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C-CAN POWER SYSTEMS INC.

INSTRUCTION MANUAL

HFR HF, HF-APF, and
MC Variants

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Table of Contents

1. FOREWORD 4

2. WARRANTY STATEMENT 5

3. SPECIFICATIONS 6

3.1 Electrical Data 6

3.2 Output Ratings 6

3.3 Output Regulation 6

3.4 Output Noise 6

3.5 Acoustic Noise 6

3.6 Environmental Data 7

4. FEATURES 8

4.1 Metering/Controls 8

4.2 Status Indicators 8

4.3 Alarm Indicators (Red LED) 8

4.4 Remote Connections/Controls 8

4.5 Cooling 8

4.6 Control Range and Factory Settings 9

5. ISOLATION 10

6. AC/DC CABLE SIZING/INPUT BREAKER SIZING 11

7. SHIPPING, HANDLING AND UNPACKING 12

7.1 Shipping 12

7.2 Handling 12

7.3 Unpacking 12

7.4 Storage 12

8. POWER CABLE TERMINATIONS 13

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9. INDICATORS/CONTROLS/ALARMS, SETTINGS, & ADJUSTMENTS 14

9.1 Indicators/Controls/Alarms 14

9.1.1 Input AC Circuit Breaker 14
9.1.2 AC/DLY - AC Line Monitor, Start Delay 14
9.1.3 Float/Equalize 14
9.1.4 Current Limit 14
9.1.5 Hi Temp 14
9.1.6 Hi Temp SD 14
9.1.7 DC High Volts Shutdown Control 15
9.1.8 Rectifier Fail Alarm 15
9.1.9 DC Breaker Indicator 15
9.1.10 Low Volts 15
9.1.11 Boost Mode (optional) 15
9.1.12 Amps/Volts 15
9.1.13 Output Breaker 15
9.1.14 Sharing Control 15

9.2 Settings 16

9.3 Adjustment 16

9.3.1 Adjustment Tool 16
9.3.2 Start Delay 16
9.3.3 Float/Equalize/Boost Voltages (Off Line) 16
9.3.4 DC Low Volts Alarm (Off Line) 16
9.3.5 DC High Volts Shutdown Adjustment (Off Line) 17
9.3.6 Current Limit Adjustment 17

10. REMOTE CONNECTIONS 18

10.1 Remote Input/Outputs 18

10.1.1 Share 18

10.2 Remote Inputs 18

10.2.1 Temperature Compensation 18
10.2.2 Remote Equalize 18
10.2.3 Remote Shutdown 18

10.3 Remote Outputs 18

10.3.1 Rectifier Fail 18

10.4 Connector Pin Outs 19

10.4.1 HFR48/100HF, HFR48/50HF, HFR24/50HF, HFR24/100HF,HFR48/25 APF-1A 19
10.4.2 HFR 48/50MC 19

11. GENERAL OPERATION 20

11.1 Introduction 20

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11.2 Mechanical Construction 20

11.3 Adding/Removing Rectifiers 20

11.3.1 Adding/Removing Rectifiers From AC Hard-Wired Plants 20
11.3.2 Adding/Removing Rectifiers From AC Connectorized Plants 21

12. TROUBLESHOOTING PROCEDURE 22

12.1 Trouble Shooting Procedure: 22

13. MAINTENANCE 24

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1. FOREWORD

This manual covers part of the HFR (High Frequency Rectifier) line of rectifiers built by C-Can Power Systems. It details the HF (Horizontal Fan cooled), HF-APF (Horizontal Fan cooled, Active Power Factor corrected), and MC (Modular Convection cooled) models. Should any questions arise on any particular feature, a technical description will be found in the sub-section relating to that feature. This manual will provide all necessary information for the User to acquaint himself with the proper use and maintenance of the rectifier. It is important that the User become familiar with the contents of this manual in order to ensure trouble free operation of the rectifier and the system which it is a component of.
We thank you very much for selecting **C-CAN POWER SYSTEMS INC.**

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2. **WARRANTY STATEMENT**

1. Equipment sold hereunder by C-CAN POWER SYSTEMS INC. is warranted to be free of defects in material and workmanship when properly installed and under normal operating conditions for a period of thirty (30) months from date of shipment or twenty-four (24) months from startup, whichever occurs first. C-CAN'S SOLE AND EXCLUSIVE OBLIGATIONS AND LIABILITIES UNDER THIS WARRANTY IS AND SHALL BE LIMITED TO REPAIR OR REPLACE ANY MATERIAL MANUFACTURED BY C-CAN AT THE SOLE DISCRETION OF C-CAN. C-CAN SHALL NOT REIMBURSE OR MAKE ANY ALLOWANCE TO BUYER FOR ANY LABOUR CHARGES INCURRED BY BUYER FOR REPLACEMENT, ADJUSTMENT OR REPAIR OF ANY GOODS OR PARTS THEREOF OR FREIGHT OR FOR ANY OTHER WORK UNLESS SUCH CHARGES ARE AUTHORIZED IN ADVANCE BY C-CAN. UNDER NO CIRCUMSTANCES WILL C-CAN BE HELD RESPONSIBLE FOR ANY CONSEQUENTIAL DAMAGES TO OTHER THAN C-CAN MANUFACTURED GOODS.
2. If Buyer has any claim of defective material or workmanship and such warranty has not expired, C-Can shall either examine the goods at site, or in its sole discretion, issue a return authorization number for return of the goods or any defective parts thereof. If any goods or parts thereof are returned to C-Can, the Buyer shall prepay all transportation charges.
3. Any claim for breach of C-Can's warranties shall conclusively be deemed to be waived unless written notice of such claim is given to C-Can within fourteen (14) days after the date on which the claimed defect is discovered.
4. C-Can's warranties can not be transferred unless C-Can is advised of such transfer in writing giving full details of original owner and new owner within fourteen (14) days of such transfer.
5. Warranty shall be null and void if such advice of transfer of the warranted goods is not received by C-Can.
6. C-Can's warranties shall be null and void on any goods or parts which have been subjected to any misuse, neglect or accidental damage or which contain defects which are in any way attributable to improper installation or to alterations or repairs made or performed by any person or entity not authorized by C-Can. C-Can's warranties shall not apply to any goods or parts hereof which are obtained from any source other than direct from C-Can.
7. The warranties set forth herein are C-Can's sole and exclusive warranties for or relating to the goods. Seller neither makes nor assumes any warranty of merchantability, any warranty of fitness for any particular purpose, or any other warranty of any kind, express, implied or statutory. C-Can neither assumes nor authorizes any person or entity to assume for it any other liability or obligation in connection with the sale or use of the goods, and there are no oral agreements or warranties collateral to or affecting the sale of the goods.
8. C-Can's warranties, obligations and liabilities and Buyer's remedies set forth herein are limited to their precise terms. C-Can shall not be liable for any damages of any kind including, without limitation, special, incidental or consequential obligations and liabilities of C-Can and the remedies of Buyer set forth herein shall be C-Can's sole and exclusive obligations and liabilities and Buyer's sole and exclusive remedies for, resulting from or in connection with C-Can's warranties or any breach thereof or the sale of goods by C-Can.

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3. SPECIFICATIONS

3.1 Electrical Data

Voltage:	120 VAC, +/-15%, 1 phase 47 to 63 Hz – HFR 48/25 APF-1A All others: 220/240VAC, +/-15%, 1 Phase, 47 to 63 Hz
Phase:	Single Phase
Current:	12 A RMS @ 120 VAC – HFR48/25 APF-1A 9 A RMS @ 220 VAC - HFR24/50HF, HFR48/33HF-APF 12 A RMS @ 220 VAC - HFR48/50HF-APF 16 A RMS @ 220 VAC – HFR48/50MC, HFR48/50HF, HFR24/100HF 36 A RMS @ 220 VAC – HFR 48/100HF
Inrush at Turn On:	Current limited to less than peak operating current

3.2 Output Ratings

Voltage:	24 VDC Nominal - HFR24/50HF, HFR24/100HF 48 VDC Nominal - HFR48/50HF, HFR48/100HF, HFR48/50MC, HFR48/50HF-APF, HFR48/33HF-APF, HFR 48/25 APF-1A
Float:	Adjustable 23 to 31 Volts - HFR24/50HF, HFR24/100HF Adjustable 44 to 61 Volts - HFR48/50HF, HFR48/100HF, HFR48/50MC, HFR48/50HF-APF, HFR48/33HF-APF, HFR 48/25 APF-1A
Equalize:	Adjustable 23 to 31 Volts - HFR24/50HF, HFR24/100HF Adjustable 44 to 61 Volts - HFR48/50HF, HFR48/100HF, HFR48/50MC, HFR48/50HF-APF, HFR48/33HF-APF, HFR 48/25 APF-1A
Current Limit:	Normally adjustable from 50 to 103% of rated output. Shipped @ 100%.

3.3 Output Regulation

Line:	+/- 0.1% maximum
Load:	+/- 1% maximum
Sharing:	Electronic sharing to better than +/- 5% of full capacity between rectifiers

3.4 Output Noise

Voice Band:	< 24 dBrnC without battery connected
Broad Band:	< 5 mV RMS maximum broadband DC - 200kHz without battery connected

3.5 Acoustic Noise

<55dBa at 1m - HFR24/50HF, HFR24/100HF, HFR48/50HF, HFR48/50MC, HFR48/50MC, HFR48/50HF-APF, HFR48/33HF-APF, HFR 48/25 APF-1A
<58dBa at 1m - HFR48/100HF

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3.6 Environmental Data

Operational:	0 ^{O}C to 50 ^{O}C self de-rating
Storage:	-40 ^{O}C to + 80 ^{O}C
Humidity:	To 90% non-condensing
Cooling:	Fan cooled (HF variants and 1A), Convection cooled (MC variants)

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4. FEATURES

4.1 Metering/Controls

- 3 l/2 Digit liquid crystal display for Amps and Volts (optional 4 ½ digit)
- Meter accuracy: +/- 1 %, +/- 1 digit.
- Float/Equalize selector buttons.
- Boost selector switch (optional).
- Volts/Amps meter selector switch.
- AC Input and DC Output breakers.

4.2 Status Indicators

- AC/DLY (green)
- Float (green)
- Equalize (yellow)
- Current Limit (yellow)
- Hi Temp (yellow)
- Boost (amber) (Optional)
- Display-Amps (green)
- Display-Volts (green)

4.3 Alarm Indicators (Red LED)

- DC High Volts Shutdown
- DC Low Volts
- Rectifier Fail
- DC Breaker Trip
- Hi Temp SD

4.4 Remote Connections/Controls

- Remote Shutdown
- Remote Equalize
- Temperature Compensation (requires external controller)
- Rectifier Fail Form ‘C’ contacts
- Sharing

4.5 Cooling

- Units available with fan or convection cooling
- Fan cooled units have dual speeds to extend fan life

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4.6 Control Range and Factory Settings

NOTE: Factory settings will apply unless order specifies otherwise.

FUNCTION	RANGE	FACTORY SET*	MODEL
Float Voltage	23-31V	27V (2.25V/Cell)	HFR24/50HF, HFR24/100HF HFR48/33HF-APF,
	44-61V	54V (2.25V/Cell)	HFR48/50HF-APF, HFR48/50HF, HFR48/50MC, HFR48/100HF HFR 48/25 APF-1A
Overvoltage Shutdown	23-31V	30V	HFR24/50HF, HFR24/100HF HFR48/33HF-APF,
	56-61V	60V	HFR48/50HF-APF, HFR48/50HF, HFR48/50MC, HFR48/100HF HFR 48/25 APF-1A
Current Limit	0-103%	100%	HFR24/50HF, HFR24/100HF HFR48/33HF-APF, HFR48/50HF-APF, HFR48/50HF, HFR48/50MC, HFR48/100HF HFR 48/25 APF-1A
Output Power	1350 Watts @ 27 Volts		HFR24/50HF, HFR 48/25 APF-1A
	1780 Watts @ 54 Volts		HFR48/33HF-APF
	2700 Watts @ 27 Volts		HFR24/100HF
	2700 Watts @ 54 Volts		HFR48/50HF, HFR48/50MC, HFR48/50HF-APF
	5400 Watts @ 54 Volts		HFR48/100HF

* Factory Setting is for valve regulated lead acid batteries.

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5. ISOLATION

HFR HF and MC models:	
Input To Ground:	1500 VAC
Output To Ground:	1150 VAC
Magnetics Hi-Pot:	3000 VAC
HFR HF-APF models:	
Input To Ground:	1800 VAC
Output To Ground:	1150 VAC
Magnetics Hi-Pot:	3000 VAC

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6. AC/DC CABLE SIZING/INPUT BREAKER SIZING

HFR MODEL	24/50
MAXIMUM INPUT POWER (VA)	2000
INPUT CABLE	12 GA/3.31mm^2
OUTPUT WIRE CABLE	6 GA/13.3mm^2
RECOMMENDED FEED BREAKER SIZE	20A

HFR MODELS	48/33HF-APF
MAXIMUM INPUT POWER (VA)	2000
INPUT CABLE	12 GA/3.3mm^2
OUTPUT WIRE CABLE	6 GA/13.3mm^2
RECOMMENDED FEED BREAKER SIZE	20A

HFR MODELS	48/50HF-APF, HFR 48/25 APF-1A
MAXIMUM INPUT POWER (VA)	3000
INPUT CABLE	10 GA/5.26mm^2
OUTPUT WIRE CABLE	6 GA/13.3mm^2
RECOMMENDED FEED BREAKER SIZE	25A

HFR MODELS	48/50HF, 48/50MC
MAXIMUM INPUT POWER (VA)	4100
INPUT CABLE	10 GA/5.26mm^2
OUTPUT WIRE CABLE	6 GA/13.3mm^2
RECOMMENDED FEED BREAKER SIZE	30A

HFR MODEL	24/100HF
MAXIMUM INPUT POWER (VA)	4100
INPUT CABLE	10 GA/5.26mm^2
OUTPUT WIRE CABLE	4 GA/21.15mm^2
RECOMMENDED FEED BREAKER SIZE	30A

HFR MODEL	48/100HF
MAXIMUM INPUT POWER (VA)	8200
INPUT CABLE	8 GA/8.37mm^2
OUTPUT WIRE CABLE	4 GA/21.2mm^2
RECOMMENDED FEED BREAKER SIZE	50A

Note: These are recommended cable and breaker sizes based upon the requirements of the Canadian Electrical Code. Where very long cable runs are used a larger cable size may be required to reduce wire voltage drop. Local electrical codes must be adhered to where applicable.

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7. SHIPPING, HANDLING AND UNPACKING

7.1 Shipping

When shipped separately, the rectifiers are each placed in a plastic bag and are surrounded with impact foam inside individual cartons.

7.2 Handling

Since the rectifier is fragile electronic equipment, handle it carefully. After receiving the carton containing the rectifier, visually inspect the package for mishandling or shipping damage. Report any damage **immediately to the transport company** and to the manufacturer. Leave damaged packages alone until the insurance and transportation companies inspect them.

7.3 Unpacking

Unpack the rectifier in a clean and dry environment. Carefully open the carton and remove the top half of the packing to reveal the rectifier. Remove the rectifier from the carton, but retain the original packing material until the rectifier has been fully tested.

7.4 Storage

If the rectifier is required for future use, the rectifier should be stored in the original packing material in a cool, dry storage area. *Do not stack items on top of the rectifier.*

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8. POWER CABLE TERMINATIONS

WARNING: ***Make all AC and DC connection with their respective circuits OFF Do Not bend or twist wire strands sharply, also take care to avoid nicking or cutting wire strands.***

All DC connections are made using high current modular connectors. These should be crimped on using the proper type of crimping tool to prevent failure.

IMPORTANT: The red connector is positive, the black connector is negative. For a –48V system, the positive must be grounded. For a +24V system, the negative must be grounded.

All AC connections are made using screw in type terminal blocks or twist lock connectors. It is critical that screw in terminals are tightened firmly to prevent arcing and overheating of connections leading to eventual failure. It is important that twist lock connectors are fully locked to prevent possible failure of the connector.

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9. INDICATORS/CONTROLS/ALARMS, SETTINGS, AND ADJUSTMENTS

The rectifier controls are located on a printed circuit card which is mounted on the front panel along with the AC and DC circuit breakers. All controls are accessible to the operator with the cabinet closed through openings on the front panel.

- All indicators are long life, light emitting diodes (LEDs) or liquid crystal displays (LCDs).
- Controls are potentiometers, push buttons, and toggle switches.

9.1 Indicators/Controls/Alarms

9.1.1 Input AC Circuit Breaker

This breaker is used to manually turn the rectifier ON and OFF and provide protection against excessive AC current. It has an interrupting capacity of 5000 amps.

9.1.2 AC/DLY - AC Line Monitor, Start Delay

This indicator tells the user what the status of the rectifier is in the startup sequence. After the AC power is turned on, the rectifier monitors the AC line, and will not allow a start up under low or high line conditions. An AC line fault condition is indicated by the AC/DLY LED flashing for more than 1.5 minutes.
The Start Delay control pot allows the user to set an adjustable time delay between the AC power on and the rectifier starting up. This is also indicated by the AC/DLY LED flashing, but has a maximum setting of 1.5 minutes.

9.1.3 Float/Equalize

These controls allow the user to preset two possible output voltages using the Float and Equalize pots, and select between them using the appropriate push button switches.
The adjustment pots are found next to the Float/Equalize LEDs.

Notes: i) Before adjustment of the Float and Equalize settings Temperature Compensation (if equipped) must be turned off.

ii) Adjusting the Float/Equalize will affect the Boost setting.

9.1.4 Current Limit

- A YELLOW LED indicates that the rectifier is in current limit.
- The current limit adjustment is on the front panel next to the Current Limit LED.

9.1.5 Hi Temp

This indicator tells the user that the unit is in a high temperature condition. This may be due to high ambient temperature, or the fan filters may be require cleaning.

This mode also de-rates the rectifier's current output to approximately 60% of capacity to try and prevent shut-down.

9.1.6 Hi Temp SD

This indicator shows that the unit has shut down to a high temperature condition. The unit will restart automatically as soon as the unit cools.

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9.1.7 DC High Volts Shutdown Control

If the DC output voltage of the rectifier exceeds the set point, the rectifier is electronically latched in an "OFF" position. A rectifier fail indication will also occur when this happens. The set point is adjusted using the pot next to the HI VOLTS LED. A manual reset is required to restart the rectifier by opening the AC breaker momentarily.

9.1.8 Rectifier Fail Alarm

The rectifier fail alarm circuit monitors the output voltage of the rectifier. When a failure is detected, a Form 'C' contact is activated, and a RED LED is lit on the rectifier alarm panel if the AC is on and present.
The following conditions produce a Rectifier Fail Alarm:

- High or Low DC Output
- High Internal Temperature/Fan Fault
- AC Line Fault
- AC or DC Circuit Breaker Open

9.1.9 DC Breaker Indicator

This indicator shows that the output breaker of the unit is in the off position.

9.1.10 Low Volts

This indicator shows that the output voltage has dropped below the level preset.
This is adjusted by the pot next to the Low Volts LED.

9.1.11 Boost Mode (optional)

The unit has an optional Boost mode that is selected using a toggle switch. There is an amber LED to indicate when this function is active, and the adjustment pot is beside the indicator LED. Boost mode is implimented as an offset to the output Float/Equalize setting, so it can only be set in either Float or Equalize modes. Any adjustment of the Float/Equalize voltage that the Boost was referenced from will result in a change in the Boost voltage.

Note: Before adjustment of the Boost setting Temperature Compensation (if equipped) must be turned off (just like for Float and Equalize).

9.1.12 Amps/Volts

These switches allow the user to select the operating mode of the digital LCD meter in the unit. The appropriate LED illuminates to show which mode the meter is in.

9.1.13 Output Breaker

The DC breaker protects the rectifier's output from reverse polarity power connection, and allows the unit to be taken off-line for setup and adjustment.

9.1.14 Sharing Control

This rectifier contains an automatic sharing circuit, which controls rectifier output when paralleled. When the rectifiers are set up correctly they will share the load current to within +/- 5% of the rectifier's capacity. The sharing system works even when rectifier output voltages differ by up to 1 V, but with less accuracy.

Notes on sharing function:

1) Sharing is only active when the system output current is greater than 10% of the system's capacity.
2) The further apart the rectifier voltages are set, the farther apart the rectifier output currents will be.
3) Only rectifiers of the same rating/capacity can be interconnected.

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4) The sharing line must be connected between rectifiers for sharing to operate. The BX4847 circuit board is provided on the back of each rectifier for this purpose. If the power plant has a CSU this is done by using a ribbon cable to connect the CSU to each rectifier (connector P2 on the BX4847 board). In all other cases this is done by connecting the share output of every rectifier in the plant together (using connector P4 pin 8 on the BX4847 board)

5) When set up correctly it is normal to see some differences in rectifier output. For example, with two HFR48/100HF's, it would be acceptable to see one unit putting out 30A, and the other putting out 38A (one unit running ~4% of capacity above the ideal load of 34A, the other ~4% of capacity below the ideal of 34A). However if total load was below 20A, sharing would not be active.

9.2 Settings

Each rectifier is factory tested and, unless otherwise specified, the controls are preset to the values indicated. The adjustment potentiometers can accurately re-calibrate the control and alarm settings from the front panel, if required.

9.3 Adjustment

9.3.1 Adjustment Tool

When making any adjustments, use a small flat bladed tool to gain access to the slots in the potentiometers. SLOT DIMENSIONS : 0.1 in. x 0.025 in. (2.5 mm x 0.6 mm).
Each control can be adjusted with ease. Accurate settings achieved by gentle rotation of the potentiometers.

Abbreviations:	CW	Clockwise
	CCW	Counterclockwise
Rotation of Pots	CW	Increases settings
	CCW	Decreases settings

9.3.2 Start Delay

a) Turn off the rectifier
b) Turn on the rectifier and time from that instant until the AC/DLY light stops flashing.
c) If this time is less than the desired delay, increase the Start Delay setting and go back to step a)
d) If this time is greater than the desired Start Delay, decrease the setting and go back to step a)

9.3.3 Float/Equalize/Boost Voltages (Off Line)

a) Turn the DC output breaker off.
b) Switch the rectifier to the charging mode to be adjusted.
c) Adjust the output voltage to the desired level.
d) Return the rectifier to the previous charging mode.
e) Turn on the DC output breaker.

Note: If a Boost mode is equipped on the rectifier, the Boost voltage setting will need to be reset after adjusting the rectifier's Float/Equalize setting.

9.3.4 DC Low Volts Alarm (Off Line)

a) Turn off the DC output breaker.
b) Set the rectifier to Float mode.
c) Adjust the rectifier output to the desired Low Volts Alarm setting.
d) Set the Low Volts Alarm pot full CCW.

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e) Adjust the Low Volts Alarm CW until the alarm just comes on.
f) Reset the Float voltage back to the normal level.
g) Set the rectifier to the previous charging mode.
h) Turn on the DC output breaker.

9.3.5 DC High Volts Shutdown Adjustment (Off Line)

a) To check complete shutdown operation, open the DC breaker.
b) Set the "DC High Volts" potentiometer fully CW.
c) Adjust the voltage potentiometer to the desired "DC High Volts" setting using the panel meter.
d) Slowly adjust the "Hi Volts" potentiometer CCW. Stop at the point at which the "Hi Volts" shutdown LED comes ON.
e) Rotate the voltage potentiometer CCW and cycle the power to the rectifier.
f) To test setting, increase the voltage, slowing down as the set point is approached until the “Hi Volts” shutdown occurs. Rotate the voltage potentiometer CCW and cycle the power to the rectifier when complete.
g) Reset the voltage to the original volt setting.
h) Close the DC Breaker to restore normal operation.

Notes: At higher output currents the Hi Volts threshold is automatically lowered slightly the ensure that during parallel operation the highest rectifier will shut down if a fault occurs.

9.3.6 Current Limit Adjustment

a) Operate the rectifier in float mode.
b) Adjust the current limit potentiometer fully CW.
c) Apply a load slightly greater than the desired current limit level.
d) Monitor the rectifier ammeter and turn the current limit potentiometer CCW until the desired current limit setting is reached (The current limit light will illuminate and voltage and current will decrease as the pot is turned CCW).
e) Remove the test load when complete.

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10. REMOTE CONNECTIONS

10.1 Remote Input/Outputs

10.1.1 Share

The Share line is to be connected ONLY to the share line of any other same capacity rectifiers that are running in parallel.

10.2 Remote Inputs

10.2.1 Temperature Compensation

This input is driven with a 12 Volt, 1kHz PWM signal proportional to the amount of temperature compensation desired. The total range available is 3V.

10.2.2 Remote Equalize

When this input is driven with 12 Volts the unit will switch to Equalize mode. On removal, it will return to the mode it was in previously.

10.2.3 Remote Shutdown

There are three slightly different remote shutdowns available on the HFR rectifier, which must chosen at the time of ordering. In both cases this input is driven with 12 Volts the unit will turn off. On removal, it will restart. There is not start delay after a remote shut down.

The first mode will turn the rectifier completely off, i.e. the output voltage and current will be 0.

The second mode does not shut the rectifier completely off, but only turns the output down to ~44V/22V depending on the rectifier type. This allows a battery test to be easily implimented, and if the batteries fail the rectifiers will still power the load without the system having any down time.

The third mode is only available with the CSU control and supervisory system, and allows selection of up to 7 rectifiers to be turned off remotely (in any order/number). To do this each rectifier has a rotary switch on the back to allow the configuration of the unit's ID number.

10.3 Remote Outputs

10.3.1 Rectifier Fail

Rectifier Fail alarm relay contacts have been provided for common rectifier fail alarm. The relay is energized under normal operating conditions and drops out under alarm conditions (fail-safe). The Rectifier Fail Alarm consists of a set of isolated Form "C" Contacts. Contacts are rated at 48 VDC at 0.5A. When using ribbon cable to connect rectifiers in parallel for share/remote control capabilities, the Form 'C' contacts are not available.

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10.4 Connector Pin Outs

10.4.1 HFR48/100HF, HFR48/50HF, HFR24/50HF, HFR24/100HF

These products use the BX4847 Connector board attached to the rear of the unit. When the Form 'C' Rectifier Fail contacts are not used, or a CSU is connected then ribbon cable can be used to connect the share and control line on all rectifiers using the P2 connector. Otherwise all connections must be made through the P3 and P4 terminal blocks.

Connector Pin Outs

Connector P2 - Ribbon cable connections only.

Connector P3

Pin	Function
1	Rectifier Fail Common
2	Rectifier Fail Normally Closed
3	Rectifier Fail Normally Open
4	Not Used
5	Not Used
6	Not Used
7	Not Used
8	Not Used

Connector P4

Pin	Function
1	Temperature Compensation +
2	Not Used
3	Remote Shutdown +
4	Remote Equalize +
5	Signal Common
6	Signal Common
7	Signal Common
8	Share

10.4.2 HFR 48/50MC

This unit can only be used with ribbon cable to connect multiple rectifiers, and so does not have the Rectifier Fail Form 'C' connections available. C-Can does have two monitor/alarm/control panels available (the CSU, and the MAE) which have Rectifier Fail Form 'C' outputs if these are required.

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11. GENERAL OPERATION

11.1 Introduction

The operating theory of a High Frequency type rectifier is the conversion of low frequency AC power to smooth communications quality DC through an intermediate high frequency switching converter. The DC output is filtered extensively to provide an extremely low noise level.

11.2 Mechanical Construction

The rectifier is built in a modular fashion using an aluminum cabinet to permit light weight and high durability. Within the HFR module there are the following sub-assemblies: The faceplate (including display and meter boards, and fan filters), the power module (including power board, interface board, control board, and fans), and the main cabinet (including input surge suppression, diode bridge, input filtering, breakers, and input/output connectors). The modular design of the rectifier allows quick and easy removal and repair of any failed components in the rectifier.

The DC connections are made using a high current DC connector which is easy to remove and install. AC connections are made on standard terminal blocks which provide a high contact area connection that permits very easy and reliable terminations without the aid of any tools except for a flat head screwdriver that is used to loosen (or tighten) the terminal screws. AC connections are protected by a box/cover which held shut by Phillips screws to prevent unintensional contact.

11.3 Adding/Removing Rectifiers

Note: All rectifiers have easy to remove DC output connectors on them. All alarms and the share control connections are made using ribbon cable, or terminal block. AC connection type depends on what option the customer has ordered. Rectifiers come with terminal block AC connections normally, but a twist lock AC connector is optionally available for all models with output powers of 3000W and less.

11.3.1 Adding/Removing Rectifiers From AC Hard-Wired Plants

11.3.1.1 Adding Additional Rectifiers

a) Turn off the AC feed to the rectifier to be installed.
b) Remove the cover to the AC box on the back of the rectifier.
c) Install the rectifier into the plant.
d) Connect the AC to the terminal block inside of the AC box. It is very important that all connections are secure, and all local electrical codes are adhered to.
e) Connect the DC, Share, and Alarms (as required).
f) Turn on the AC feed to to rectifier.
g) Turn on rectifier, with the DC Breaker off and set the Float and Equalize voltages, and all alarms to the desired levels.
h) Turn on the DC breaker, and the unit is in service.

11.3.1.2 Removing Rectifiers From Existing Plants

a) Turn off the AC power to the rectifier to be removed.
b) Remove the cover to the AC box on the back of the rectifier.
c) Disconnect the AC from the terminal block inside of the AC box.
d) Disconnect the DC, Share, and Alarms (as required).
e) Remove the rectifier from the plant.
f) Install the cover back onto the AC box.

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11.3.2 Adding/Removing Rectifiers From AC Connectorized Plants

11.3.2.1 Adding Additional Rectifiers

a) Install the rectifier into the plant.
b) Connect the AC conector to its mate on the AC box.
c) Connect the DC, Share, and Alarms (as required).
d) Turn on rectifier, with the DC Breaker off and set the Float and Equalize voltages, and all alarms to the desired levels.
e) Turn on the DC breaker, and the unit is in service.

11.3.2.2 Removing Rectifiers From Existing Plants

a) Turn off the AC power to the rectifier to be removed.
b) Disconnect the AC connector from the AC box.
c) Disconnect the DC, Share, and Alarms (as required).
d) Remove the rectifier from the power plant.

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12. TROUBLESHOOTING PROCEDURE

Tips to avoid getting electrical shocks:

- The rectifier is most likely to be connected to a load and a battery. Therefore, we can consider the rectifier to have more than one power source connected to it - the AC supply and the batteries.
- The output terminals will still be energized when the rectifier's DC output breaker is OFF. Always check the device that you are going to be working on for voltage.

What To Do When...

- The AC feed breaker to the rectifier trips
- The input breaker trips
- The output breaker trips
- The output voltage doesn't adjust
- The rectifier is inoperable
- The display works, but there is no output
- The output of the rectifier is not stable

12.1 Trouble Shooting Procedure

The AC Breaker to the rectifier trips

- If the rectifier is being energized for the first time, measure the input voltage to the rectifier and verify if it's within range.
- If the input voltage is within range, de-energize the AC breaker on the rectifier, measure the voltage at the input terminal block just to make sure, and check the input varistors on the input of the rectifier. It should also be determined that the feed breaker is the correct size.
- If the feed breaker is the correct size, the rectifier input breaker should trip before the feed breaker does.

NOTE: ***The Rectifier contains no user serviceable parts and therefore in case of field failure, the module should simply be replaced and the defective unit returned to an authorized repair depot.***

The Output Breaker Trips:

The rectifier has an electronic current limit. It should protect the rectifier from any short circuits applied to the output. Check the load for shorts or mechanical damage on output connectors. Check for battery mis-connected (reverse polarity). Another possibility is that the Ammeter is out of calibration, and the actual output current is much higher than indicated.

The Output Voltage doesn't adjust:

- First verify the output voltage with a hand held multi-meter. The problem might be the digital meter on the rectifier.
- Check the output current of the rectifier to make sure the rectifier is not in current limit.
- If possible, turn off the output breaker and try to adjust the float pot. This removes the rectifier from the load. If the rectifier is not in current limit and still does not adjust the voltage with the pot, replace the unit and return for service.

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The Rectifier is completely inoperable:

- Check the AC input voltage through the rear connection point. If AC is present and no status indication is shown on the display LED's, replace unit and return for service.

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The Display works but there is no output:

- Confirm status of indicator lights. Are they showing a correct status? If so correct external fault. The following chart will give the User some common indications and their corrective action:

INDICATION ON PANEL	POSSIBLE CAUSE	CORRECTIVE ACTION
Rectifier Fail + AC/DLY flashing >2 minutes	AC Input voltage out of range	Correct AC condition
Rectifier Fail + Hi Volts	High Voltage Shutdown	Reset rectifier and monitor output voltage. Correct with adjustment. If no adjustment-replace unit.
Rectifier Fail & Hi Temp or Hi Temp SD	High internal temperature (possibly shutdown) due to filter clogging, fan failure, or out of specification high ambient temperature.	Measure ambient. If too high correction condition; check filters & clean if necessary; check operation of each fan-replace if necessary.
Rectifier Fail & Breaker Trip	Breaker trip or open	Investigate cause and correct

NOTE: ***"Replace unit" means field replace the rectifier in the plant with a spare rectifier and return defective to an authorized repair depot for service. Most faults can be easily repaired on a bench tester using the separate "Technical Service Manual for HFR-1 PH", available to authorized service facilities only.***

The output of the rectifier is not stable

- Verify that the load on the rectifier is stable. If it is not, it may make the rectifier look unstable when it as actually just doing its job and providing the power being asked for.
- If possible take the rectifier off-line and verify that it is unstable by itself. If so return for service.

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13. MAINTENANCE

The only required maintenance on the HFR 1 Phase rectifier is a periodic check of the fan filters/heatsinks. Should they become clogged with dirt then a restricted airflow may occur causing overheating of the rectifier. Although this would not cause any physical damage, it may lead to nuisance “high temperature shutdowns“ on the rectifier. Dependent on installation cleanliness, C-CAN recommends at least a 6 months inspection and a yearly cleaning of the filters/heatsinks.

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