

**HFM48AC7.5
SWITCHED MODE
RECTIFIER
FOR POWER PLANTS**

**PRODUCT MANUAL FOR
Generic 100-7507-48, 48VDC 7.5A Model
With Functional References to Power Plant,
Power Shelf, and Rack Mount Product Applications**

C&D Technologies, Inc.
Integrated Power Systems,
Power Systems Division
65 Industrial Park Road, Dunlap, TN 37327
Customer Service, Voice: (800) 440-3504
Customer Service, Fax: (423) 949-3647
Field Service: (800) 299-3907
Web site – <http://www.cdpowercom.com>

RECEIVING INSTRUCTIONS & GENERAL EQUIPMENT INFORMATION

Please Note: For your protection, the following information and the product manual should be read and thoroughly understood before unpacking, installing, or using the equipment.

C & D Technologies presents all equipment to the delivering carrier securely packed and in perfect condition. Upon acceptance of the package from us, the delivering carrier assumed responsibility for its safe arrival to you. Once you receive the equipment, it is your responsibility to document any damage the carrier may have inflicted, and to file your claim promptly and accurately.

1. **PACKAGE INSPECTION**

- 1.1 Examine the shipping crate or carton for any visible damage: punctures, dents, and any other signs of possible internal damage.
- 1.2 Describe any damage or shortage on the receiving documents, and have the carrier sign their full name.
- 1.3 If your receiving freight bill notes that a Tip-N-Tell is attached to your freight, locate it. If the Tip-N-Tell arrow has turned even partially blue, this means the freight has been tipped in transport. Make sure the carrier notes this on your receipt before you sign for the freight.

2. **EQUIPMENT INSPECTION**

- 2.1 Within fifteen days, open the crate and inspect the contents for damages. While unpacking, be careful not to discard any equipment, parts, or manuals. If any damage is detected, call the delivering carrier to determine appropriate action. They may require an inspection.

***SAVE ALL SHIPPING MATERIAL FOR THE INSPECTOR TO SEE!**

- 2.2 After the inspection has been made, call C & D Technologies. We will determine if the equipment should be returned to our plant for repair, or if some other method would be more expeditious. If it is determined that the equipment should be returned to C & D Technologies, ask the delivering carrier to send the packages back to C & D Technologies at the delivering carrier's expense.
- 2.3 If repair is necessary, we will invoice you for the repair so that you may submit the bill to the delivering carrier with your claim form.

- 2.4 It is your responsibility to file a claim with the delivering carrier. Failure to properly file a claim for shipping damages may void warranty service for any physical damages later reported for repair.

3. **HANDLING**

Equipment can be universally heavy or top-heavy. Use adequate humanpower or equipment for handling. Until the equipment is securely mounted, be careful to prevent the equipment from being accidentally tipped over.

4. **NAMEPLATE**

Each piece of C & D Technologies equipment is identified by a part number on the nameplate. Please refer to this number in all correspondence with C & D Technologies.

5. **INITIAL SETTINGS**

All equipment is shipped from our production area *fully checked and adjusted*. Do not make any adjustments until you have referred to the technical reference or product manual.

6. **SPARE PARTS**

To minimize downtime during installation or operation, we suggest you purchase spare fuses, circuit boards and other recommended components as listed on the Recommended Spare Parts List in the back of the product manual. If nothing else, we strongly recommend stocking spare fuses for all systems.

ISSUE HISTORY

ISSUE	PAGE(S) ALTERED	DESCRIPTION	DATE
6	ALL	Incorporate instructions to eliminate low current alarms (PN990.5827.00) and to correct the website information as well as other important information is correct throughout the manual. See ECN 13655	MCM 10/18/01
7	ALL	SEE ECN 15563	MCM 6/6/06

DOCUMENT SUMMARY

SCOPE

This manual covers the HFM48AC7.5 Switched-mode Rectifier Part Number 100-7507-48 as used in the following Power Plants (PP), Power Shelf (PS), and Rack Mount (RM) products:

<u>Rack size</u>	<u>C&D Product #</u>	<u>Rating - Max Capacity</u>	<u>Rectifiers per</u>
23 inch	110-4025-00 (PP)	1350 W (22.5 A @ 60V)	3
19 inch	110-4015-00(PP)	900 W (15 A @ 60V)	2
23/19 inch	100-7610-XX(RM)	450 W (7.5 A @ 60V)	1
19 inch	111-3886-00(PS)	2700 W (45 A @ 60V)	6
23 inch	110-4202-00(PP)	3600 W (60A @60V)	8

PURPOSE

This manual provides the technical product specifications, design features, operation and maintenance information for the HFM48AC7.5 Rectifier. In addition the manual provides references regarding its' specific implementation within the various Power Plant, Power Shelf, and Rack Mount products that utilize this rectifier.

LEGAL DISCLAIMER

C&D Technologies, Inc., believes that all information contained in this manual is accurate and reliable. However, this information does not constitute any guaranty or warranty by C&D, nor does it make C&D responsible for any damage that might occur during the installation, use or maintenance of the equipment described in this manual.

C&D Technologies, Inc., also does not guarantee that the suggested equipment uses given in this manual do not infringe upon any existing or pending patents.

Those who install, use, and maintain this equipment, should not assume that all possible safety measures that should be taken with this equipment are mentioned in this manual. Furthermore, no one should assume, that no other precautionary measures may be required for safe installation, use and maintenance of this equipment, where unusual environmental conditions or circumstances dictate otherwise.

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TABLE OF REFERENCES

DOCUMENT NUMBER	TITLE
ANSI C 39.1	Requirements for Electrical Analog Indicating Instruments
ANSI T1.311-1991	DC Power Systems - Telecommunications Environment Protection
ANSI/IEEE C 62.41- 1980	IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits, ANSI
IEC 801-2	IEC Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment October 1987
NEC 1993	NEC Handbook 1993, National Fire Protection Association
No Number	OI-28 Standards
No Number	Central Office Telecommunications Equipment Engineering Standards December 1984
PUB 77350	U S West Telecommunications Equipment Installation & Removal Guidelines June 1990
PE-7-1985	Communications Type Battery Chargers, NEMA/ANSI
STD 487-1980	IEEE Guide For The Protection of Wire-Line Communications Facilities Serving Electrical Power Stations
TR-EOP-000151	Bellcore Generic Requirements for 24-, 48-, 130-, & 140-Volt Central Office Power Plant Rectifiers May 1985
TR-EOP-000154	Bellcore Generic Requirements for 24-, 48-, 130-, & 140-Volt Central Office Power Plant Control and Distribution May 1985
TR-NWT-000063	Bellcore Network Equipment-Building System Generic Equipment Requirements Issue 4, July 1991
TR-TSY-000078	Bellcore Generic Physical Design Requirements for Telecommunication Products and Equipment

TABLE OF ABBREVIATIONS

ABBREVIATION, ACRONYM OR SYMBOL	MEANING
ANSI	American National Standards Institute
AWG	American wire gauge
CEV	controlled environment vault
CM	circular mils
CEMF	Counter Electro-motive Force
DIP	dual in-line package
EMI	electromagnetic interference
ESD	electrostatic discharge
HVSD	high voltage shutdown
IEC	International Electrical Commission
IEEE	Institute of Electrical and Electronic Engineers
LED	light emitting diode
NEMA	National Electrical Manufacturers Association
NEC	National Electric Code
PCB	printed circuit board
PDR	Power distribution rack
PFC	Power factor correction
RBOC	Regional Bell Operating Company
RFA	rectifier failure alarm
UBC	Uniform Building Code
UL	Underwriters Laboratory
Vdc	volts direct current

CHAPTER ONE: INTRODUCTION

1.0 GENERAL DESCRIPTION

The 48V/7.5A Modular Switched-Mode Rectifier converts AC input power into -48 volt DC power. Designed for the Telecommunications Market the rectifier is compliant with all applicable standards. The open frame cost effective design provides excellent modularity. The HFM48AC7.5 rectifier has been incorporated into range of power plant, power shelf, and Rack Mount products to provide a solution for any low power application. This manual provides generic rectifier technical data along with references, where applicable, to specific product model types.

2.0 STANDARD FEATURES

2.1 HFM48AC7.5 features

- Lightweight, hot swap-able modules allow low mean-time-to-repair, without requiring Power Plant shutdown for repair work or preventive maintenance.
- Active PFC of greater than 0.99, and efficiency of > 82% mean low operating costs.
- Universal input power; HFM48AC7.5 rectifiers operate from 105 V_{AC} to 264 V_{AC}.
- Designed for Bellcore compliance making them acceptable to all RBOCs.
- Installation requires no tools; modules are easily inserted & removed by hand.
- Front-panel indicator LEDs for RFA, Remote Operation, Equalize, and Power Good, which provides coded alarm and status information. A form c RFA alarm relay output is provided on all power shelf, plant, and Rack Mount products.
- On/off power switch disables DC output only without interrupting AC power.
- Individual output current monitoring with internal shunt via test jacks on front panel.
- Separate potentiometers for manual Float and Equalize voltage adjustments.
- Rectifier(s) support remote single point voltage adjustment
- Rectifier(s) support Battery Temperature Compensation by a Plant controller.
- Each HFM48AC7.5 has a pre-set, internal High Voltage ShutDown (HVSD) set point. Remote HVSD and Restart inputs are also provided for use with a plant controller.
- Each HFM48AC7.5 has a fail safe internally monitored thermal shutdown set point.
- All HFM48AC7.5 rectifiers operating in parallel automatically share the load current equally, as long as their output voltages are set to within one half volt of each other.
- All electrical connections to the HFM48AC7.5 are made within the Power Shelf or Plant, protecting service personnel from potentially dangerous voltages and currents.
- HFM48AC7.5 rectifiers can be operated in true N + 1 redundancy mode.

2.2 Modular Power Shelf, Power Plant and Rack Mount Features

- Installation utilizes card guides with no tool requirements.
- Designed for rack mounting all models provide AC & DC power connections, basic control inputs, and alarm outputs.
- Power plants provide distribution options, microprocessor control of all the rectifiers features, with all the typical Telecom power plant options and alarm outputs.

3.0 MONITOR AND CONTROL FEATURES

3.1 Monitor Features

3.1.1 Rectifier Failure Alarm (RFA) output & [RFA] LED indicator

Each HFM48AC7.5 monitors its own output power. If the rectifier detects a problem (including low load current), the red front panel **[RFA]** LED illuminates and an internal form C alarm is De-energized. The RFA alarm generally signifies a rectifier output shutdown, or impending shutdown in the case of temperature, if any of the following conditions occur:

- Ambient and internal heatsink temperatures are monitored. An RFA is generated when ambient exceeds 80°C or internal heatsink exceeds 110°C. Actual rectifier shutdown will occur at 90°C ambient or 125°C on an internal heat sink. See Electrical Specifications, Section 6.12, automatic temperature derating for high ambient use.
- The rectifier's cooling fan fails to operate normally.
- The rectifier senses buss voltage greater than 60.5 Volts DC (HVSD) and it is sourcing more than 10% of its rated full load output current.
- Some crucial internal function of the rectifier is not operating correctly.
- The current being drawn from a rectifier drops below 5% of full load output.

NOTE: Load current <5% is the only condition that will produce the RFA alarm signal and the red **[RFA]** LED, but will not suspend normal rectifier operation.

In Power Shelf and Rack Mount products the RFA relays common and normally open contact is made available to the user as a contact closure when an RFA occurs. A ground connection is also provided that can be used to convert the contact closure to a ground closure by connecting the common relay contact.

In power plants the rectifiers RFA alarm relay provides even more information. The plant controller can determine the number of rectifiers on line, detect ac power failures, and provide Minor to Major alarm up-grades with one or more failures.

Each HFM48AC7.5 rectifier provides a 10A full scale @ 50mv shunt output via test jacks on the rectifiers front panel. The test jacks allow the individual rectifiers output current to be monitored to verify proper load sharing or troubleshoot power plant problems.

Two yellow status LED's provide indicators for operation in the Equalize and Remote Control modes. A green Power Good LED is illuminated when the rectifier is load sharing and operating normally. Should a problem arise the LED uses coded series of short and long flashes to annunciate the problem. See the Troubleshooting section of this manual for details on error codes.

3.2 Control Features

3.2.1 Remote Restart (RS)

3.2.1.1 Remote Restart (RS), & High Voltage Shut-Down (HVSD)

Each HFM48AC7.5 has a built-in High-Voltage Shut Down (HVSD) set point of 60.5 V_{DC}. No rectifier component failure should result in an output voltage greater than this. In addition a remote HVSD input is provided for external control via a power plant controller.

This input is made available on the rear of power shelves and Rack Mount products also. A contact closure to ground on this input will immediately initiate HVSD. The external HVSD control is integrated into power plants with adjustable trip points between -56.0 V_{DC} and -59.5 V_{DC}.

An output voltage of more than $60.5 V_{DC}$, will put all rectifiers that are sourcing more than $0.75 A_{DC}$ (10%) to the load into HVSD mode. Since the rectifier that is producing the high voltage will tend to hog the current this feature may prevent other rectifiers from shutting down.

Where total current draw is much greater than a single rectifiers output rating a single failure may cause all the rectifiers to HVSD. This scenario will generally require a manual rectifier restart, described below, to get the good rectifiers back on line operating normally.

3.2.1.2 Remote Restart (RS) signal input requirements

Each HFM48AC7.5 has a remote Restart (RS) signal input available on the rear of power shelves and Rack Mount products. An automatic attempt at restart is integrated into power plants via the controller that requires no personnel intervention. Connecting the RS input to ground will (attempt to) restart normal rectifier operation. As described above the automatic restart may not be effective in all situations.

3.2.1.3 Reasons for using remote Restart (RS)

Remote Restart (RS) is normally used for two reasons.

First: to restart a rectifier that did not HVSD due to any fault of its own.

Second: to test a rectifier, to determine if it caused an HVSD occurrence, and needs to be replaced (if after a remote Restart, it HVSD's again).

3.2.1.4 Rectifier restart methods: remote Restart (RS), & local manual Restart

There are two methods that can be used to restart a rectifier that has HVSD.

Method one: remote Restart: Momentarily place a ground closure (to rectifier output return) on the Restart (RS) input.

Method two; Local Manual Restart: Toggle the front panel DC Power switch to the OFF position for a few seconds, then switch back to the ON position again.

3.2.1.5 Rectifier restart response, & operational status determination

If the cause of the HVSD occurrence has been eliminated, and the rectifier in question was not the cause, it should resume normal operation when one of the above two methods is used to restart the rectifier. If after either of the above two actions was performed a rectifier continues to go into HVSD mode it needs to be sent back to C&D for repair.

3.2.2 Remote Equalize (EQ) signal input

Each rectifier has a remote Equalize signal input available on the rear of power shelves and Rack Mount products for wiring by the customer when required. The Equalize function is integrated into all power plants with manual and automatic modes of operation.

When the equalize input signal line is left open, the rectifier is operating in the normal Float mode. To put a rectifier into Equalize mode the Equalize input must be connected to ground. The rectifier will remain in the Equalize mode indicated by a front panel yellow LED as long as the input remains grounded.

In the manual Equalize mode the rectifier output voltage is controlled by the setting of the equalize potentiometer on the front of the rectifier. Rectifier(s) must be individually set to the same equalize voltage.

In power plants that support auto Equalize and Remote Control mode the plant controller determines the output voltage. The local control potentiometers are bypassed in the Remote Control mode (see 3.2.3)

3.2.3 Remote Control & ATC signal inputs

The HFM48AC7.5 rectifier supports remote float and equalize voltage adjustments. A ground closure on the Remote Control input pin places the rectifier(s) in the remote control mode indicated by a yellow REM LED on the front panel. This input is available on the rear of all Power Shelves that may be used as part of a C&D custom power system. The Rack Mount rectifier with a single rectifier does not provide for this input. In C&D power plants this control is integrated as a selectable option with other features.

The remote control feature utilizes the battery temperature compensation control inputs referred to as ATC+ and ATC- to set the float and equalize voltage. The adjustment ranges in the remote control mode for float and equalize voltage are:

- Float Voltage: -50.0 to -56.0 vdc
- Equalize Voltage: -54.0 to -58.0 vdc

A DC control voltage ranging from -2 to +2 vdc applied across the ATC inputs results in a -4 to +4 vdc (2:1 ratio) change in the output voltage from the default voltages. In C&D Power Plants battery temperature compensation and float voltage control are integrated into a single control voltage. The remote control mode allows a single remote control potentiometer to adjust the output voltage on an unlimited number of rectifiers.

The ATC inputs are made available on Power Shelves that might be used with C&D controllers in a custom power system. The Rack Mount product does not support temperature compensation or remote voltage control features.

3.2.4 Automatic Temperature Compensation

The ATC inputs described in 3.2.3 can be used in the local or remote voltage adjustment modes to implement Battery Temperature Compensation. In the local control mode battery temperature compensation will vary around the settings of the rectifiers front panel adjustment potentiometers. C&D Power plants provide an integrated solution that calibrates battery temperature sensor outputs into a 2 mv/°F control voltage, when the ambient or room temperature is at 77°F. the voltage offset is = 0mv. User's wishing to implement their own versions of this algorithm via the ATC inputs should contact the factory for engineering assistance.

3.2.5 Temporary Reset (TR)

The HFM48AC7.5 rectifier incorporates the Temporary Reset (TR) function that allows the rectifiers output to be disabled by a remote input without actually turning the rectifier off. The TR function is an old Telecom feature dating back to Ferro technology where energy management was very important. This feature has not been actively implemented in C&D Power plants. The TR function is available on C&D power shelves as individual inputs to each rectifier for use at the User's discretion. A ground closure on any TR input will disable that rectifier output until the ground is removed. The TR function is not supported on Rack Mount products.

4.0 PHYSICAL SPECIFICATIONS

	Rectifier Dimensions	As Used in C&D Products
Height	2.4" (6.1 cm)	Requires 2 rack spaces mounted horizontally
Width	4.75" (12.07 cm)	Requires 3 rack spaces mounted vertically
Depth	11" (27.94 cm)	Typically requires 12" product depth
Weight	2.88 lbs. (1.31 kg)	See specific product data for total weights

5.0 ENVIRONMENTAL SPECIFICATIONS

5.1 Temperature & Humidity Ranges

5.1 Temperature & Humidity vs Altitude	Temperature Range	Humidity Range	Altitude Range
Storage	-40°F – +185°F (-40°C – +85°C)	0 – 95%	0 – 7,000 ft. (0 – ~2km)
Operation	-40°F – +149°F (-40°C – +65°C)	0 – 95%	0 – 7,000 ft. (0 – ~2km)
Operation	To +185°F (+85°C) with deratings*	0 – 95%	0 – 7,000 ft. (0 – ~2km)

- See 6.11 regarding temperature derating

5.2 Altitude & Humidity

The HFM48AC7.5 rectifier is rated for use without derating to 7,000 ft. (2,133 meters) and operation with humidity of 0 to 95%, non-condensing.

5.3 Heat Dissipation & Cooling

The HFM48AC7.5 rectifier utilizes fan cooling with built in alarms and automatic derating for over temperature conditions (See 6.11).

Maximum Heat Dissipation occurs at low AC line and full DC output of 60 vdc @ 7.5A
 Maximum Dissipated Watts = 105, Maximum Dissipated BTU/Hr = 358, Nom.BTU/Hr @ 54vdc =264.

5.4 Earthquake

An HFM48AC7.5, used in C&D Power Shelf, Power Plants, or Rack Mount product are designed for use, without power interruption, through seismic zone 4 earthquakes the magnitude of which do not exceed those described in TR-EOP-000063, and the Uniform Building Code of 1982.

5.5 Electro-Magnetic Interference (EMI)

The conducted EMI emissions of each HFM48AC7.5 are below the maximum acceptable levels, described in the following specifications:

- FCC Part 15, Subpart J, Class A
- VDE-0875, Class N conducted emissions
- TA-NWT-001089
- CISPR Publication number 22, Class A.

5.6 Electrostatic Discharge

Each HFM48AC7.5 can withstand repeated electrostatic discharges of up to 15 Kilovolts DC, to any location on its front face plate, while it is operating within a C&D Power Shelf, power plant, or Rack Mount product without sustaining damage to any internal components. This performance exceeds the requirements specified in TR-NWT-000063.

6.0 ELECTRICAL SPECIFICATIONS

6.1 Input Voltage Supply Range

Each HFM48AC7.5 will operate normally at any line voltage between 105 V_{AC} and 264 V_{AC}.

6.2 Input Current Per Rectifier Module

Each HFM48AC7.5 draws < the following input currents, when supplying 7.5 A_{DC} @ 60 V_{DC}: 5.5 A_{AC} at 120 V_{AC}; 3.0 A_{AC} at 208 V_{AC}; and 2.6 A_{AC} at 240 V_{AC}.

6.3 Operating Efficiency

Each HFM48AC7.5 has an operating efficiency of > 84% at the following conditions: Delivering full output power (450 Watts) at 25°C with an input voltage of 240 V_{AC}. The unit's operating efficiency is > 50%, when delivering 10% of full power at the same conditions.

6.4 Operating Frequency

Each HFM48AC7.5 operates normally from an AC input power source, the frequency of which is between 45 Hertz and 65 Hertz.

6.5 Input Source Power Factor

The Power factor of the AC input power source connected to each HFM48AC7.5 will remain greater than 0.97, when the rectifier is operating at full output power (450 Watts) at all AC input line voltages within the range of 105 V_{AC} to 264 V_{AC}.

6.6 Input Current Total Harmonic Distortion

Each HFM48AC7.5 causes less than 5% total harmonic distortion of its input current waveform. This performance exceeds the requirements specified by IEC 555.

6.7 Input Current Maximum Single Harmonic Amplitude

Any single harmonic amplitude of the input source frequency that an HFM48AC7.5 produces on its input current waveform will be less than requirements specified by IEC 555.

6.8 Rated Output Voltage

The output voltage of the HFM48AC7.5 rectifier is rated for -60 V_{DC} @ 7.5A maximum.

6.9 Float & Equalize Voltage Ranges

The HFM48AC7.5 rectifier's FLOAT and EQUALIZE voltages, are both individually adjustable.

FLOAT range: -48 to -56 V_{DC}

EQUALIZE range: -52 to -60 V_{DC}

6.10 Output Voltage Adjustment Range vs. ATC Voltage Range

A rectifier's output voltage changes $\cong 2$ V_{DC} for each volt applied to the Remote Control ATC+ & ATC- inputs.

6.11 Automatic Output Current Temperature Derating

The HFM48AC7.5 rectifier has been optimized for use in high ambient locales by utilizing an automatic temperature-derating algorithm that linearly drops the output current beginning at 65°C to 50% at 95°C. However, the rectifier is designed to shutdown the output completely at 90°C. An RFA is generated at an ambient of 80°C or an internally monitored heatsink temperature of 110°C to warn of an approaching shutdown condition. The power good LED provides a warning code for these conditions.

6.12 Output Current

The output current of the HFM48AC7.5 rectifier is rated at 7.5 A_{DC} maximum.

6.13 Output Voltage Regulation

Each HFM48AC7.5 rectifier maintains its output voltage between $\pm 0.5\%$ of the value that the output voltage is set to, over all acceptable conditions of line and load.

6.14 Output Voltage Dynamic Response

During any step load change, {from near no load (5%) to near full load (95%), or from near full load (95%) to near no load (5%)}, that occurs within a 50 μ sec. time period; the output voltage of an HFM48AC7.5 rectifier, does not overshoot or undershoot $> 5\%$ of the value that the output voltage is set to, and returns to being within regulation before one millisecond of time has elapsed.

6.15 Input Circuit Protection Devices; Fuses (Over Current)

Each HFM48AC7.5 has two internal input protection fuses, one in series with each AC input line. Each fuse is a fast blow, rated at 8 A_{AC}. Turning OFF the front panel switch does not disconnect AC input power from the unit; it only disables normal rectifier operation. To disconnect a rectifier from the AC input power provided to it by the Power Shelf or Plant, the rectifier must be disengaged from the edge connector on the Back-plane of the Shelf/Plant.

6.16 Input Circuit Protection Devices; MOVs (Surge & Lightning)

Each HFM48AC7.5 has internal MOVs to protect it against lightning strikes and power line surges, and will survive surges and ringing on the input power lines that do not exceed the following specifications:

Surges: ≤ 6 KVolts pk, with rise times ≤ 1.2 μ sec. & fall times ≤ 50 μ sec. (open circuit) & $\leq 3,000$ Amps pk, with rise times ≤ 8 μ sec. & fall times ≤ 20 μ sec. (short circuit)

Ringing: ≤ 0.5 μ sec. in duration, at 100 kHz, at ≤ 2.5 kV peak, from a 100 Ω impedance.

6.17 Output Circuit Protection Device; OR-ing Diode

Each HFM48AC7.5 has one internal OR-ing Diode, in series with the $-48 V_{DC}$ output, to prevent an internal short from pulling current from off of the output buss. This component is not field or user replaceable. An HFM48AC7.5 that needs to have its OR-ing Diode replaced must be sent back to C&D Technologies for repair.

6.18 DC Output Current Limiting

Each HFM48AC7.5 limits its output current to between $7.5 A_{DC}$, and $7.8 A_{DC}$.

6.19 Walk-on Current

When an HFM48AC7.5 is turned ON, its output current increases gradually, eliminating output voltage overshoot and preventing the ac source from seeing a step change in the amount of current drawn by the rectifier. No load to full load walk-on, will occur in \geq eight seconds.

6.20 Warm-up Time

Each HFM48AC7.5 takes less than two hours to fully warm-up, and its output voltage drifts $\leq 5\%$ of the value that the output voltage is set to, during the warm up time period.

6.21 Output Voltage/Temperature Coefficient

Each HFM48AC7.5 has a voltage/temperature coefficient of $< 0.02\%$ of output voltage change, per each $1^{\circ}C$ change in ambient operating temperature.

6.22 Stability

The HFM48AC7.5 rectifier operates in a stable manner under any and all of the previously specified input, output and environmental conditions of operation.

6.23 Grounding

Each HFM48AC7.5 gets connected to earth (safety) ground, through its AC input edge connection. The Power Shelf, Power Plant, or Rack Mount chassis that the rectifiers plug into, busses each individual rectifier(s) earth (safety) ground together, and connects them to the chassis and AC feeders earth ground connection via terminal blocks or bolted connections.

Each input power feed should contain a green, earth (safety) ground wire, that is connected to an approved earth ground, at the source of the power feed. Each HFM48AC7.5 rectifier product provides a UL compliant termination for the green earth safety ground wire.

6.24 Electrical Isolation

The input and output circuits of the HFM48AC7.5, are electrically isolated from each other and from the chassis of the rectifier, as specified in TR-EOP-000151.

7.0 NOISE SPECIFICATIONS

7.1 High Frequency Noise

High frequency noise on the output of an HFM48AC7.5 does not exceed 35 mv rms, or 500 mv peak-to-peak, for frequencies up to 30MHz.

7.2 Voice Frequency Noise

Voice frequency noise on the output of an HFM48AC7.5 does not exceed 32 dBrnC; whether the rectifier is connected to a battery or not, under all input, output and environmental conditions, as long as a minimal load of one-percent is maintained.

7.3 Audible Noise

No single HFM48AC7.5 will, nor will a Power Plant full of them, generate any audible noise in excess of 65 dBA (when measured five feet above the floor, and two feet from the front surface of the rectifiers), while they are delivering any power level specified in this manual. This performance exceeds the requirements specified by Bellcore TA-NWT-000406.

8.0 SAFETY SPECIFICATIONS

Caution: The HFM48AC7.5 Rectifier utilizes an open frame design with exposed heat sinks that may become excessively hot when operating at load. Always use the built-in handle gripping only the edges of the PCB, when necessary, to remove the unit.

8.1 Materials Safety

The materials and components used in the HFM48AC7.5, and in any C&D Technologies, Inc. product that said rectifiers are designed to operate in, present no dermatological, environmental, or other safety hazards, as currently defined (as of this writing) by industry standards, or any applicable federal, state, or local laws and regulations currently in force.

8.2 Safety Agency & Regulatory Agency Compliance

The materials and components used in the HFM48AC7.5, and in any C&D Power Shelf or Plant that said rectifiers are designed to operate in, are only intended to be used for applications that comply with the requirements of the following safety and regulatory agencies:

- The Federal Communications Commission (FCC)
- The National Electric Code (NEC)
- Underwriters' Laboratories (UL)
- The Department of Labor's Occupational Safety and Health Administration (OSHA)

The AGM 25 & AGM 15 power plants, AGM 45 Power Shelf, and SM48 7.5 Rack Mount power supply are UL/CUL, CE, & VDE certified.

8.3 Fire Resistance Compliance

The HFM48AC7.5 and any C&D product that they are designed to operate in, exceed the fire resistance specifications declared in Section 4.3 of TR-EOP-000063, Network Equipment-Building System (NEBS) Generic Equipment Requirements.

9.0 ALARM INDICATORS

9.1 Front Panel Alarm Indicators

The HFM48AC7.5 provides a red rectifier fail (RFA) LED indicator.

9.2 Remote Alarm Signal Contacts

The HFM48AC7.5 provides a Form C RFA output alarm relay that is energized when the rectifier is On and operating normally. The relay is normally energized so that even if AC power is lost there will be an alarm given. The RFA output alarm relay is integrated into all power plants and available as a discrete output on C&D Power Shelves and Rack Mount products.

10.0 TROUBLESHOOTING

The HFM48AC7.5 rectifier generates coded short and long flashes of the green Norm LED to enunciate out of range conditions to assist the user in quickly determining the source of a problem. This section lists symptoms and probable causes of common problems that may occur with the HFM48AC7.5 rectifiers. The rectifier troubleshooting information can be used in conjunction with power system troubleshooting aids to help solve power system level problems. If the following information does not enable you to solve your rectifier(s) problem, please contact the Field Service Department of C&D Technologies, Inc at 1-800-299-3907.

HFM48AC7.5 Rectifier/Power Shelf: Problem–Symptom–Cause–Solution Table
Flashing NORM LED Code Legend: Short Flash = 200msec. Long Flash = 800msec.

SYMPTOM	POSSIBLE CAUSES	SOLUTIONS
Red RFA LED is ON, Green NORM LED is Flashing: 1 short flash; unit cooling fan is running, but unit is supplying no current to the load.	1 Short Flash = Low Current Alarm (unit is sourcing < 5% of Full Load) The rectifier’s output voltage is set more than 0.5 volts lower than the Shelf or Plant’s Buss voltage	Adjust the output voltage of the rectifier to < 0.5 volts below the Shelf or Plant Buss voltage. (Rectifiers with low output voltage cannot current share)
Red RFA LED is ON, Green NORM LED is Flashing: 2 short flashes; unit cooling fan is running, but unit is supplying no output voltage to the load.	2 Short Flashes = OVP condition The rectifier has detected an abnormally high voltage on it’s output, and is in Over Voltage Protection (OVP) mode.	Determine and eliminate the cause of the Over Voltage condition (which could mean replacing the rectifier itself) If a rectifier continually OVPs, replace it.
Red RFA LED is ON, Green NORM LED is Flashing: 3 short flashes; unit cooling fan is running, but unit is supplying < 7.5 A _{DC} to the load	3 Short Flashes = AC line voltage sag. The rectifier has detected an abnormally low input line voltage (there is a Brown- Out, a phase has dropped out, or the unit is not properly detecting line voltage)	Restore the line voltage to normal (if possible) or wait until it comes back. (the Rectifiers will continue to function at a reduced output, but current sharing is disabled)
Red RFA LED is ON, Green NORM LED is Flashing 4 short flashes; unit cooling fan is probably not running.	4 Short Flashes = heatsink temp.> 110°C The unit cooling fan is not working right or the airflow is blocked, and the ambient is probably near or exceeding +65°C	Find the causes of over heating (in-operative cooling fan, blocked airflow, and excessive ambient temp.) and remedy it.
Red RFA LED is ON, Green NORM LED is Flashing: 1 long flash; unit cooling fan may not be running	1 long flash = Fan Alarm (the difference between heatsink temp. and ambient is > 30% more than it is with normal airflow): this code will show, only if I out ≥ 2 A _{DC}	Verify fan is operating normally, if not replace. If fan is operating normally problem is probably internal to rectifier.
Red RFA LED is ON, Green NORM LED is Flashing: 2 long flashes; unit cooling fan is running but V out & I out = 0.	2 long flashes = external Shutdown The Rectifier is not operating because it has received an external Shutdown command.	Verify Controller HVSD setting is at least 2 volts above float or Equalize setting. If ok, replace Controller.
Red RFA LED is ON, Green NORM LED is Flashing: 1 long flash & 1 short flash; unit cooling fan is running & V out = setting of active control pot.	1 long flash & 1 short flash = Voltage on Remote Control (RC) inputs is out of out of bounds. The voltage present across the RC inputs is > ± 2 V _{DC} (in this condition, unit V out control is returned to the active pot)	Probably the result of a Controller fault. Verify controller is operating properly.
Red RFA LED is ON, Green NORM LED is Flashing: 1 long flash & 2 short flashes; unit cooling fan is running but unit is not current sharing.	1 long flash & 2 short flashes = Voltage on Load Share (LS) inputs is out of out of bounds. The voltage present across the LS inputs is > ± 2 V _{DC} (in this condition, load sharing is inactive)	Remove one rectifier at a time to until problem goes away. Replace that rectifier. If problem persist after checking all rectifiers call Field Service
Red RFA LED is ON, Green NORM LED is Flashing: 1 long flash & 3 short flashes; unit cooling fan is running but I out current limit is derated.	1 long flash & 3 short flashes = Ambient over temperature condition > + 80°C. This alarm warns of an impending rectifier thermal shut-down. Take action to lower ambient or load.	Determine the cause of the high ambient temperature and reduce it to below +80°C, or wait until it comes down, before operating the Rectifiers.
Red RFA LED is OFF, Green NORM LED is OFF, unit cooling fan is not running & unit appears to be inoperative	The Rectifier is not seated into the edge connectors on the backplane of the Power Shelf or Plant, or it has an actual internal failure.	Properly seat the rectifier into the connector on the backplane of the Power Shelf or Plant, or (if bad) return to C&D Technologies for repair.
Red RFA LED is ON, Green NORM LED is OFF, and unit cooling fan is not running.	Remove the rectifier from the Shelf and verify fan plug is connected.	If fan connection is ok, return unit for servicing.

CHAPTER TWO: INSTALLATION

1.0 GENERAL

1.1 Scope of Installation Instructions

These instructions provide general installation and handling information appropriate to the use of the HFM48AC7.5 rectifier in C&D power plants, power shelves, and Rack Mount products. Detailed installation information will be included in the specific product documentation.

1.2 Where to get more help:

If you have installation problems or questions, technical assistance can be obtained by calling one of the following phone numbers:

Customer Service: 1-800-440-3504

Field service: 1-800-299-3907

Each HFM48AC7.5 has a model and serial number on the side of it. Each C&D Technologies power plant, power shelf, or Rack Mount product will also have a model and serial number on the side of it. Having these numbers available when you call will expedite our ability to provide technical assistance.

1.3 Recommended tools & equipment for unpacking & installation

- Small adjustment screwdriver for voltage adjustments
- Safety glasses
- Anti-static wrist strap
- Multimeter, with clamp-on ammeter probe (true rms.)

1.4 Rectifier Factory Settings

The FLOAT and EQUALIZE Factory default voltage settings for the HFM48AC7.5 rectifier are:

$$\begin{aligned}\text{FLOAT} &= 54.26 \text{ V}_{\text{DC}} \\ \text{EQUALIZE} &= 55.9 \text{ V}_{\text{DC}}\end{aligned}$$

2.0 RECEIVING, INSPECTING AND UNPACKING

2.1 Recommended HFM48AC7.5 rectifier receiving, inspecting & unpacking

NOTE: See RECEIVING INSTRUCTIONS & GENERAL EQUIPMENT INFORMATION sheets at the beginning of this manual.

3.0 POWER PLANT/SHELF MECHANICAL CONCERNS

3.1 Power Shelf or Plant Mounting Checks

1. Verify the safety ground connection between the C&D power plant/shelf or Rack Mount product chassis to the relay rack or mounting framework.

Caution: The HFM48AC7.5 rectifiers leakage current requires chassis ground connections before powering units.

2. Rack or enclosure mounting should always include paint breaking washers on both sides of the Shelf.
3. Never install rectifiers until all AC and DC Power checks are complete.
4. Power plant/shelf chassis should be centered and level within their rack mounting space to eliminate possible chassis racking or access door binding.
5. Be sure there at least 1 or 2 inches of clearance behind units so that cooling is not restricted.

4.0 AC INPUT POWER CONCERNS

The range of HFM48AC7.5 rectifier products include a number of different AC power connections from pre-wired cable pigtails to front access terminal blocks. The details for these varied wiring methods are left to the specific product documentation. The following general information and guidelines are provided:

4.1 Power Shelf or Plant AC Power Wiring

PROCEDURE

1. Input power feeds should be protected at their source end, by a delayed-trip circuit breaker (rated at 5–10 Amps over the maximum current draw) in series with each feed. All HFM48AC7.5 C&D products will include documentation with maximum current draw and recommended AC protection breaker ratings.
2. C&D Power plants and shelves rated >25 amps support dual AC power feeds. The AC power connections to the rectifier slots are interlaced so that adding rectifiers automatically keeps the load balanced. Odd numbered slots 1, 3, etc. are connected to AC feed A, while even numbered slots 2,4, etc. are wired to AC feed B.
3. Powering more than 4 rectifier slots from a 120 vac power source is not recommended. The high current draw and large cabling requirements are not easily accommodated in most HFM48AC7.5 C&D products. Single source power to products with 6 or 8 total slots should use 208/240 vac power sources.
4. Always verify proper AC wiring, protection breakers, and voltage before plugging in any rectifiers.

5.0 BATTERY, LOAD, AND GROUND CABLES

C&D Power plant and shelf documentation provides formulas and charts for selecting the proper cabling for the maximum load and minimum voltage drop. This section addresses safety issues regarding these connections.

⚠*Precautionary measures when working around a live Power System

1. Remove all jewelry, including wrist watches, and use insulated tools.
2. Identify all connections and verify proper connections
3. Power systems with battery back up will always have live connections whether the rectifiers are powered, or not. Use extreme caution when making measurements.

NOTE: The HFM48AC7.5 rectifier is designed so that all hazardous voltages within the rectifier are bled off immediately upon its' removal to eliminate any shock potential.

5.1 Battery System Considerations

1. Leaving a battery system in Equalize, or higher than float voltage, mode for extended periods could result in catastrophic battery failure and personnel injuries.
2. You will not be able to adjust the float voltage on rectifiers lower than the current float voltage of the batteries.
3. Always turn the DC power switch off before inserting or removing a rectifier.

6.0 MONITOR AND CONTROL INPUTS

This section refers to the C&D Power Shelf and Rack Mount products where the User determines the rectifier interface. None of the alarm and control connections are required for the rectifier to operate properly with one possible exception. The Rack Mount 7.5 amp rectifier if used with multiple units should have the load share (LS) line daisy chained together so all the rectifiers load share with one another.

6.1 Rectifier Fail Alarm (RFA)

The RFA alarm relay output is always provided for User monitoring. On C&D Power Shelf products only the common and normally closed contacts are made available while on Rack Mount products all three relay contacts are available. The RFA relay is normally energized so the normally closed contact will be open during normal operation and close should a problem arise. A connection to ground is provided labeled either “Gnd”, “Sig Gnd”, or “+48v” for jumpering to the common relay contact to provide a typical ground closure output. RFA alarms can be monitored for each individual rectifier or the normally closed contacts can be ganged together for a single alarm if any rectifier fails.

6.2 High Voltage Shutdown (HVSD) and Restart (RS)

HVSD and RS inputs are not generally implemented unless the User has his own system controller with these control features built in. The rectifiers have HVSD built in and there is a risk of shutting down multiple units with the external HVSD input. HVSD's generally occur during the initial start-up where light loading and a lot of On and Off cycling may cause voltage overshoot, and HVSD. These situations are easy to correct by turning the DC power switch Off momentarily, then On again.

6.3 Temporary Reset (TR), Remote Operation (REM), ATC Control Inputs

The function of these control inputs are explained in Chapter 3. User's wishing to make use of these features will need to design suitable interfaces that meet the requirements detailed in Chapter 3. User's can contact Customer Assistance for help in implementing these features.

7.0 INSTALLING RECTIFIERS

NOTE: The HFM48AC7.5 rectifier modules should “snap” into the edge connector on the back plane of the C&D Power Shelf and Power Plant chassis, when each one is fully inserted. If a rectifier is not fully inserted into a Shelf or Plant, the front door of the Shelf/Plant can not be properly closed.

WARNING: Very little force is required to correctly seat a rectifier in a Shelf/Plant. Rectifiers should not be slammed into the Shelf/Plant that they are being installed within! Slamming rectifiers into a Plant or Shelf can damage the rectifier modules and/or the backplane of the Power Shelf or Plant.

7.1 Rectifier installation

PROCEDURE

1. Line up the outer edges of the rectifier's main printed circuit board, with the grooves in the card edge rails in each rectifier slot.
2. Slide the rectifier into the slot, until it touches the Back-plane edge connector.
3. Press on the bottom two corners of the rectifier's front faceplate, with both thumbs, until the rectifier "snaps" into the Back-plane edge connector.

CHAPTER THREE: OPERATION

1.0 OPERATION

Operation of the rectifier involves setting the Float and Equalize voltages, understanding the load share and HVSD requirements, and alarm monitoring.

2.0 ADJUSTMENTS

2.1 Float & Equalize Voltage Adjustments

The output FLOAT and EQUALIZE voltages of each rectifier are independently adjustable with potentiometers located on the front panel. Turning the adjustment potentiometer clockwise will increase the rectifier's voltage output.

2.2 Load Share Considerations

WARNING: If you adjust the output voltage of any one HFM48AC7.5 rectifier more than 0.5V_{DC} apart from the other rectifiers in the system, it will not properly share current with the other rectifiers.

If you are adjusting the output voltage of HFM48AC7.5 rectifiers that are operating in parallel, you may need to wait up to 30 seconds after adjusting each rectifier, for the automatic load current sharing circuit to adjust to the new voltage value.

In any product where multiple rectifiers are utilized the initial set-up should include a careful adjustment of the float and equalize voltages to keep the settings between rectifiers as close as possible. Although the rectifiers will load share within 0.5vdc of one another this margin could result in 0.5vdc voltage shifts if the rectifier with the highest setting was removed. Load share will always be with respect to the rectifier with the highest voltage setting.

2.3 HVSD Scenarios

As described previously, HVSD is rarely a significant problem. Most HVSD events will occur during the initial set-up when rectifiers are being turned on and off rapidly. Another source is lightning or related surge induced voltage fluctuations. These types of induced HVSD events rarely cause permanent rectifier damage and are easily cleared by turning the affected rectifier(s) momentarily Off, then On to produce a Restart sequence.

Power plant documentation will detail tests for HVSD that verify the controller operation. User's wishing to verify the rectifiers internal HVSD and Restart response can do so simply as part of the initial powering up sequence described next.

2.4 Initial Power-Up

Initial power-up should not occur until after all the mechanical and electrical pre-checks have been completed. If possible, batteries and actual load equipment should be left disconnected until after the initial power-up and checkout is completed. An adjustable load box is recommended for the initial power-up check out.

NOTE: When the HFM48AC7.5 rectifier is powered with no load attached there will be 2.0 to 3.0 volts on the output even when the DC power switch is in the Off position. A high impedance leakage path via the Automatic Temperature Compensation circuitry creates the voltage. This voltage will disappear when any load is attached and should be of no concern to the User.

2.4.1 Initial Rectifier Power-up

1. Insert the first rectifier with the DC Power switch on the front of the rectifier in the OFF position. Attach a DC voltmeter and load across the output.
2. Turn ON the AC circuit breakers at the source end of the power feed.
3. Set the load for 20% of the available load current. Flip the DC power switch to the On position, allow 30 seconds for the rectifier(s) to come up and settle into automatic load share mode.
4. Verify the DC output voltage at 54.26vdc \pm 0.05v, adjust if necessary, then turn the DC power switch off.
5. Plug in the next rectifier repeating steps 3 & 4 until all the rectifiers have been plugged and their DC output voltage verified.
6. Set the load for 20% of the total current available. Turn all the rectifiers DC power switches ON, allow 30 seconds for all of the rectifiers to load share indicated by the green LED on all the rectifiers being in the solid on condition.
7. Verify the DC output voltage is still the same voltage set in Step 4.
8. Skip this step if RFA alarm outputs will not be monitored. Turn one rectifiers DC power switch Off, verify the red RFA LED flashes, and the appropriate RFA alarm output changes states. Turn that rectifier back ON, and then repeat the test for each rectifier. When done leave all the rectifiers On.
9. Adjust the load for 90 to 100% of the total available output current. Verify the rectifiers load share within 30 seconds and the output voltage remains within 0.5% of the setting. Return the load to the 20% of the total available setting.

2.4.2 Equalize Adjustment

If Equalize will not be used skip this step. Select the Manual Equalize mode in power plant products. In Power Shelf or rack Mount products connect ground to the Equalize input. Every rectifier(s) yellow Equalize LED should be on. Repeat the same process as setting the float voltage. Turn all but one rectifier off and set the -55.90vdc \pm .05v Equalize voltage with Equalize adjustment potentiometer. Repeat the process for each rectifier. Once complete turn all the rectifiers On and verify load sharing and proper voltage. Switch the Manual equalize off or remove the ground jumper to return to normal float voltage operation.

2.4.3 HVSD Verification

The only feasible method for testing HVSD utilizes the external inputs to verify the rectifiers will HVSD and restart. These inputs are labeled on the rear of C&D power shelf and Rack Mount products. Methods for verifying HVSD in C&D Power Plants are detailed in the power system documentation. This test should be done after the Float and Equalize voltage settings have been completed. With all the rectifiers on and approximately 20% load applied momentarily ground the HVSD input. All the rectifiers should immediately shutdown with no output voltage indicated. With no battery on line there will be no front panel indication other than the fans will still be operating. Then momentarily ground the Restart (RS) input. All the rectifiers should restart and load share within 30 seconds.

2.4.4 Low Current Alarm Elimination

PURPOSE:

To eliminate low current alarms on HFM48AC7.5 rectifiers caused by operation below low current alarm threshold(0.375A).

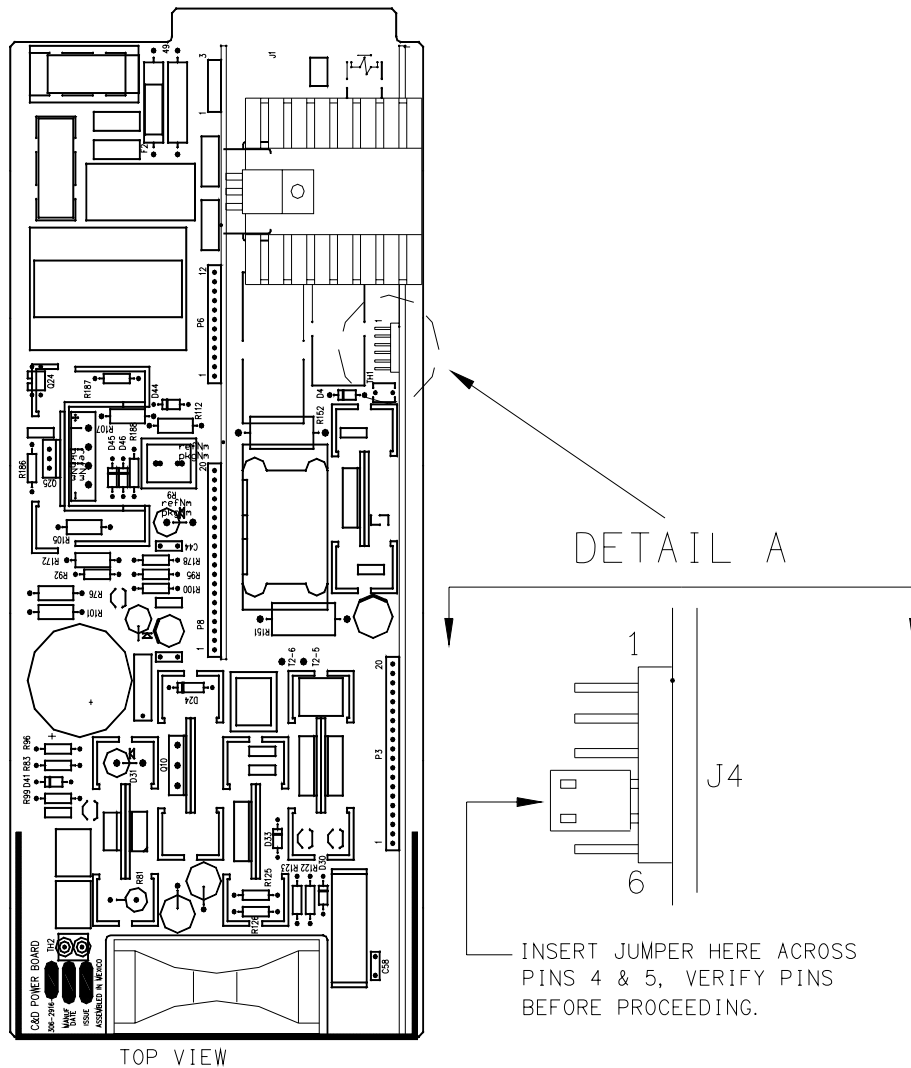
EQUIPMENT:

Two position jumper supplied.

PROCEDURE

The low current alarm threshold can be turned off with a jumper on J4 PINS 4 and 5.

1. If the system has redundancy, simply remove rectifiers on at a time. Perform the procedure and replace rectifiers before proceeding.
2. Locate the J4 connector from the rectifier top view diagram.
3. Simply slip the supplied jumper onto PINS 4 and 5, as shown.



CHAPTER FOUR: MAINTENANCE

1.0 SEMIANNUAL PREVENTIVE MANTENANCE

PROCEDURE

1. Verify that all rectifiers are operating normally (the green “NORM” LED is solid ON) and that they are load sharing properly (each reads approximately the same ± 5 mv value on their output current test points).
2. If the load on the Power Plant allows, remove the rectifiers, one at a time, to clean them. Use low-pressure compressed air to remove any dust or debris from the entire rectifier, especially the cooling fan at the front end and the heat sinks.
3. Re-install the rectifier back into the Power Shelf or Plant, and toggle its front panel switch ON. Allow 30 seconds for it to resume normal operation and load sharing.
4. After you have cleaned the rectifiers and have them all back up and running again, verify that each one is sharing the load current adequately (they should each measure the same value of millivolts on their front panel test jacks, ± 5 mv).

2.0 REPLACEMENT PARTS

NOTE: The only field replaceable part in an HFM48AC7.5 rectifier, is the cooling fan.

Part Name/Description: Cooling Fan
C&D Technologies Part Number: 350-7608-00

3.0 COOLING FAN REPLACEMENT

PROCEDURE

1. Remove the rectifier from the Shelf or Plant, and place it on a suitable work surface.
2. Remove the four plastic rivets that hold the fan to the front cover plate.
3. Unplug the fan from the PCB and remove the fan from the rectifier.
4. Remove any accumulated dust and debris from all heat sinks within the rectifier.
5. Put the new fan in the rectifier, with the airflow direction arrow pointing into the unit.
6. Replace the four plastic rivets, securing the new fan to the front plate.
7. Plug the new fan connector into the PCB, observing the polarity of both the plug and the connector on the PCB (Do NOT plug it in backwards!).