore two monitor boards must be used in each chassis box. Slot assignments are shown in the tables below:

PC 20 / PC 19 CHASSIS					
slot	supply	circuit breaker			
1	SEQ PC20 UPPER	1			
2	SEQ PC20 LOWER	2	2	5.0V 160A	5.2V 80A
3	SEQ PC19 UPPER	3	3	5.0V 160A	5.2V 80A
4	SEQ PC19 LOWER	4	4	5.0V 160A	5.2V 80A
5	DFE PC20	5	5	3.3V 160A	5.0V 40A
6	DFE PC19	6	6	3.3V 160A	5.0V 40A
7	<unused>	n/a	n/a	n/a	n/a

PC 03 / PC 04 CHASSIS					
slot	supply	circuit breaker	DB15 connector	OUTPUT#1	OUTPUT#2
1	SEQ PC03 UPPER	1	1	5.0V 160A	5.2V 80A
2	SEQ PC03 LOWER	2	2	5.0V 160A	5.2V 80A
3	SEQ PC04 UPPER	3	3	5.0V 160A	5.2V 80A
4	SEQ PC04 LOWER	4	4	5.0V 160A	5.2V 80A
5	DFE PC03 UPPER	5	5	3.3V 160A	5.0V 40A
6	DFE PC03 LOWER	6	6	3.3V 160A	5.0V 40A
7	Mixer Box	7	7	3.3V 160A	n/a

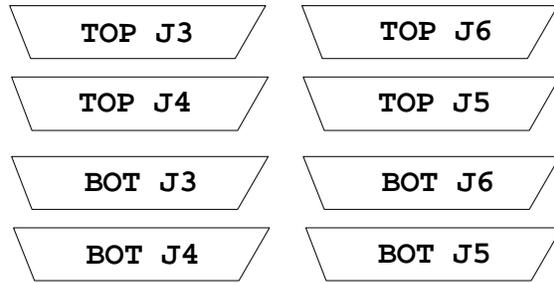
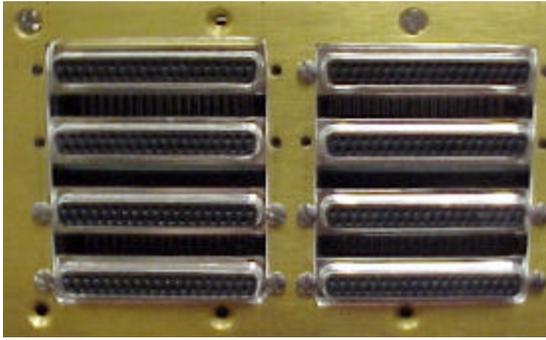
Monitor boards are powered by a small switcher supply contained in the upper compartment of the chassis box. This little supply is powered by the AC distribution box, which is controlled by the Interlock system. If for any reason power is removed from the Interlock BNC connector on the AC distribution box all power supplies *and* the monitor boards will shut down.

The monitor board has the capability to shut down all supplies in the chassis box. Individual supplies cannot be turned on or off. Shutdown can happen locally (using the switches on the front panel of the power supply chassis box) or remotely through the rack monitor. Note that when the PFC mini supply is shut down the fans continue to run.

Monitor boards buffer analog inputs such as current and voltage and send them to the rack monitor. The monitor boards also check for over-voltage and over-current conditions and shut down *all* of the supplies in the chassis when over-voltage or over-current conditions exist. To

clear the trip and enable the supplies, press the reset button (if local) or assert the RESET line (if Remote).

There are a total of 8 connectors used to interface the chassis box to the 1553 Rack Monitor (J3,J4,J5, and J6) for both the top and bottom monitor boards. *Any cells referencing the Mixer power supply apply only to the chassis PC03/PC04 chassis.*



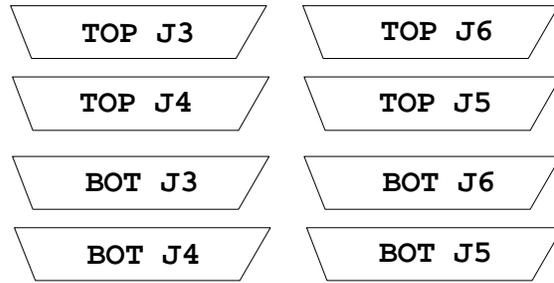
J0024

connector	pin	description	type
J3 BOT	*	unused	*

connector	pin	description	type
J4 BOT	1	Main Power On =1	digital out
J4 BOT	2	Operating Mode: Remote=0 / Local = 1	digital out
J4 BOT	3	unused	digital out
J4 BOT	4	unused	digital out
J4 BOT	5	SEQ supply, slot 1, +5V trip = 1	digital out
J4 BOT	6	SEQ supply, slot 1, 5.2V trip = 1	digital out
J4 BOT	7	SEQ supply, slot 2, +5V trip = 1	digital out
J4 BOT	8	SEQ supply, slot 2, 5.2V trip = 1	digital out
J4 BOT	9	SEQ supply, slot 3, +5V trip = 1	digital out
J4 BOT	10	SEQ supply, slot 3, 5.2V trip = 1	digital out
J4 BOT	11	SEQ supply, slot 4, +5V trip = 1	digital out
J4 BOT	12	SEQ supply, slot 4, 5.2V trip = 1	digital out
J4 BOT	13	unused	digital out
J4 BOT	14	Reset status: Reset = 1	digital out
J4 BOT	15	OverVoltage trip = 1	digital out
J4 BOT	16	OverCurrent trip = 1	digital out
J4 BOT	17	unused	digital out
J4 BOT	18	unused	digital out
J4 BOT	19	unused	digital out
J4 BOT	20-37	GND	GND

connector	pin	description	type
J5 BOT	*	unused	*

connector	pin	description	scale	type
J6 BOT	1	SEQ supply, slot 1, +5V voltage	1x	analog out
J6 BOT	2	SEQ supply, slot 1, +5V current	1V / 100A	analog out
J6 BOT	3	SEQ supply, slot 1, 5.2V voltage	1x	analog out
J6 BOT	4	SEQ supply, slot 1, 5.2V current	1V / 100A	analog out
J6 BOT	5	SEQ supply, slot 2, +5V voltage	1x	analog out
J6 BOT	6	SEQ supply, slot 2, +5V current	1V / 100A	analog out
J6 BOT	7	SEQ supply, slot 2, 5.2V voltage	1x	analog out
J6 BOT	8	SEQ supply, slot 2, 5.2V current	1V / 100A	analog out
J6 BOT	9	SEQ supply, slot 3, +5V voltage	1x	analog out
J6 BOT	10	SEQ supply, slot 3, +5V current	1V / 100A	analog out
J6 BOT	11	SEQ supply, slot 3, 5.2V voltage	1x	analog out
J6 BOT	12	SEQ supply, slot 3, 5.2V current	1V / 100A	analog out
J6 BOT	13	SEQ supply, slot 4, +5V voltage	1x	analog out
J6 BOT	14	SEQ supply, slot 4, +5V current	1V / 100A	analog out
J6 BOT	15	SEQ supply, slot 4 5.2V voltage	1x	analog out
J6 BOT	16	SEQ supply, slot 4, 5.2V current	1V / 100A	analog out
J6 BOT	17 - 37	GND		GND



J0024

connector	pin	description	type
J3 TOP	1	Remote ON/OFF(1=ON)	digital in
J3 TOP	2	Remote RESET (1=RESET)	digital in
J3 TOP	3-37	GND	GND

connector	pin	description	type
J4 TOP	1	Main Power On =1	digital out
J4 TOP	2	Operating Mode: Remote=0 / Local = 1	digital out
J4 TOP	3	unused	digital out
J4 TOP	4	unused	digital out
J4 TOP	5	DFE supply, slot 5, +3.3V trip = 1	digital out
J4 TOP	6	DFE supply, slot 5, +5V trip = 1	digital out
J4 TOP	7	DFE supply, slot 6, +3.3V trip = 1	digital out
J4 TOP	8	DFE supply, slot 6, +5V trip = 1	digital out
J4 TOP	9	MIXER supply, slot 7, +3.3V trip = 1	digital out
J4 TOP	10	unused	digital out
J4 TOP	11	unused	digital out
J4 TOP	12	unused	digital out
J4 TOP	13	unused	digital out
J4 TOP	14	Reset status: Reset = 1	digital out
J4 TOP	15	OverVoltage trip = 1	digital out
J4 TOP	16	OverCurrent trip = 1	digital out
J4 TOP	17	unused	digital out
J4 TOP	18	unused	digital out
J4 TOP	19	unused	digital out
J4 TOP	20-37	GND	GND

connector	pin	description	type
J5 TOP	*	unused	*

connector	pin	description	scale	type
J6 TOP	1	DFE supply, slot 5, +3.3V voltage	1x	analog out
J6 TOP	2	DFE supply, slot 5, +3.3V current	1V / 100A	analog out
J6 TOP	3	DFE supply, slot 5, +5V voltage	1x	analog out
J6 TOP	4	DFE supply, slot 5, +5V current	1V / 100A	analog out
J6 TOP	5	DFE supply, slot 6, +3.3V voltage	1x	analog out
J6 TOP	6	DFE supply, slot 6, +3.3V current	1V / 100A	analog out
J6 TOP	7	DFE supply, slot 6, +5V voltage	1x	analog out
J6 TOP	8	DFE supply, slot 6, +5V current	1V / 100A	analog out
J6 TOP	9	Mixer supply, slot 7, +3.3V voltage	1x	analog out
J6 TOP	10	<unused>	1V / 100A	analog out
J6 TOP	11	<unused>	1x	analog out
J6 TOP	12	<unused>	1V / 100A	analog out
J6 TOP	13	<unused>	1x	analog out
J6 TOP	14	<unused>	1V / 100A	analog out
J6 TOP	15	<unused>	1x	analog out
J6 TOP	16	<unused>	1V / 100A	analog out
J6 TOP	17 - 37	GND		GND

