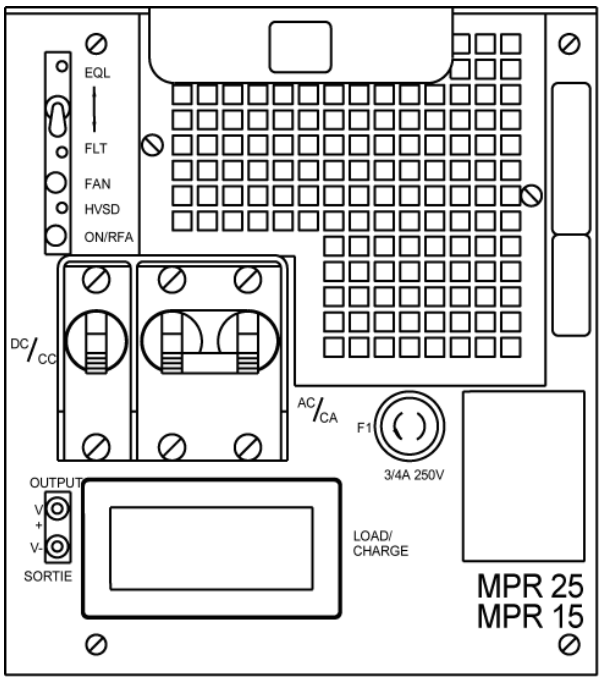
Astec Advanced Power Systems

UM5C06D (169-2071-504)

Helios Rectifier 25/48 Single Phase -48V, 25 A Power Factor Corrected Switch Mode Rectifier NT5C06D

Installation and User Manual



P0831010 Standard 7.00 May 2001

Astec Advanced Power Systems
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This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions contained in the Installation and User Manuals, can cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

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August 1996

Std. release 3.0. Removal of extended temperature rectifier models Table 1 and Table 6 (note) revised.

February 1996

Std. release 2.0. This issue is to cover the revision of "Installation and Start-Up" procedures and Figures 1, 2, 3, 7 and 9

November 1995

Standard release 1.0.

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1. Introduction

Description

The NT5C06D Switch Mode Rectifier is rated for 25 A at -48 V DC. This rectifier incorporates AC input power factor correction circuitry, is highly efficient and lightweight (15 lbs.). It is fully connectorized and plugs into a power shelf into which up to three rectifiers can be installed. The rectifier is forced air cooled with air entering from the front and exhausting out the rear of the power shelf.

Separate or common AC power feeds are connected to the power shelf to provide power to each rectifier through the back plane connectors. The rectifier requires a single phase AC source at a nominal voltage of 208/240 V AC, 50 or 60 Hz. The AC power can be supplied from a single phase source or a three-phase system connected phase to phase. The rectifier can also be powered from a 380 V AC WYE system connected phase to neutral (that is, 220 V phase-neutral).

The negative and positive outputs of each rectifier are connected to two common busses (BAT -48 and BAT RTN +). The power shelf is designed for a typical capacity of 75 A. The design of the rectifiers allows rectifiers located in the same power shelf, or other shelves, which are connected in parallel, to share the load, either by forced load share or by an output negative slope method.

The back plane of the power shelf is equipped with two types of signal connectors. One is an eight-pin (male) connector that provides the interface to analog type controllers. The other connector is a twenty-six-pin flat cable (female) type connector compatible with the Helios system family and provides a larger diagnostic capability.

Each rectifier provides a variety of monitoring and alarm features such as, rectifier failure alarm, fan fail alarm, ac fail alarm, remote sensing, sense fail alarm, local and remote high voltage shutdown, automatic high voltage shutdown reset, temporary release, remote and local equalize, and remote shunt monitoring.

Applications

The rectifier is designed to function as the prime source of power for equipment requiring -48 V DC. It will also operate as a battery charger or as a battery replacement (batteryless operation). Its low output noise and good voltage regulation, combined with a 0.01% V coefficient for each degree C of temperature, provides an excellent charging facility to maintain a battery fully charged.

The NT5C06D rectifier is designed to operate continuously in a small or large power system. The NT5C06D is compatible with all other Astec rectifiers, and can be interfaced with other commercially available standard (compatible) rectifiers and power plants. The NT5C06DA/DB is designed to operate in temperatures ranging from 0°C to 65°C.

Equipment Identification

This section contains a description of the major components and available options for the NT5C06D Rectifier, and the MPS75 power shelves.

NT5C06DA -48 V / 25 A Switch Mode Rectifier, brown

NT5C06DB -48 V / 25 A Switch Mode Rectifier, dolphin grey

NT5C10C(X) Rack mount power shelf family, 23" mounting

***Note*:** Many shelf models, with different colors and features, are available.

MPS75 NT5C10C(X) — power shelf (23-inch)

The MPS75 is a power shelf that can support up to three NT5C06 rectifiers. The rectifiers plug into the shelf, which provides interconnection points for AC input, DC output, and alarm and control signals. Each power shelf requires either three AC feeds (one for each rectifier) for the individual AC models, or a single AC feed for the three shelf rectifiers for the common AC models. Its output connects to the charge busbar or to the load distribution panel through two cables—battery and battery return. Each rectifier position has its own connector-terminated alarm and control cable going to the power plant control and monitor unit.

Helios Rectifier 25/48 — NT5C06D(X) –48 V / 25 A Switch Mode Rectifier

The NT5C06D provides -48 V / 25 A of isolated, filtered, and regulated DC power from a single phase AC source, for powering a load while charging a positive grounded battery. The output voltage can be adjusted from 46.0 to 56.0 V for floating a 23 or 24 cell battery string.

The rectifier is designed for automatic precharge upon insertion into the MPS75 power shelf. When the NT5C06D is plugged into a power shelf with battery back-up, or with other rectifiers running, the DC circuit breaker must be in the OPEN position (OFF position).

Each rectifier plugs into the MPS75 power shelf and does not require any other connections. The rectifier is equipped with a 13 A, two-pole, AC input circuit breaker; a 35 A, single-pole, DC output circuit breaker; a digital ammeter; and a set of LEDs, switches and potentiometers for threshold adjustments and alarm indication. The rectifier uses high frequency switching technology, is cooled by forced air, and can be equipped with an optional air filter.

Figure 1 - -MPS75 Modular Power Shelf-NT5C10C with 8-pin signal cables

Height: 178 mm (7.0 inches)
Depth: 305 mm (12.0 inches)
Width: 533 mm (21.0 inches)
Weight: 10.5 kg (23.0 lbs)

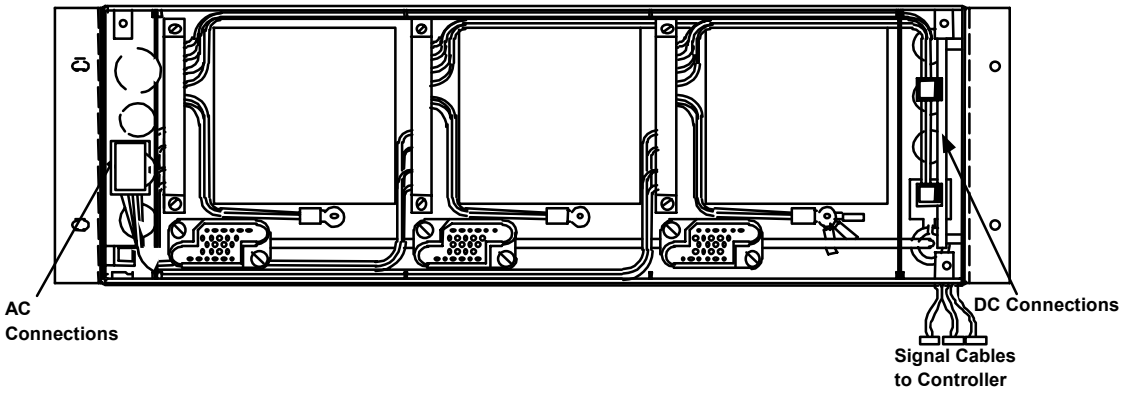


Figure 2 - MPS75 Modular Power shelf- NT5C10C with 26-pin signal connectors

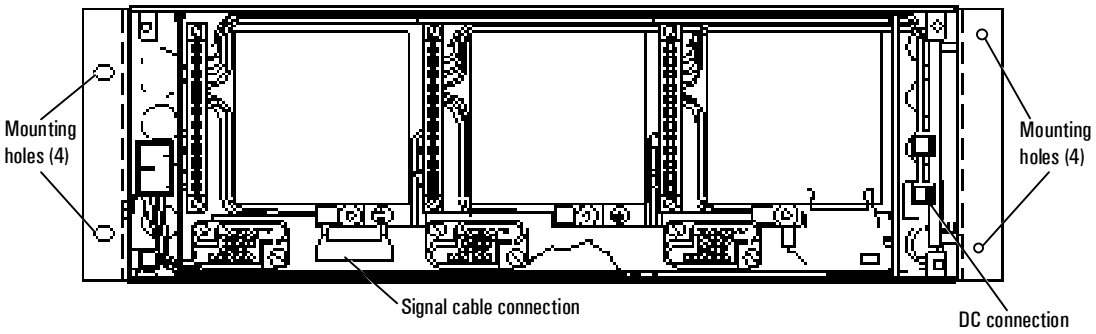
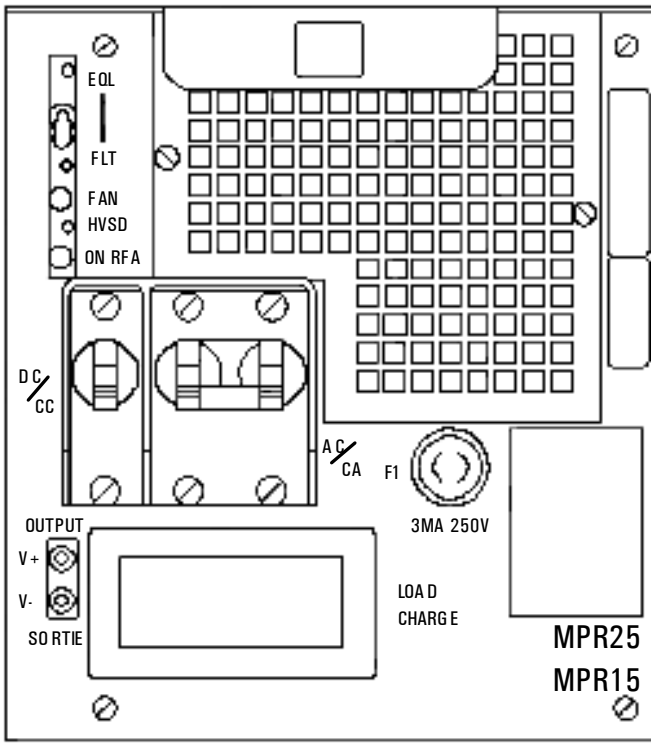


Figure 3 - NT5C06D Switch Mode Rectifier

Height: 168 mm (6.60 inches)
Depth: 260 mm (10.25 inches)
Width: 149 mm (5.85 inches)
Weight:6.8 kg (15 lbs)



2. Specifications

Electrical specifications

The NT5C06D rectifier operates within the electrical specifications listed in Table 1. (Refer to the Product Specification which can be obtained from the Engineering department of Astec Advanced Power Systems).

Table 1 - Electrical specifications

Input Voltage Rating:	Nominal 208 / 240 V AC single-phase, 47-63 Hz. Input Voltage Range 176 to 264 V AC. Starting range 184 to 260 V AC. When three-phase 208 / 240 V AC source is available to power the MPS75, it is preferable to distribute the rectifiers among the phases.
Input Current Rating:	7.5 A nominal at 208 V AC input and -56 V DC, 25 A output. Use RW-90 wire (or equivalent) as listed in Table 2.
Recommended AC Service Input Fusing:	Two slow flow fuse—PRN type or equivalent, one for each AC line input; or one slow trip circuit breaker for each rectifier, as listed in Table 3.
Output Voltage Rating:	Float: -46 V DC to -56 V DC Equalize: 0 - 4 V DC over float. Maximum -59.5 V DC.
Output Current Rating:	25 A for each rectifier.
Input Protection:	Two-pole 13 A circuit breaker, opens both lines for 208 / 240 V AC service.
—continued—	

Table 1 - Electrical specifications (continued)

Output Protection:	A single pole 35 A circuit breaker is connected in series with the negative output lead of the rectifier. The rectifier contains an adjustable output current limit circuit for protection against damage from overloads. This circuit is factory set to limit the output current to 30 A. It can, however, be adjusted from 12.5 A to 30 A.
Output Regulation:	At point of regulation: within ± 0.5% of the selected value for all specified input and output variations and within ± 1% for any combination of specified input, output, and environmental conditions.

Output noise and ripple

Less than 22 dBrnC at voice frequency (with or without batteries and measured at the point of regulation) from a 1 A load current to full load, including the current limit mode. Less than 32 dBrnC for loads less than 1 A.

Less than 10 mVrms in any 3 kHz band between 10 kHz and 20 MHz. Measurements are made with batteries at the output terminals of the power shelf and with the rectifier in the local sensing mode.

Less than 250 mV peak to peak switching voltage spikes measured differentially by an oscilloscope with a 100 MHz bandwidth.

Efficiency and Power Factor

Efficiency is better than 90% at a nominal input voltage of 240 V AC, -54 V DC and an output load greater than 15 A.

The power factor is 0.98 at loads greater than 10 A and 0.99 for loads greater then 20 A.

Reliability

The rectifier has a predicted mean time before failures (MTBF) greater than 120,000 hours under normal operating conditions at 30°C.

Heat Dissipation

The maximum heat dissipation is 156 W or 8.87 BTU's / minute at -56 V / 25 A.

Electromagnetic interference (EMI)

The rectifier meets the EN50081-1 (CISPR22 and EN55022) class "B" requirements for conducted and radiated EMI.

Environmental specifications

Operating

CAUTION
An airflow clearance must be left at the rear of the shelf. A minimum of three inches is recommended.

The rectifier will operate satisfactorily under the following environmental conditions:

Temperature Range:	0° to +65° C (32° to 149° F)
NT5C06DA/DB	equipped without an air filter
	0° to +50° C (32° to 122° F)
	equipped with an air filter
Humidity:	0 to 95% RH (non-condensing)
Altitude:	Sea level to 2100 m (7000 ft.)

Transportation

During transportation the rectifier can be subjected to the following conditions without sustaining damage:

Temperature Range:	-55° C (-67° F) for 16 hours
	+70° C (158° F) dry heat
Humidity:	0 to 95% (non-condensing) 4 kPa max.
Vibration:	38mm/sec max. (10 to 30 Hz).
	610 mm (24 inch) drop when packaged.
Pressure:	12 kPa min. (equiv. to 15 000 m altitude).
Temp. Shock:	-55° to 70°C (-67° to 158°F) (5 cycles)

Storage

For storage, the rectifier must not be kept in an environment exceeding:

Temperature Range:	-55°C (-67°F) +70°C (158°F) dry heat
Humidity:	0 to 95% (non-condensing) 4 kPa max.

The rectifier contains aluminum electrolytic capacitors having a shelf life of 5 years or greater when stored at the maximum rated storage temperature.

3. Installation and start up

The power shelf must be installed on the framework and all AC, DC and control and alarm wiring must be connected before the rectifiers are physically plugged in.

Tools and test equipment

The following tools and test equipment are required:

- Screwdriver, flat blade (3/8-inch)
- Screwdriver, flat blade (3/32-inch)
- Screwdriver, Burns No. 60, or equivalent
- Cable strippers / electrician's knife
- Wire stripper
- Cable cutters (2/0)
- Linesman's pliers
- Open and box ended wrenches (set)
- Socket set (1/2-inch drive)
- Ratchet Wrench (1/2-inch drive)
- Torque limiting torque wrench (1/2-inch drive)
- Crimper, T & B 12 or 15 Ton head with 94H die
- Digital Multimeter, Fluke 8000A or equivalent

Installing the power shelf

Installation of the power shelf consists of mounting the shelf in a cabinet or relay rack and connecting the AC, DC, and control and alarm connection cables.

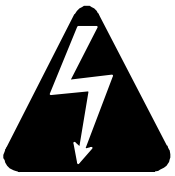
Procedure 1 - Installing the power shelf

Step	Action
1	Position the power shelf, without any rectifiers plugged in, against the framework.
2	Secure the shelf in the position indicated by the job drawing (normally directly below the controller or another shelf). At least one star washer must be installed on one holding screw to ensure maximum framework ground continuity.
3	Release the clamping bar from the front of the power shelf
4	Remove the AC and DC junction box cover, located on the left and right sides. Store the parts for reinstallation after the wire connections have been completed.
—end—	

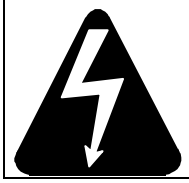
Wiring the power shelf

Once the power shelf has been installed and firmly secured proceed with the wiring.

CAUTION
The power shelf wiring should be installed by qualified personnel and in accordance with the local electrical codes.



DANGER
Input voltage to the rectifier and the power shelf is at a hazardous potential. Ensure that the power switch is OFF at the AC service panel working on the power shelf. Hazardous voltages may still be present at the terminals even if the rectifiers are OFF. Use a voltmeter to verify the absence of voltage.



DANGER
Improper wiring can cause personal injury and equipment damage. Verify the proper polarity of the battery leads before connecting them to the power shelf, and clearly identify the positive and negative leads.

Installing the AC power

Permanent AC connection to the MPS75 power shelf is done using two armored cable conductors, RW-90 or equivalent, as listed in Table 2. One must be routed to L1, and the other one to L2 and to the safety shelf frame ground (FR GND). The cabling must comply to the local electrical code. The power shelf is equipped with a strain relief to terminate the conduit. The cable length should be minimized and be properly secured.

Table 2 - AC cable wire size

	2 RECTIFIER POSITIONS	3 RECTIFIER POSITIONS
Individual AC	12 AWG for each rectifier	12 AWG for each rectifier.
Common AC	8 AWG	6 AWG

Table 3 - AC Fuses

	2 RECTIFIER POSITIONS	3 RECTIFIER POSITIONS
Individual AC	20 A max for each rectifier	20 A max for each rectifier
Common AC	40 A max.	60 A max.

Figure 4 - Power shelf common AC connection

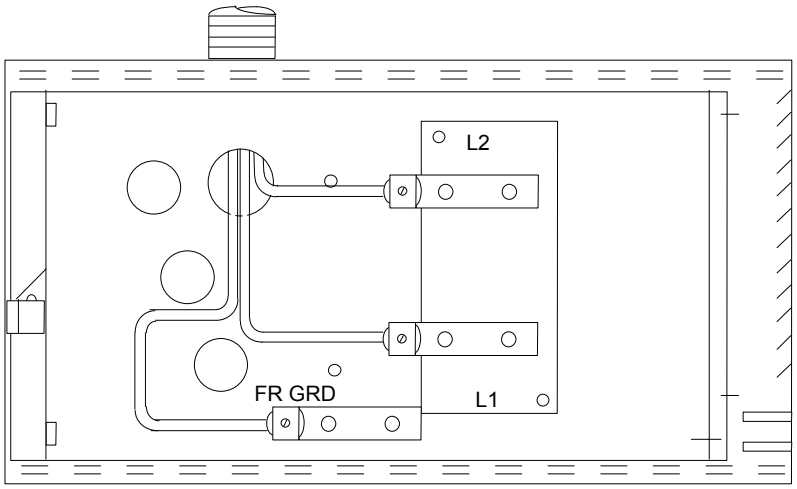
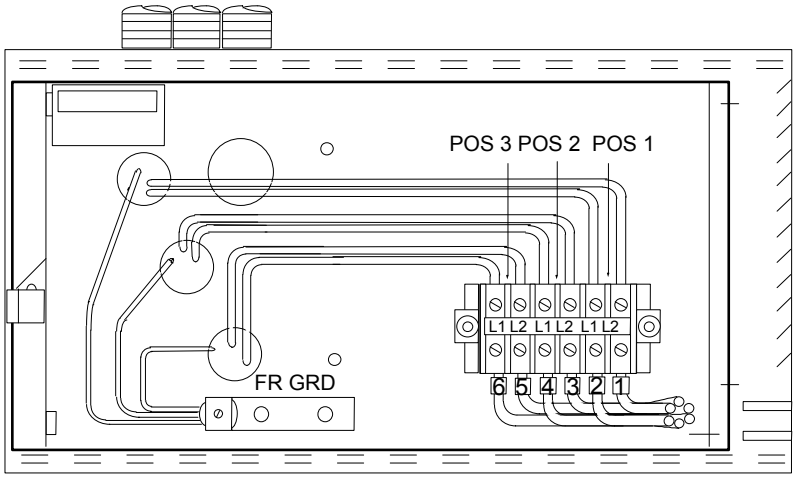


Figure 5 - Power shelf individual AC connection



When cabling the AC to the power shelf, make sure that each corresponding safety ground wire is properly connected to the terminal designated FR GND.

This grounding is proven to be sufficient, but for systems requiring an extra ground connection, an 8 AWG cable wire (color green, insulation 105°C) can be installed in addition to the existing cable and be connected to an external system ground. The new ground wire can be installed on one of the existing FR GND terminal screws located inside the power shelf with a 0.25-inch terminating ring lug. The wire must be routed along the top back of the shelf and come out the back opening on the right DC cabling side. Make sure that the wire does not interfere with the rectifier connections.

CAUTION

Do not insert fuses or operate circuit breakers (switches) until the entire system has been assembled and you have been instructed to do so in the appropriate procedure.

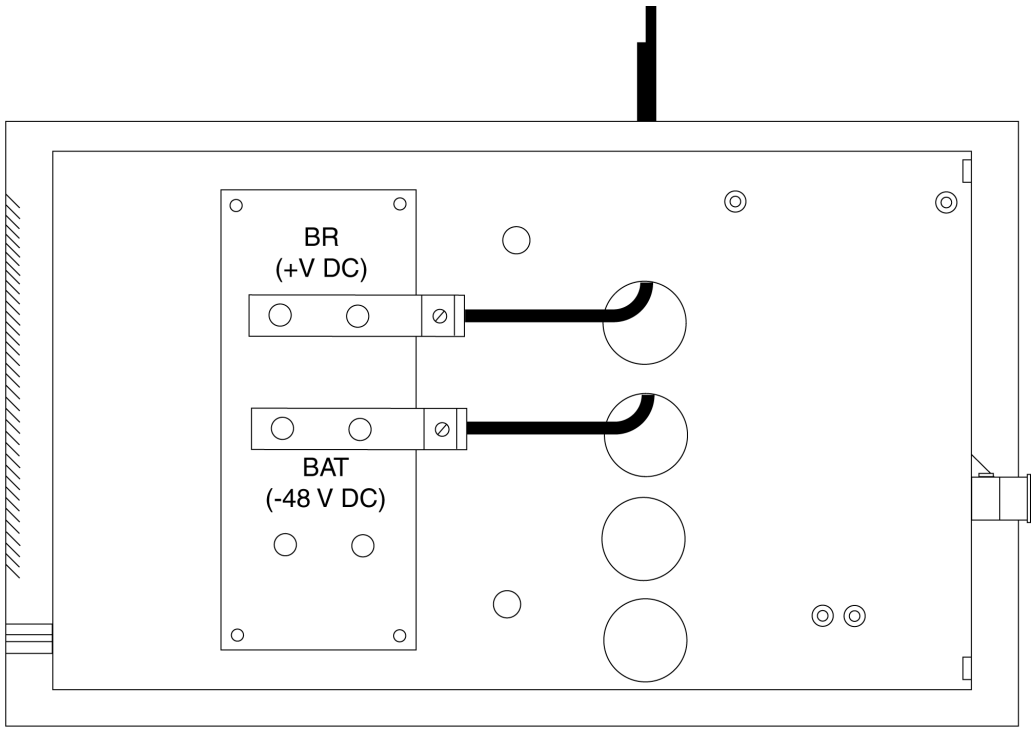
DC Conductors Installation

Make the connections at the power shelf prior to connecting DC leads to the battery or the distribution (load). Permanently connect the shelf to the interconnect and distribution panel using the properly-size cable by referring to Table 4. The DC output of the rectifiers is terminated on two busbars (RTN & -48 V) located on the right side of the shelf. The length of the conductors should be minimized to reduce voltage drops and interference.

Table 4 - DC cable wire size

1 RECT. POSITION	2 RECT. POSITIONS	3 RECT. POSITIONS
8 AWG	6 AWG	4 AWG

Figure 6 - Connecting the DC power shelf



Control and Alarm Connections

The rectifier is interfaced to the power plant controller through the signal connectors provided on the backplane of the power shelf (see Figures 1 and 2 for location). These signal connectors provide control, alarm, and monitoring signals.

The power shelf provides two types of signal connectors. One ribbon cable 26-pin female connector, or multiple eight-pin male cable connectors are used to interface the rectifiers to the power plant controller and monitoring unit. The control inputs are activated by a BAT RTN signal. The alarm signals extended by relay contacts are isolated from each other and from the chassis. All contacts are rated 60 V DC and 0.5 A.

Table 5 - Rectifier and Controller interface connections (8-pin connectors)

Pin #	Design.	Description	Signal
1	EQL	Remote Equalize	BAT RTN
2	RG+	Sensing Positive	BAT RTN
3	RC-	Sensing Negative	-48V
4	FAN ALM	Fan Failure	BAT RTN
5	HVSDR	Remote High Voltage Shutdown Reset	BAT RTN
6	HVSD	Remote High Voltage Shutdown	BAT RTN
7	RFA	Rectifier Failure Alarm	BAT RTN
8	TB	Temporary Release	BAT RTN

Note: Both RFA and Fan alarm relays are energized during normal operation and are de-energized during an alarm condition.

Table 6 - Rectifier and Controller interface connections (26-pin connector)

Pin #	Designation	Description	Signal
1	RC1 -	Sensing Negative rect (1)	BAT-
2	RFA1 (NC)	Rectifier (1) fail alarm	NC
3	TR1	Temporary Release Rect (1)	Bat RTN
4	SH1+	Shunt Positive Rect (1)	50 mV
5	SH1-	Shunt Negative Rect (1)	50 mV
6	RC2-	Sensing Negative Rect (2)	BAT-
7	RFA2 (NC)	Rectifier (2) fail alarm	NC
8	TR2	Temporary Release Rect (2)	Bat RTN
9	SH2+	Shunt Positive Rect (2)	50 mV
10	SH3-	Shunt Negative Rect (3)	50 mV
11	RC3-	Sensing Negative Rect (3)	BAT-
12	RFA3 (NC)	Rectifier (3) fail alarm	NC
13	TR3	Temporary Release Rect (3)	Bat RTN
14	SH3+	Shunt Positive Rect (3)	50 mV
15	SH3-	Shunt Negative Rect (3)	50 mV
16	CUR SHARE	Current Share	0 - 12VDC
17	RFA (C)	Rectifier Fail Alarm	Common
18	ALM COMMON	Alarms Common	Common
19	EQL	Remote Equalize	BAT RTN
20	RG+	Sensing Positive	BAT RTN
21	HVSDR	Remote High Voltage Shutdown Reset	BAT RTN
22	HVSD	Remote High Voltage Shutdown	BAT RTN

—continued—

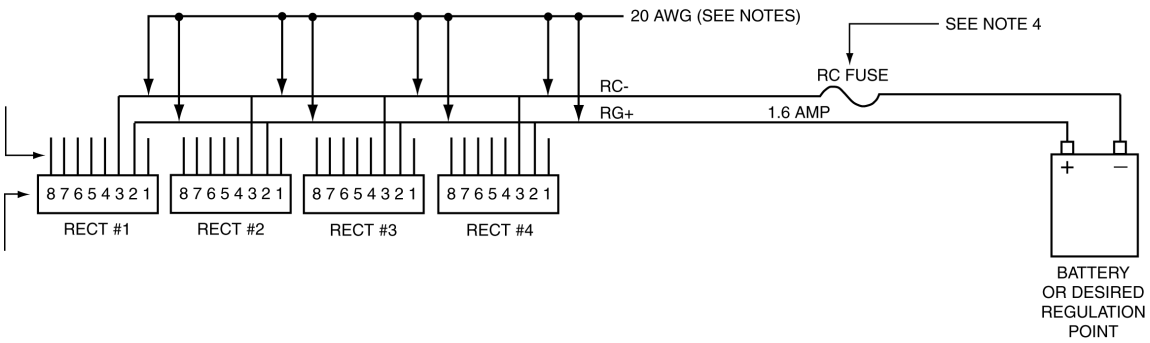
Table 6 - Rectifier and Controller interface connections (26-pin connector) (continued)

Pin #	Designation	Description	Signal
23	DC BRK ALM	DC Circuit Breaker	NC
24	AC FAIL ALM	AC Line Fail Alarm	NC
25	SENSE FAIL ALM	Sense Fail	NC
26	FAN ALM	Fan Alarm	NC

Note: The normally closeed (NC) annotation signifies that the alarm is sent when the contact between the alarm (NC) and alarm common is closed (short-circuited). The alarm RFA (C) and alarm common pins 17 and 18 are floating. These two alarm commons must be connected to the bat RTN at the system level for applications requiring non-floating alarm signals. The rect (1) indicates the rectifier in position (1) located on the right side of the MPS75 shelf.

In applications where no controller is available or desired, the current sharing functions among rectifiers in SLOPE or FORCE mode are still available. The signal cable remote sense connections RC- and RG+ must be connected to the desired remote sensing location (batteries). In forced share mode, the forced share signal line of each shelf must be connected together in a daisy chain fashion. See Figures 7A and 7B for suggested methods of connecting the signal wire.

Figure 7 - No controller, remote sensing connection for 8-pin signal cable shelves



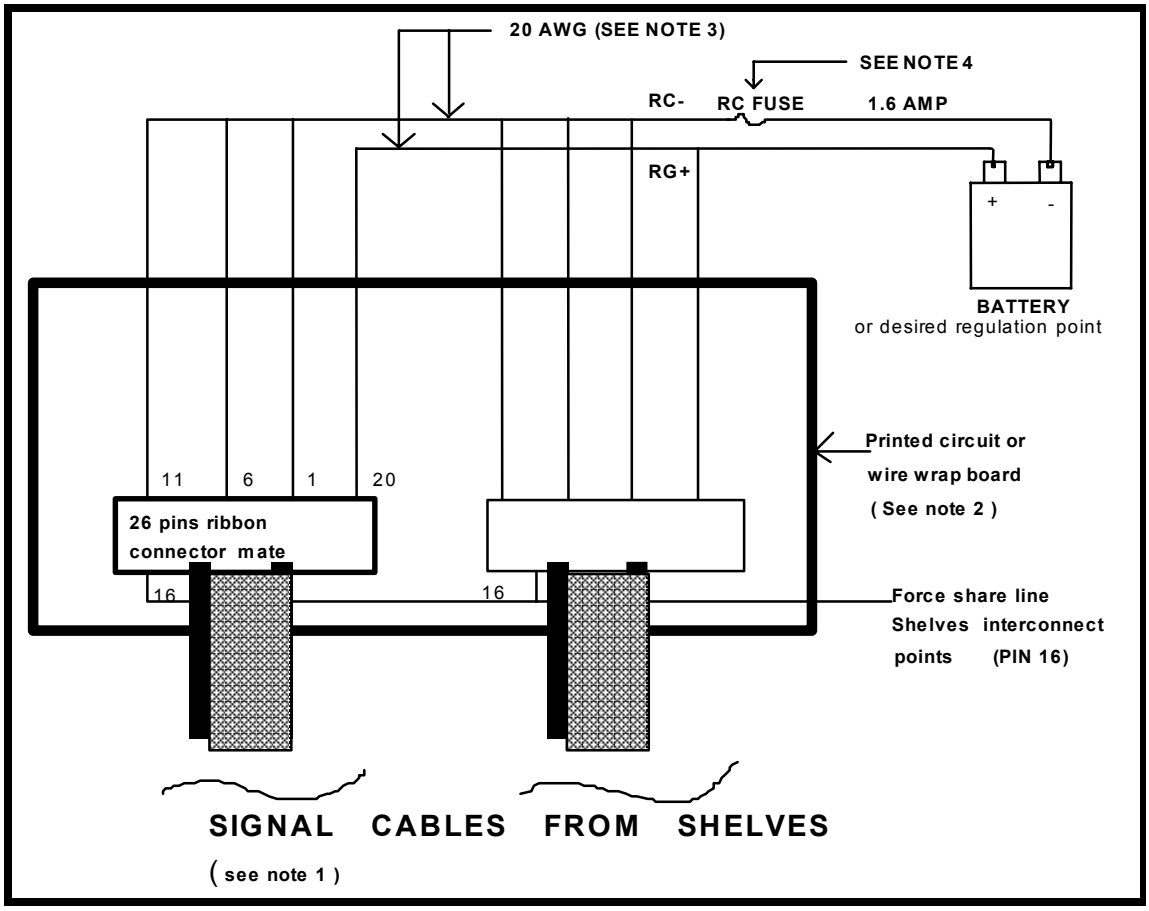
Note 1: Refer to MS5C06 for available 8-pin ribbon signal cables of different lengths to connect from the shelf back plane rectifier position to the remote sensing point.

Note 2: Identify the wire color corresponding to RG+ pin 2 and RC- pin 3 to be used for the remote sensing. Completely cut out completely the 8-pin connector, leaving the signal wires loose. Insulate each unused wire with electrical tape. Use the pin references to identify the signals as described above.

Note 3: Use #20 AWG (105°C) wire.

Note 4: Use 1.6A fuse A0384386 with ferrule type fuse holder A0384387.

Figure 8 - No controller, remote sensing connection for a 26-pin signal connector shelf



Note 1: Refer to MS5C06 for available signal cables of different lengths, to connect from the shelf backplane rectifier position to the remote sensing point.

Note 2: Use a printed circuit or wire-wrap board to interface all the 26-pin connector ribbons from all the shelves. All RC- signal connections (pin 11, 6, 1) must be joined together. All the RC+ connections (pin 20) must also be joined together. For forced share current mode applications, the force share signal (pin 16) must also be interconnected between the shelves.

Note 3: Use #20 AWG (105°C) wire.

Note 4: Use 1.6A fuse A0384386 with ferrule type fuse holder A0384387.

Verification

After completing the wiring of the power shelf perform the following:

Procedure 2 - Verification

Step	Action
1	Verify that the power shelf has been mechanically secured.
2	Verify that all the wiring performed is correct by using a voltmeter.
3	Verify that all connections are mechanically correct (that is, tight, correct connector, correct marking etc.)
4	Reinstall the AC and DC junction box cover on the left and right sides.
—end—	

Installing the rectifier

The NT5C06D rectifier is a plug-in unit intended for use in the MPS75 power shelf.

Procedure 3 - Rectifier installation procedure

Step	Action
1	Release the clamping bar by loosening the two captive screws
2	Remove the blank panel for the rectifier to be installed (place a finger in the hole, lift up, pull forward, then lower to disengage upper tabs from the shelf top). Store the panel at the bottom of the shelf, under the rectifier.
3	Ensure that both AC and DC circuit breakers are in the OFF position.
4	Use a voltmeter to verify that the AC supply at the input of the shelf is 208 / 240 V AC nominal.
5	Carefully slide the rectifier in position on top of the stored blank panel.
6	Insure that the rectifier is firmly slid and seated into position.
7	Reinstall the clamping bar by securing the two captive screws.
—end—	

Factory setting

The rectifier is factory set as indicated in Table 7.

Table 7 - Rectifier settings

	Load Sharing	Slope load sharing method
Rectifier Output Voltage (FLOAT)	54.5 V DC	± 0.1 V
Rectifier Output Voltage (EQUALIZE)	55.2 V DC	± 0.1 V
Rectifier High Voltage Shutdown (HVSD)	59.0 V DC	± 0.1 V
Rectifier Output Current Limit	30 A	± 0.5 A

Rectifier meter accuracy

The rectifier's current meter is precise within ± 2%.

Start-up and verification

Repeat the following steps for each rectifier in turn.

Procedure 4 - Starting up the rectifier

Step	Action
1	Close the AC circuit breaker in the AC service (main) panel.
2	Connect an external meter to test points V- and V+ on the rectifier to be tested.
3	Switch the AC circuit breaker of the rectifier. The voltmeter will indicate a float voltage. ***Note:*** If the float voltage remains at 0 V DC, verify that the input voltage is within the specified range. If it stills remains at 0 V DC, refer to the troubleshooting section of this manual.
4	Determine the system requirements for Float, Equalize and HVSD limits found in User Manual 167-7011-010. If the rectifier's factory set limits have to be changed, proceed as follows, otherwise proceed to step 13.
High Voltage Shutdown (HVSD) Adjustment :	
5	With the DC circuit breaker OFF, keep the AC breaker on and turn the HVSD potentiometer fully clockwise.
6	Turn the FLT potentiometer slowly clockwise until the output voltage reaches the desired HVSD set point.
7	Slowly turn the HVSD potentiometer counterclockwise until the rectifier shuts down and the float voltage starts to decay down to zero. Turn the Float potentiometer counterclockwise two turns and reset the rectifier by switching the AC circuit breaker OFF and then ON.
8	Adjust the Float voltage to the correct level.
Float Voltage Adjustment :	
9	To adjust the float voltage use the FLT potentiometer. To increase the voltage turn the potentiometer clockwise, to decrease it turn it counterclockwise .

—continued—

Procedure 4 - Starting up the rectifier (continued)

Step	Action
10	In order to accurately adjust the rectifiers float and/or equalize (if different from factory setting) the current share mode setting must be taken into account. Two modes of share are offered in the NT5C06DA/DB. (i) Slope Share The output voltage linearly decreases by -300mV from 0-100% of output current capacity (0-25 A). Therefore to accurately PRESET the rectifier's float voltage, it's running current within the plant environment must be predicted and the output voltage modified according to expression below: $V.(preset) = Vo\ (desired) + \frac{Io\ (running)}{25} \times .3v$ or $\%\ Io\ (running) \times .3v$ For example: if the rectifier is expected to provide 12.5 A at 52.2 V then: $Vo(preset) = 52.2 + \frac{12.5}{25} \times .3\ V$ $= 52.2 + .15\ V$ $= 52.35\ V$ In Slope Share mode the rectifier's output may need to be corrected slightly in order for it to share equally with any other rectifiers. The SLS/FS switch of the rectifier (and all other rectifiers in parallel with it) must be pushed toward SLS for slope mode sharing.

—continued—

Procedure 4 - Starting up the rectifier (continued)

Step	Action
11	(ii) Forced Share In the forced share mode, the rectifier's output voltage setting is not modified with changes in output load as is the case in the Slope Share mode. The preset output voltage is the value the rectifier will operate at throughout its load range*. Adjust the rectifier float voltage to the desired system float voltage. Once the rectifier's output voltage has been preset with the DC breaker OFF, turn the DC breaker ON and the rectifier is now connected in the system. In forced share mode, current sharing will be automatic providing the rectifiers' outputs are preset within 0.5 V of each other. • **less than 0.1 V from no load to full load, that is:** **~ 0.2%.**
12	**Equalize Voltage Adjustment (EQL)** Maintain the FLOAT/EQL switch to the EQL position. Turn the EQL potentiometer clockwise to increase the voltage or counterclockwise to decrease it. Use the same consideration as in "Float Adjustment" for determining the desired EQL setting.
13	**Current Limit Verification (CL)** The current limit is factory set to 30 A. The CL ADJ potentiometer can be set within the range of 12.5 to 30 A. Verification or adjustment of the CL setting point requires an external load or the office load can be used. Switch OFF or adjust other rectifiers to a lower voltage, thus forcing the rectifier under test to pickup more load. When the rectifier reaches its current limit point, the current indication will remain constant and the float voltage will start to drop.
14	**Load Sharing** Two Load Sharing methods are available: - Slope load sharing - Forced load sharing (positive bus). The load sharing method can be selected with the SLS / FS switch located on the front panel of the rectifier. For more information about these two methods, see the 'Parallel Operation' Section of this manual. Go to procedure N 5 for the load share adjustment procedure.
—end—	

Slope Load Share

When the rectifier is connected in parallel with rectifiers in the same power shelf, or other power shelves, and this method of load sharing is desired, the SLS / FS switch of each rectifier must be pushed towards the SLS.

Forced Load Share

When the preferred method for load sharing is Forced Load Share, the SLS / FS switch of each rectifier must be pushed toward the FS designation. The power shelf must be connected to the next shelf through the 26-pin ribbon signal connector (pin-16), or to other compatible rectifiers equipped with a forced load share signal 0-12 volt positive bus.

Load Share Adjustment Procedure

If, after presetting the output voltage (float or equalize), the rectifier does not share the load with the other rectifiers in the power plant, take the following steps:

Procedure 5 - Adjusting the load share

Step	Action
1	Verify that all the share mode settings are the same SLS or FS.
2	Verify that all the rectifier sense points are the same.
3	Verify that all the rectifiers are in float or all are in the equalize mode (that is, the modes are not mixed).
4	If the above three cases are true, then this output voltage is maladjusted. Follow step A or B below. A) If the rectifier is in Slope Share: With the DC breaker ON, adjust the FLT (or EQL) potentiometer clockwise, if the current is too low, or counter clockwise, if the current is too high. B) If the rectifier is in Forced Share: Rectifier output is maladjusted by more than $\pm$ 0.5 V. OPEN the DC breaker and adjust the rectifier output within 0.1 V of the plant voltage. Adjust the rectifier float voltage to the desired system float voltage. CLOSE the DC breaker and the rectifier will automatically share the load.
—end—	

4. Operation

In addition to rectifying the AC, the input circuit provides EMI filtering, inrush current limiting, low and high AC inhibit, power factor compensation, surge voltage protection, and is equipped with a 13 A AC breaker for input protection.

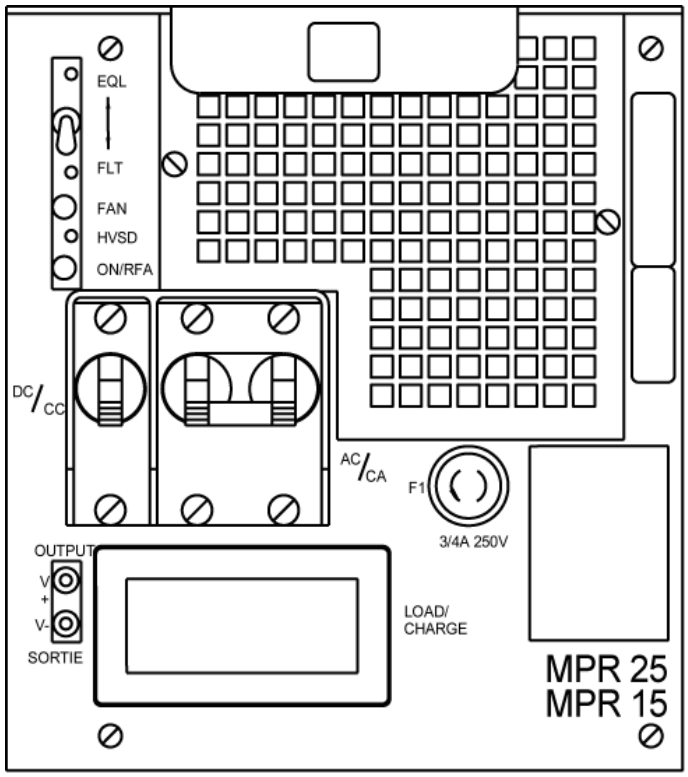
The output section provides additional EMI filtering and contains an internal shunt for output DC current measurement and a 35 A circuit breaker for output protection.

The monitoring circuitry includes; soft start, rectifier fail alarm (RFA), monitoring and control for local and remote equalize, temporary release, thermal shutdown, low and high AC voltage inhibit, loss of AC voltage alarm, local and remote high voltage shutdown (HVSD), local and remote HVSD reset, and fan failure detection.

A 2-1/2 digit output current meter displays the output current. An internal logic power supply provides the various voltages required by the logic circuitry and the cooling fan unit.

Front panel controls

Figure 9 - NT5C06D - front view



Features

In addition to the features and performance characteristics described earlier, the rectifier provides the following features.

Local float / equalize control

The rectifier is equipped with a float / equalize switch. The rectifier normally delivers a float voltage set by the FLT potentiometer. When the switch is placed in the EQL position, the rectifier changes to equalize mode and boosts the output voltage to the value set by the EQL potentiometer.

High voltage shutdown (HVSD) - local

This potentiometer sets the internal threshold level for the local high voltage shutdown monitor circuit.

High voltage shutdown - remote

The rectifier can be shut down by an external (remote) HVSD signal from the controller only if it is delivering more than 3 A +/- 0.75 A.

Start-up delay

This unit does not have a start-up delay.

Test points (V+, V-)

Test points allow the user to measure the voltage at the point of regulation. A 100 ohm PTC resistor is placed in series with both leads to prevent damage caused by short circuits at the jack terminals.

Indicators

Table 8 - Indicators

LAMP DESIGNATION	COLOR	DESCRIPTION
RFA	Red/Green	Rectifier Fail Alarm / normal operation
FAN ALM	Red	Fan Fail Alarm

Rectifier failure alarm (RFA)

The rectifier incorporates facilities for monitoring its operational status and extends a global alarm upon detection of an internal failure. An abnormal or out of range AC input voltage, an internal fuse failure, any circuit breaker opening, any system or internal shutdown (for example: Thermal or HVSD), or any internal failure causing a disappearance of power switching, will trigger the RFA alarm and light up the RFA LED (color red) located on the front panel. If the disappearance of switching, however, is caused by an incorrect adjustment of the output FLT voltage, resulting in no output load, the RFA will not be triggered since no real failure will have occurred.

Fan failure alarm

Loss of all or part of the cooling system activates the FAN ALM and lights up the appropriate LED on the front panel. An RFA will be triggered, the rectifier will be inhibited and both a FAN ALM and RFA will be generated.

The defective fan cooling fan unit can be ordered and replaced by the customer.

Internal high voltage shutdown (HVSD)

The rectifier is equipped with a high voltage monitor. Whenever the rectifier output voltage exceeds a preset value adjustable from -52 V to -59.5 V, the rectifier shuts down. The rectifier will attempt to restart itself automatically after an HVSD. However, if another HVSD occurs within approximately 5 minutes, the rectifier will shut down, lock out and transmit an RFA. This function is independent of the output load condition. The AC breaker must be toggled to reset the unit.

Local ON/OFF control (AC breaker)

The AC input circuit breaker can be used to locally turn the rectifier ON/OFF. The local ON/OFF control overrides remote control signals.

Remote ON/OFF control

When a battery return (BAT RTN) signal is applied to the 'Temporary Release' (TR) input, the rectifier inhibits its operation (no RFA will be transmitted). Upon removal of the remote ground signal the rectifier returns to normal operation.

Remote voltage sensing

Provision is made to extend the sensing leads to the battery or to the charge / discharge bus (batteryless operation) of the plant. Opening either sense lead will not adversely affect the rectifier output voltage and the rectifier will default to internal sensing mode.

Sense fail alarm (SEN FAIL)

In the event that the remote sense leads are not connected or reversed, the RC fuse on the controller fails, or the DC circuit breaker is opened. An alarm will be transmitted through the signal connector only.

Current limiting

The rectifier will limit the output current to 30 A $\pm$ 0.5 A (factory setting). The current limit level can be adjusted between 12.5 A to 30 A at 54.5 V DC, or to any combination limited to 1635 W of output power within the adjustable voltage range. Extended periods of operation in the current limiting mode and repeated transitions between constant-voltage operation and constant-current operation will have no detrimental effect on the rectifier's performance, or service life.

The rectifier is capable of starting when connected across a completely discharged battery without requiring human intervention or operation of protection devices. Transitions from constant-voltage operation to constant-current operation and constant-current operation to constant-voltage operation will occur automatically as determined by the output current. The current limit circuit will remain working in both the float and equalize modes.

Soft start / walk-in

The rectifier incorporates a walk-in circuit that limits the output current rise to about 3 A +/- 0.5A every second.

AC inrush current

The AC current during the turn-on sequence of the rectifier, under all input and output conditions specified in this document, will not exceed its full load steady-state value.

Sequential start

The rectifier TR lead is available for use with an external sequential start circuit.

Parallel operation

The rectifier is capable of operating in parallel with other rectifiers having similar output characteristics and shares the total load proportionally to its output rating.

Two load-sharing methods are available:

- Slope load sharing
- Forced load sharing (positive bus)

The load sharing method is normally set at the time of installation by the SLS / FS switches located on the front panel of the rectifier. The rectifier is factory set to the Slope Load Sharing Mode.

a) Slope Load Sharing (SLS)

When the SLS / FS switch is set to the SLS position, load sharing is achieved, by a -300 mV slope on the output voltage, from no load to full load on the rectifier. This mode should be used when rectifiers from different vendors are used which are not all equipped with the forced load-sharing feature. In this mode the units will share the load within $\pm$10% of their maximum output rating.

b) Forced Load Sharing (FS)

When the SLS / FS switch is set to the FS position, forced load sharing is achieved by an internal control circuit which, by slightly modifying the loop reference, achieves equal output current between rectifiers. For this to occur the rectifiers must communicate their operating current to other units on the same power plant. The CS terminals of the rectifiers in the same power shelf are connected through the back plane (for shelves equipped with a pcb backplane only). In this mode the units will share the load within $\pm$2% of their maximum output rating.

Discharge of output capacitors

The output capacitors will be completely discharged (< 2 V) two minutes after the AC power has been removed and the rectifier has been disconnected from the batteries or parallel units.

Input AC voltage monitor

The rectifier monitors the input voltage, inhibits its operation and sends an RFA when the AC voltage decreases below 176 or rises above 264 V AC. An AC FAIL alarm contact is transmitted through the signal connector.

The rectifier recovers its normal operation automatically when the input voltage returns within the acceptable limits, without any operator intervention.

Thermal shutdown

The rectifier protects itself against thermal over stress by inhibiting its operation for the duration of the high temperature condition. The RFA alarm is triggered.

Remote high voltage shutdown

In addition to the local high voltage shutdown feature, the power plant controller can shut down any rectifier by sending a high voltage shutdown signal, ground (BAT RTN) pulse. The rectifier will shut down within 50 ms if it is supplying more than 3 A +/- 0.75 A.

Local / remote high voltage shutdown reset

The rectifier may be reset from an HVSD condition either by toggling the rectifier's AC circuit breaker, or by applying a ground signal at the HVSDR input of the rectifier, provided that the 'TR' lead is not activated.

If the HVSD condition subsides the rectifier will restart automatically. If a second HVSD event occurs within a 5-minute interval the rectifier will lock out on the second event and have to be manually or remotely reset to restart.

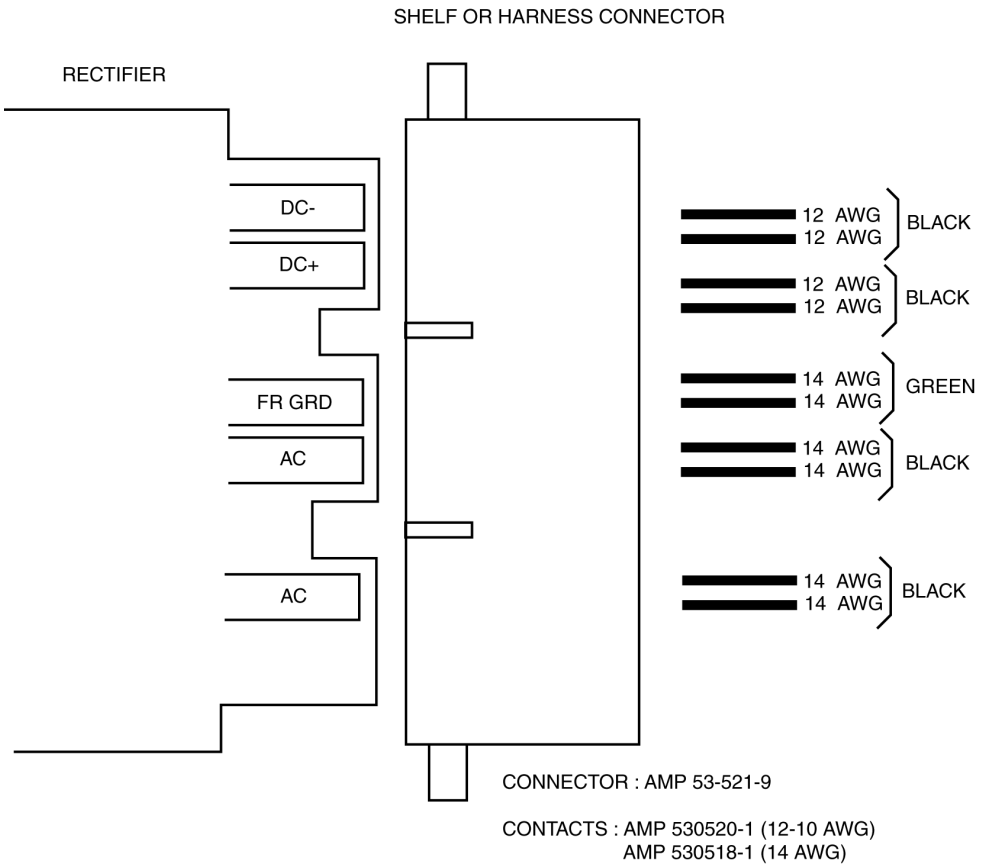
Remote equalize control

The rectifier is equipped with remote equalize control. This control is operated by applying a remote ground signal (BAT RTN) and returns to normal (Float) operation upon removal of the signal.

Power interface edge connector

The rectifier AC, DC, and chassis ground interface is done through the power interface edge connector. This connector is designed to establish the frame ground connection first. Figure 10 shows the rectifier to shelf power interface connections.

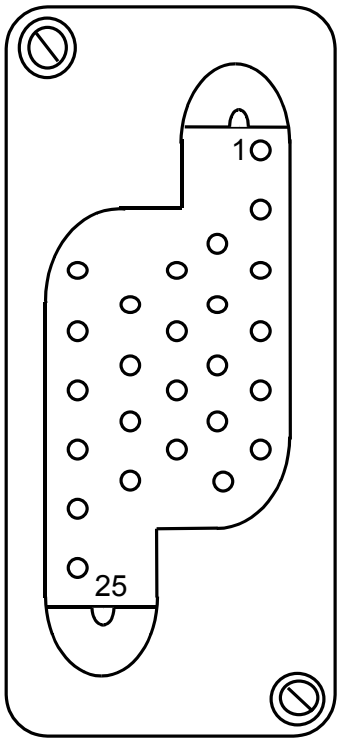
Figure 10 - Power interface connections



Signal interface connector

Figure 11 shows the pin assignment of the signal interface connector. This connector is used to interface all the control, alarm and monitoring signals with the power shelf that, in turn, interfaces these with the Controller. The control inputs are activated by a ground (BAT RTN) signal. The alarms are extended by relay contacts and are isolated from each other and from the chassis. All contacts are rated 60 V DC and 0.5 A.

Figure 11 - Control signal connections



1 - REMOTE EQL
2 - SENSING RG +
3 - SENSING RC -
4 - TEMPORARY RELEASE
5 - REMOTE HVSD RESET
6 - REMOTE HVSD
7 - RFA NC
8 - Not Connected
9 - FAN ALARM NC
10 - RFA COMMON
11 - FAN ALARM COMMON
12 - SHUNT +
13 - SHUNT -
14 - FAN ALARM NO
15 - RFA NO
16 - GROUND
17 - SENSE COMMON
18 - SENSE NC
19 - SENSE NO
20 - Not Connected
21 - Not Connected
22 - Not Connected
23 - Not Connected
24 - Not Connected
25 - Not Connected

5. Maintenance

The NT5C06D rectifier is virtually maintenance free. It requires periodic float / equalize verification (once every six months) and air filter replacement as required.

Note: If the unit operates in a dusty environment the optional air filter is recommended. It must be inspected and changed, or thoroughly cleaned, at least every 12 months, or sooner if the dust level is high.

CAUTION
Do not install a wet filter on the unit.

To remove the filter, simply unscrew it. Re-install it by reversing the operation.

Float / equalize

The float/equalize voltage level of the rectifier can be verified and adjusted with the rectifier in, or out of service. To verify the equalize setting point with the rectifier out of service, proceed as follows:

Procedure 6 - Adjusting the float / equalize

Step	Action
1	Open the DC circuit breaker.
2	Put the FLT/EQL switch to the EQL position.
3	If the voltage requires readjustment use the EQL potentiometer to set the equalize voltage to the new level.
4	Release the FLT/EQL to FLT.
5	Close the DC circuit breaker.
—continued—	

Procedure 6 - Adjusting the float / equalize (continued)

Step	Action
6	The float voltage should be adjusted with the rectifier in service, as follows: The rectifier is connected to the system and should carry some load. If the rectifier is connected in parallel with other rectifiers, verify that the total system load current is shared equally among the rectifiers. If the current reading is too low, or nil, slowly increase the FLT potentiometer, by turning it clockwise, until sharing is achieved. If the current reading is too high, or the unit is in the current limit mode, decrease the FLT potentiometer by turning it counterclockwise.
—end—	

High voltage shutdown (HVSD)

To verify or readjust the HVSD follow steps 5 to 8 of the "Rectifier Startup and Verification" section of this manual.

Cooling fan

Visually inspect the airflow intake for any obstruction by foreign objects, or excessive dust and dirt build-up. Open both the AC and DC breakers and remove the rectifier from the power shelf. Inspect the air outlet for obstruction by foreign objects, or excessive dust and dirt build-up. Visually inspect the air outlet of the enclosure or cabinet. If a problem is detected in the rectifier, contact your local Astec service facility. The unit is not designed for on site servicing.

CAUTION
Do not attempt to access the inside of the unit with a tool or a finger. Severe electrical shock could result.

Fan failure

If a fan alarm persists after the fan filter and assembly has been cleaned, replace the fan assembly as follows:

Fan replacement

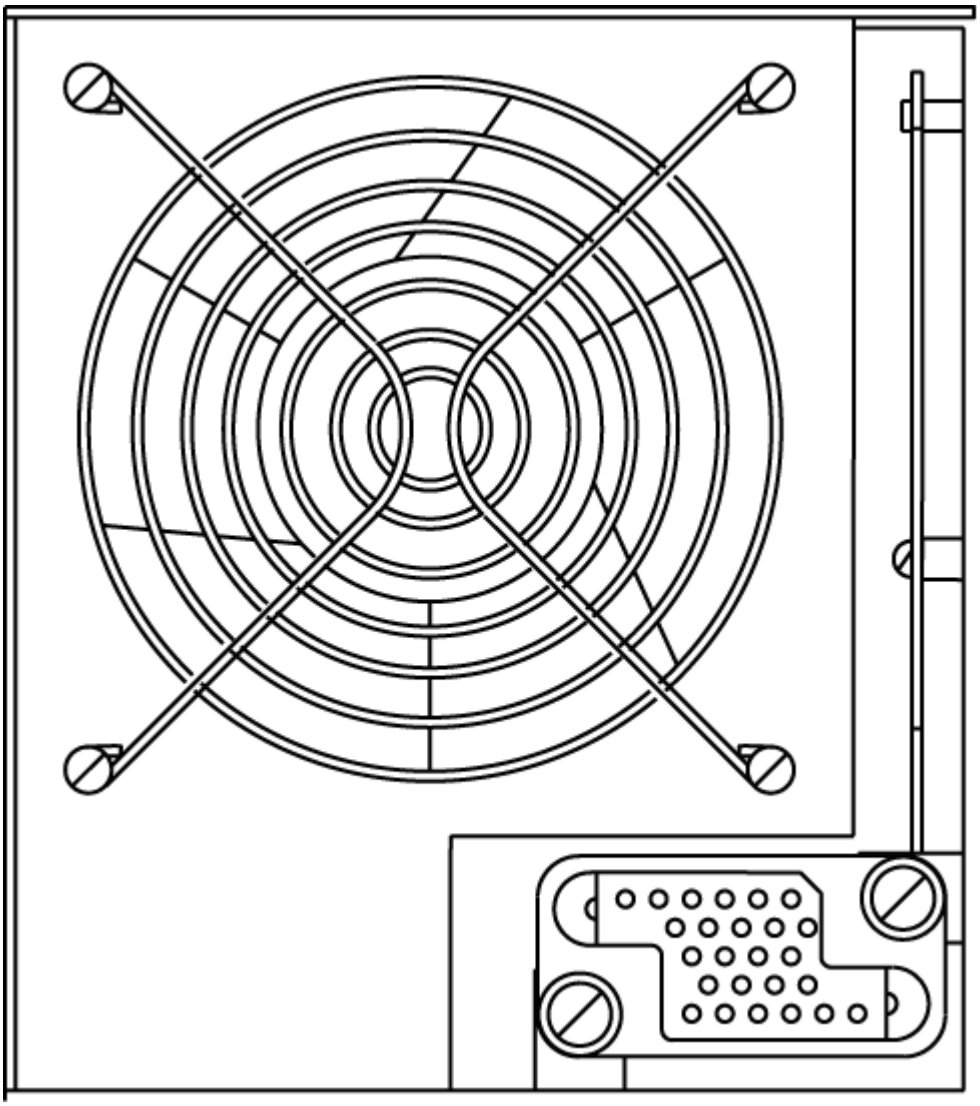
CAUTION
Before replacing the fan, turn the rectifier OFF. Completely disconnect and remove it from the shelf. Wait thirty minutes to allow all internal capacitors to fully discharge and for all components to cool down.

CAUTION
Keep any dirt, dust, moisture or metallic particles from entering into the unit.

Procedure 7 - Replacing the fan

Step	Action
1	Disconnect the 3-pin fan connector located below the fan assembly (refer to Figure 12).
2	With the unit sitting solidly on a clean workbench, carefully remove the four mounting screws that hold the fan assembly in place.
3	Slowly and carefully remove the fan assembly by pulling it from the chassis.
4	Replace with a new one.
5	Mount the fan assembly in the same orientation as the old one. Ensure the orientation of the fans is such that the air is blown outwards when the fans are operated.
6	Mount the fan and fan grill using the four retaining screws.
7	Reconnect the fan connector.
8	Plug the unit back in and power it up. Holding a piece of paper at the front of the unit should confirm that the air is pulled inwards from the front.
9	Listen carefully to detect any noise coming from the fans. They should run freely. Verify that the fan alarm is OFF.
–end–	

Figure 12 - NT5C06D rear view



	CAUTION Ensure that the fans spin freely, without interference.

CAUTION
Do not run the rectifier without a fully operational fan or with a fan other than the specified replacement for this cooling application.

Power shelf

The power shelf requires no maintenance.

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6. Troubleshooting

Alarm indication

RFA fault

Table 9 - System fault diagnosis

Fault symptom	Possible causes
RFA	No AC input or input out of bounds.
	No AC input or input out of bounds.
	AC Input/DC output circuit breaker is open.
	Rectifier has received a HVSD signal from the controller.
	An internal high voltage shutdown (HVSD) has occurred. The internal High voltage shutdown point set too low (below float or equalize setting).
	Excessive impedance in one or both sense leads.
	The cooling fan is failed.
	DC circuit breaker is open.
	A thermal shutdown has occurred.
	Defective unit.
	Excessive ambient air temperature.
	Air inlet/outlet blocked, clogged air filter.

SEN FAIL fault

Fault symptom	Possible causes
SEN FAIL	One or both remote sense leads is disconnected.
	DC breaker is open.
	Rectifier is still in walk-in.
	Sense leads are reversed.

Erratic load fault

Fault symptom	Possible causes
Erratic load	Requirement exceeds total rectifier capacity.

Current or voltage float fault

Fault symptom	Possible causes
Current or voltage float	With paralleled units, the float and/or equalize is misadjusted causing one or more units to carry the load.
	Unit is in 'equalize' mode and paralleled units are not.
	Remote sense lead has excessive impedance or are not connected on one or more rectifiers.
	System batteries are in a recharge mode after AC outage.
	Current share mode selection is not the same for all units.
	Forced share line is disconnected. (in FS only)

7. Appendix A: Replacement parts

ITEM	CPC
Fan Assembly	P0710139
Air Filter Kit	P0834732

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8. Appendix B: Technical service assistance

For technical assistance, 24-hours a day / 7 days a week, dial one of the following toll-free numbers. This service complements the services offered by field support organizations such as, the Emergency Technical Assistance Service (ETAS), and the Installation Technical Assistance Service (ITAS).

Local toll-free prefixes

The following prefixes give access to toll-free numbers in various countries. For further information please contact the local service provider.

Country	Prefix
Australia	0011
Belgium	00
Brazil	0021
Denmark	00
Finland	00 or 990
France	00
Germany	00
Hong Kong	001
Ireland	00
Japan	001 (KDD) 041 (ITJ) 0061 (IDC)
Korea	001 (Korea Telecom) 002 (Dacom) 003 (Once)
Malaysia	00
Netherlands	00
New Zealand	00
Singapore	001
Switzerland	00
United Kingdom	00

Toll-free technical assistance numbers

United States:	1-800-992-8417	**Canada:**	1-800-363-2288
In Europe:		**In Asia and the Pacific:**	
Austria	800-213-49156	Australia	800-213-49156
Belgium	800-213-49156	Hong Kong	800-213-49156
Denmark	800-213-49156	Japan	800-213-49156
Finland	800-213-49156	Malaysia	800-213-49156
France	800-213-49156	New Zealand	800-213-49156
Germany	800-213-49156	Philippines	1-800-1-110-0131
Ireland	800-213-49156	Singapore	800-213-49156
Italy	800-213-49156	South Korea	800-213-49156
Netherlands	800-213-49156	Taiwan	800-213-49156
Norway	800-213-49156		
Sweden	800-213-49156		
Switzerland	800-213-49156		
United Kingdom [*1]	800-213-49156		
In the Caribbean and Latin America (CALA):		**In the Middle-East:**	
Bahamas	1-800-389-0081	Israel	800-213-49156
Barbados	1-800-534-0225		
Brazil	08-1571-012288		
Colombia	980-192288		
Dominican Republic	1-888-7514232		
Jamaica	1-800-850-1755		
Mexico	001-800-514-2288		
Puerto Rico	1-888-680-2288		
Trinidad & Tobago	1-800-363-2288		

[*1] The United Kingdom includes England, Guernsey, the Isle of Man, Jersey, Northern Ireland, and Scotland.

For countries not covered by a toll-free service dial Canada (country code 001) at 514–832–6707.

9. List of terms and acronyms

ALM	Alarm
BAT	Battery
BAT RTN	Battery Return
C	Common
CL	Current Limit
CS	Current Share
EMI	Electromagnetic Interference
EQL	Equalize
FAN ALM	Fan Alarm
FLT	Float
FR GND	Frame Ground
FS	Forced Load Share
HVSD	High Voltage Shutdown
HVSDR	High Voltage Shutdown Reset
LED	Light Emitting Diode
LVA	Low Voltage Alarm
LVD	Low Voltage Disconnect
LVDR	Low Voltage Disconnect/Reconnect
MPA	Modular Power Adapter
MPL	Modular Power Low Voltage Disconnect
MPR	Modular Power Rectifier
MPS	Modular Power Shelf
MTBF	Mean Time Between Failures
NC	Normally Closed

NO	Normally Open
NT	Northern Telecom
PCB	Printed Circuit Board
RFA	Rectifier Fail Alarm
RG+	Sensing Battery Positive
RC -	Sensing Battery Negative
SEN FAIL	Sense Fail
SH +	Shunt Positive
SH -	Shunt Negative
SLS	Slope Load Sharing
TBD	To be Determined
THSD	Thermal Shutdown
TR	Temporary Release

Helios Rectifer 25/48 Single Phase –48 V, 25 A Power Factor Corrected Switch Mode Rectifier NT5C06D

Installation and User Manual

Astec Advanced Power Systems Ltd
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