

# **DECam PFC Power Distribution Chassis (Production Version)**

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## **General Description:**

The chassis described is used for delivering AC and DC power to the DECam's Prime Focus Cage (PFC) during normal operations when mounted on the 4-meter Blanco telescope. The primary AC power input is from a dedicated 3-phase, 208/120 VAC, 30-Amp circuit. From this input, multiple 120 VAC single-phase branch circuits are distributed and dedicated to power various electronic and utility equipment within the PFC. Also, five dedicated DC supply voltages, with provisions for a spare DC power output, are generated and distributed to dedicated pieces of equipment. In addition to the power distribution, there are provisions included to allow for remote power cycling of several circuits, the remote monitoring of various status voltages via LEDs, and an interlock feature which is determined by a series of up to three smoke detectors.

## **Power Input:**

The input power is supplied to the Power Distribution Chassis (PDC) by a dedicated 208/120 VAC, 30-Amp circuit fed from a safety shut-off switch box. A shielded power cable, divided into three segments for a total of 275 feet, is used to transport this power. Input to the chassis is via a Hubbell twist-lock inlet connection rated at 30 amps. Also, since power is transported to the PFC via a shielded, continuous-flex power cable, the cable's shield is connected to the chassis' main ground bus bar using a bolted connection. All power and grounding connections, under normal operation conditions, for the PFC, is implemented through this cable's conductors and shield connection.

From the power input connector, the three-phase power is directly connected to a three-phase surge suppressor (with the appropriate supplemental protection device) and to a three-phase inline power filter with earth choke. From the output of this filter, the power is split up into two, dedicated, 120VAC single-phase circuits and to the 3-pole main circuit breaker with interlock (under-voltage release) function.

Main power cable:	Igus Chainflex shielded power cable, 4-conductor with Ground, 8-AWG, Part No. CF31-100-05 Two segments at 125 feet each.
End power cable:	Igus Chainflex shielded power cable, 4-conductor with Ground, 10-AWG, Part No. CF31-60-05 One segment, reduced diameter, 25 feet

Chassis connector:	Hubbell Twist-Lock flanged inlet, 30-amp, 120/208VAC, Hubbell part No. HBL2815, NEMA configuration L21-30P
Cable connector:	Hubbell Twist-Lock power cord receptacle, 30-amp, 120/208VAC, Hubbell part No. HBL2813, NEMA configuration L21-30R

### **AC Power Circuits (interlocked):**

There are 9 dedicated 120 VAC branch power circuits within the chassis. Each circuit has its own branch circuit breaker and the circuit number below indicates the breaker's position as looking from left-to-right as seen on the PDC's inner panel. All of the circuits below are through the main 30-amp circuit breaker and thus are interlocked. Descriptions below indicate the Circuit Breaker (CBxx) designation and the Bulkhead Outlet (BOLxx) connector designation as listed in the schematic.

- AC circuit 1: For FEE crate 1, 120 VAC single-phase with a 10-amp breaker, Powers a single Hubbell miniature Twist-Lock bulkhead mount receptacle, 125 VAC at 15-amp, Hubbell Part No. HBL7954, (CB3, BOL5)
- AC circuit 2: For FEE crate 2, 120 VAC single-phase with a 10-amp breaker, Powers a single Hubbell miniature Twist-Lock bulkhead mount receptacle, 125 VAC at 15-amp, Hubbell Part No. HBL7954, (CB4, BOL6)
- AC circuit 3: For FEE crate 3, 120 VAC single-phase with a 10-amp breaker, Powers a single Hubbell miniature Twist-Lock bulkhead mount receptacle, 125 VAC at 15-amp, Hubbell Part No. HBL7954, (CB5, BOL8)
- AC circuit 4: For FEE HTR crate, 120 VAC single-phase with a 10-amp breaker, Powers a single Hubbell miniature Twist-Lock bulkhead mount receptacle, 125 VAC at 15-amp, Hubbell Part No. HBL79, (CB6, BOL7)
- AC circuit 5: Powers the seven DC power supplies, 120 VAC single-phase circuit with a 10-amp breaker, (CB7)
- AC circuit 6: AC power for three cooling fans/exchangers within the PFC, 120 VAC with a 6-amp breaker. Powers a single Hubbell miniature Twist-Lock bulkhead mount receptacle, 125 VAC at 15-amp, Hubbell Part No. HBL79, (CB8, BOL10)
- AC circuit 7: Auxiliary AC power, 120 VAC with a 10-amp breaker, Powers a set of two NEMA 5-15R bulkhead receptacles (Cooper 4Q3V3) rated at 125 VAC at 15-amp. Circuit also is controlled by a solid state relay (rated for 120/240 VAC at 25amp) for remote power cycling, (CB9, BOL3, BOL4)

- AC circuit 8: Diagnostic/Instrument AC power, 120 VAC with a 10-amp breaker, Powers a duplex outlet receptacle (NEMA 5-20R) mounted in the inner panel (access only with the cover down), (CB10, DOL1)
- AC circuit 9: AC power dedicated for a piece of equipment called F8, 120 VAC with a 10-amp breaker. Powers a single Hubbell miniature Twist-Lock bulkhead mount receptacle, 125 VAC at 15-amp, Hubbell Part No. HBL79, (CB11, BOL9)

### **AC Power Circuits (direct):**

There are 2 additional dedicated 120 VAC branch power circuits within the chassis. These circuits listed below are NOT through the main 30-amp circuit breaker and thus are NOT interlocked. The branch circuit breakers are fed directly from the 3-phase filter output via 10-AWG wire. Again, the Circuit Breaker's (CBxx) designation is indicated as looking from left-to-right on the PDC's inner panel.

- AC direct circuit 1: Internal control DC power supply and the chassis' cooling fan, 120 VAC with a 2-amp breaker, Powers the 24 VDC power supply, maximum output current of 4.3 amps, that is used for the smoke detector interlock and for the remote power cycling and monitor functions, (CB1)
- AC direct circuit 2: Non-interlocked, auxiliary AC power, 120 VAC with a 10-amp breaker, Powers a set of two NEMA 5-15R bulkhead receptacles (Cooper 4Q3V3) rated at 125 VAC at 15-amp, (CB2, BOL1, BOL2)

### **DC Power Circuits:**

There are 7 separate DC power supplies that supply output power for six dedicated DC output circuits. Four of them have a maximum output current of 4.3 amps. One supply provides 36 VDC and the other three provides 24 VDC. All have isolated DC outputs. The three smaller DC power supplies have a maximum output current of 2.1 amps and they also have isolated outputs.

- DC circuit 1: Labeled "Shutter PWR" (CC4), 36 VDC at 4.3 amps. Powers an output connector used for the shutter controller, circular bulkhead connector, 6-socket (contact rating is 5 amps), circuit output controlled by a solid state relay (Crydom DC60S5, rated for 60 VDC at 5 amps) for remote power cycling.
- DC circuit 2: Labeled "Filter Control PWR" (CC5), 24 VDC at 4.3 amps, Powers an output connector used for the filter changer controller, circular bulkhead connector, 6-socket (contact rating is 5 amps), circuit output controlled by

a solid state relay (Crydom DC60S5, rated for 60 VDC at 5 amps) for remote power cycling.

- DC circuit 3: Labeled “Compact RIO PWR” (CC6), 24 VDC at 4.3 amps, Powers an output connector used for a NI cRIO instrumentation crate, circular bulkhead connector, 6-socket (contact rating is 5 amps), circuit output controlled by a solid state relay (Crydom DC60S5, rated for 60 VDC at 5 amps)
- DC circuit 4: Labeled “Compact FP PWR” (CC7), 24 VDC at 4.3 amps, Powers an output connector used for NI cFP instrumentation crate, circular bulkhead connector, 6-socket (contact rating is 5 amps), circuit output controlled by a solid state relay (Crydom DC60S5, rated for 60 VDC at 5 amps) for remote power cycling.
- DC circuit 5: Labeled “Focal Plate Photodiode Power” (CC8), +/-12 VDC at 2.1 amps, Powers an output connector used for the photodiode detectors within the Imager vessel, circular bulkhead connector, 6-socket (contact rating is 5 amps). Circuit output is NOT controlled by a solid state relay. Thus, cannot be remotely power cycled.
- DC circuit 6: Labeled “BCam or Auxiliary Power” (CC9), +24 VDC at 2.1 amps, Powers an output connector originally intended for the BCam DC power. If not used, it can be used as a spare 24 VDC power source. Circular bulkhead connector, 6-socket (contact rating is 5 amps), circuit output controlled by a solid state relay (Crydom DC60S5, rated for 60 VDC at 5 amps) for remote power cycling.

### **Interlock Function:**

The main 3-pole circuit breaker is equipped with an under-voltage release that operates at 24 VDC. The interlock is provided through a series of up to three smoke detectors. The detector bases are equipped with auxiliary relay contacts that change upon an alarm. The relays are connected in series to provide a return path for the 24 VDC interlock control voltage. Any one detector that detects smoke will break this return path and thus drop the interlock, tripping the main breaker. If a smoke detector is not used, a shorting plug must be used to maintain the circuit's return path. Since the smoke detector base relay contacts are rated for 2-amps maximum, the interlock circuit power within the chassis is protected using a 2-amp slow-blow fuse (F1).

The interlock function can be disabled through the use of a SPDT locking lever switch. In the DISABLE position, the switch will short the path of the series-connected relay contacts and thus provide a continuous path for the under-voltage relay's control voltage. Note: The 24 VDC control voltage power supply and the direct AC circuit output (AC direct circuit 2) will not be affected by the interlock being dropped.

### **Remote Power Cycling Function:**

One AC power branch circuit (AC circuit 7) and five DC power circuits (DC circuits 1-4, and 6) are controlled using a set of six solid state relays (described above). These SSR control circuits route the SSR's return path of the control voltage through the remote cable connector. Another chassis, called the Power Distribution Control Chassis (PDCC), contains locking-lever SPDT switches (one for each controlled output) and these are used to control this return path. The PDCC's switch is moved in the UP position to complete this return path (to enable the output) or moved in the DOWN position to break this return path (to disable the output). In this way, the direct 24 VDC control power is not directly connected to the cable conductors and thus limit the possibility of a direct short. The cable used is a 13-pair, 24-AWG shielded cable.

The remote functions can also be enabled or disabled through the use of the two 3PDT locking lever switches accessible via the PDC's inner panel. Each switch controls the operation of three SSRs (three SSRs on the top mounting plate, Plate1, and three SSRs on the bottom mounting plate, Plate2). In the DISABLE position, the switches provide a direct return path for the SSR control voltage and thus bypassing the remote cable connection to the PDCC. In the ENABLE position, control of the SSR's control voltage return path is routed through the remote cable connection and thus to the PDCC.

It is important to note that the individual DC and AC power circuits cannot be power cycled individually when the remote power cycling switches, on the PDC inner panel, are in the DISABLE position. For example, the 24 VDC power for the Compact RIO slow controls crate cannot be power cycled individually. This feature exists only when the power distribution control chassis (PDCC) unit is connected to the power distribution chassis (PDC).

### **Remote Monitoring Function:**

There are nine LEDs, mounted on the Power Distribution Control Chassis (PDCC) front panel, that monitor the state of all six of the DC output voltages of the Power Distribution Chassis (PDC) and three internal control voltages. These three internal control/status voltages are: 1) the under-voltage release control voltage status, 2) the status of the control voltage's power supply output, and 3) the status of the surge suppressor's operation (via a set of relay contacts).

Each monitoring or output voltage connection to the remote control/monitoring cable connector is through a resistor (appropriately sized for the supply voltage) that enables an LED, mounted in the remote control/monitoring chassis, to be driven. Thus, there is no direct connection of any cable conductor to a power supply output. However, in the remote chance a direct supply output contact is made to a cable conductor, the conductor size is 24-AWG and the maximum available DC current is 4.3 amps. Therefore, no conductor fusing is implemented.

## To Turn ON or Power Up:

- 1) If connecting up the main AC power cord, make sure that all breakers in the OFF position. Plug in the 3-phase power cord in the inlet connector and connect up the shield strap to the grounding block.
- 2) Turn ON the surge suppressor's 4-pole protection breaker.
- 3) Move the Smoke Detector Interlock switch to the DISABLE position.
- 4) Turn ON the control/interlock breaker labeled "CNTR PWR SUPP". The cooling fan should now be running.

Note: This CNTR breaker must remain ON at all times. If this breaker is turned OFF, the PDC's control DC power supply's output will go to zero volts and this will cause the under-voltage release relay to trip the main 3-pole breaker.

- 5) Turn ON the main 3-pole breaker.
- 6) If the smoke detector interlocks function is not desired or needed, leave the Smoke Detector Interlock switch in the DISABLE position and proceed to step (7). If the interlocks function is desired, at this time, move the interlocks switch to the ENABLE position. The Main breaker should still be ON. If it trips, there may be a problem with the smoke detectors (cable not hooked up) or with the interlock circuit.
- 7) Now, turn ON the branch circuit breakers as needed.

Note: To remotely cycle the DC power output circuits or the interlocked AC power circuit, move the Remote Power Cycle switches to the ENABLE position. The SSR Plate1 switch enables the outputs for the 1) shutter, 2) filter changer controller, and 3) the Compact RIO crate. The SSR Plate2 switch enables the 1) Compact FP crate, 2) BCam or Auxiliary DC power, and 3) interlocked AC circuit 7. This will enable the individual power cycling of the described circuits. However, if the remote control/monitoring cable is not plugged in or the PDCC is not utilized, the power will not be present at the outputs. If remote power cycling is not desired, leave the switches in the DISABLE position.

## To Turn Power OFF:

- 1) Turn OFF all the branch circuit breakers FIRST.
- 2) Turn the main 3-pole breaker OFF.
- 3) Lastly, turn OFF the CNTR breaker.

**To Clear a Smoke Detector Interlock Trip:**

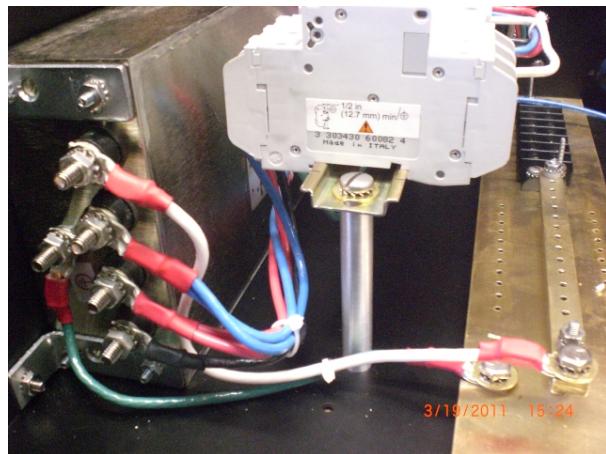
- 1) Turn OFF the 2-amp CNRT breaker to cut power to the smoke detectors. Wait 5 seconds.
- 2) Turn OFF all the branch circuit breakers. The Main breaker should already be in the OFF position from the trip.
- 3) Proceed with the Power Up procedure described, starting with step (3).

## Power Distribution Chassis Assembly and Panel Pictures:

AC Power Inlet:



Power Filter Output:



AC Outlet Wiring:



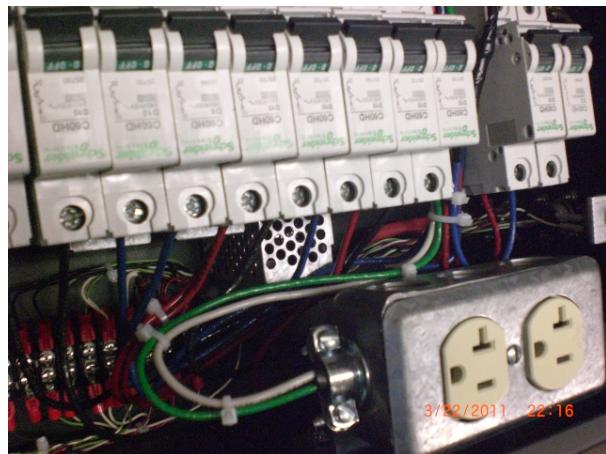
AC Outlet Wiring:



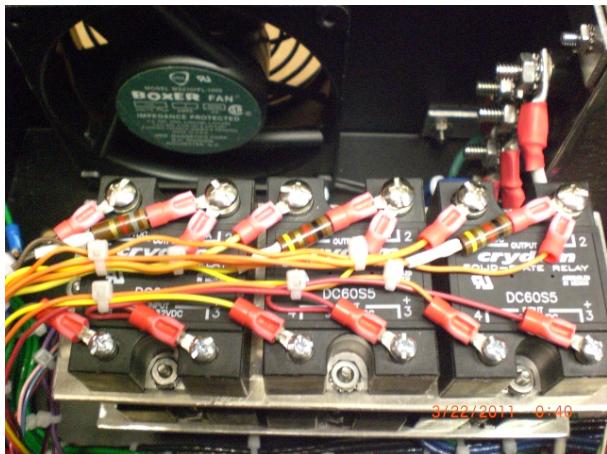
Main Circuit Breaker:



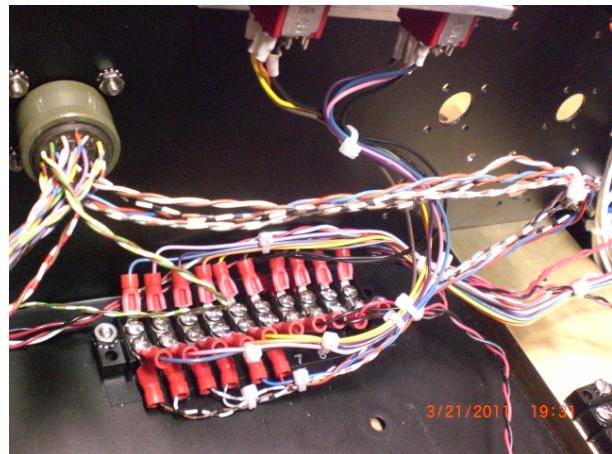
Branch Circuit Breakers:



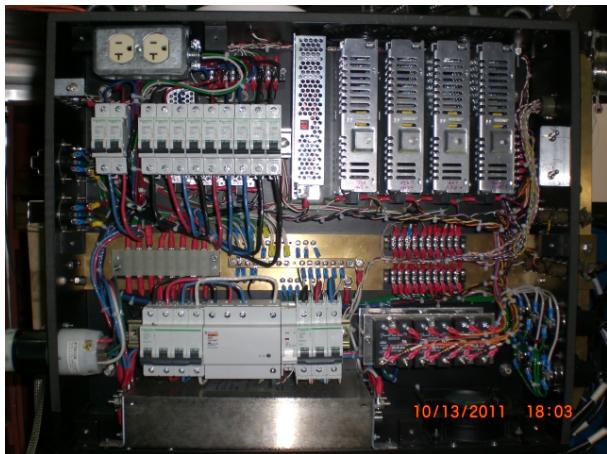
### Solid State Relay Wiring:



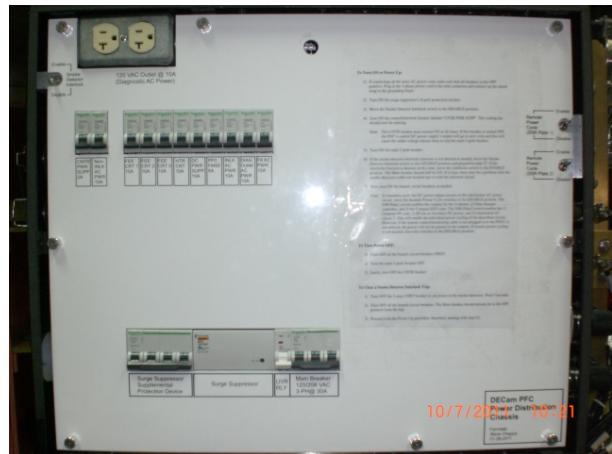
### Controls Wiring:



### Finished Inside Wiring:



### Inner Panel Mounting:



### Inlet Side of PDC:



### Power Outlet Side of PDC:

