Lucent Technologies
Bell Labs Innovations

Lineage® 2000 125-Ampere, 60-Hertz Ferroresonant Rectifier J85502C-1

Product Manual
Select Code 169-790-121
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Notice:
Every effort was made to ensure that the information in this document was complete and accurate at the time of printing. However, information is subject to change.

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1 Introduction

General Information

This product manual (Select Code 169-790-121) describes the J85502C-1 125-ampere rectifier. The J85502C-1 rectifier converts commercial 208 or 240 volts ac input power at 60 Hz into highly regulated and filtered, low-noise, ±24 or –48-volt dc output power for telecommunications equipment loads. Since central offices usually obtain their electrical power from potentially noisy commercial ac lines (and emergency generators during commercial power failures), and since high quality dc power is required in order for the equipment to operate correctly, the J85502C-1 rectifier is an excellent choice for any telecommunications battery plant.

The J85502C-1 rectifier can be used with a Lineage® 2000 battery plant, older vintage Lucent Technologies battery plants, or any commercial battery plant. With certain options, it can also operate off battery.

Customer Training

Lucent Technologies offers customer training on many Power Systems products. For information call 1-972-284-2163. This number is answered from 8:00 a.m. until 4:30 p.m., Central Time Zone (Zone 6), Monday through Friday.

Customer Service

For customers in the United States, Canada, Puerto Rico, and the US Virgin Islands, call 1-800-THE-1PWR (1-800-843-1797). Services provided through this contact include initiating the spare parts procurement process for out of service emergencies, ordering Lucent Technologies documents, and providing other product and service information.

For other customers worldwide, call 001-972-840-0382. This number is answered from 8:00 a.m. until 4:30 p.m., Central Time Zone (Zone 6), Monday through Friday.

Technical Support

Technical support for Lucent Technologies customers is available around the world during the normal product warranty period and also while specific contractual agreements extend this service.

For customers in the United States, Canada, Puerto Rico, and the US Virgin Islands, call 1-800-CAL-RTAC (1-800-225-7822) to contact a product specialist to answer your technical questions and assist in troubleshooting problems.

For other customers worldwide, contact your local field support center or your sales representative to discuss your specific needs.

Product Repair and Return

Repair and return service is provided for Lucent Technologies customers around the world.

For customers in the United States, Canada, Puerto Rico, and the US Virgin Islands, call 1-800-255-1402 for information on returning of products for repair.

For other customers worldwide, contact your sales representative to discuss your particular circumstances.

Warranty Service

For warranty service worldwide, contact your Warranty Service Manager (WSM). The WSM serves specific customer-groups, who have taken ownership of the product. For product conformance issues prior to customer ownership, contact your local customer service.

On-Line Power Systems Product Manuals

For Lucent Technologies users logging in from inside the corporate firewall, the address of the "Power Systems On-Line Product Manuals" page is *http://www.cic.lucent.com/lineage.html*.

For customers logging in from outside the firewall, the address is *http://www.lucent8.com/lineage.html*. The annual subscription fee for access to this site is $25. To obtain a password, follow the instructions on-line or call 1-888-Lucent8 (1-888-582-3688).

When prompted for an order number, enter or say "167-790-010."

2 Product Description

Overview

In most telecommunications applications, the output of the rectifier system is electrically connected in parallel with the batteries. The rectifiers provide both the power to the telephone equipment through the plant distribution and the charging and float current to the batteries. In the event of commercial power failure, the batteries supply the required dc power to the telephone equipment. This transition needs no switching because of the parallel connection of the rectifiers and batteries.

The rectifier provides alarms and accepts control signals from an external source. It is Underwriters Laboratory (UL) listed and Canadian Standards Association (CSA) certified. The rectifier uses controlled ferroresonant technology, which reduces noise and transients from commercial lines.

All components in the rectifier meet Lucent Technologies' strict specifications and reliability standards. The rectifier uses an extremely efficient free-convection cooling system that keeps components operating at temperatures well below the recommended maximum, resulting in high reliability.

All circuits for power control, alarms, voltage regulation, current limiting, restart, plant interface, and remote monitoring/control are mounted on replaceable circuit modules. Front access to the circuit modules simplifies replacement or adjustment, if required. Standardized modules simplify parts inventory, resulting in lower costs and better equipment availability.

The rectifier can be used in a plant with or without batteries and with or without a controller. One each of two input voltages, two output voltages, and either negative or positive polarity may be ordered. Optional noise filtering can be added. Each option

requires different equipment which Lucent Technologies has organized into numbered lists to simplify ordering.

Ferroresonant Technology

The J85502C-1 rectifier is a member of the Lucent Technologies family of Lineage® 2000 rectifiers. Like all the rectifiers in the family, it represents a significant advancement in efficiency, space savings, and serviceability. The rectifier uses the electronically controlled, closed-loop, ferroresonant technology developed by Lucent Technologies Bell Laboratories. This technology provides excellent output regulation in spite of variations in the incoming commercial line voltage and frequency, and the outgoing current or "load."

Ferroresonant technology and the rectifier's physical design features combine to provide reliable service, easy maintenance, and greater cost-effectiveness on a dollars-per-output-ampere basis.

Ferroresonant technology also:

- Eliminates internal switching transients typically associated with other technologies.
- Reduces noise and transients from commercial lines. As the interface between commercial power and telephone equipment, the ferroresonant rectifier significantly attenuates noise and lightning surges from commercial lines.
- Introduces far less noise into closely coupled telephone lines due to lower harmonic components in the input current waveshape compared to other technologies.
- Provides highly efficient power conversion.

Standard Features

The J85502C-1,125-ampere rectifier has the following standard features.

- **Output current "walk-in":** This circuit controls the time required for the rectifier to reach its rated output voltage after it is turned on. Initially, the output voltage is about 80 percent of normal, and gradually increases to the required value in approximately 10 seconds. As the output voltage "walks in," so does output current. This feature minimizes

the starting surge on the customer's power source and is especially important with a more limited power source, such as an emergency generator set.

- **Internal selective high voltage shutdown:** If the rectifier voltage goes too high, and it is delivering at least 10 percent of its rated output current, the rectifier shuts down. If the rectifier is connected to a Lineage® 2000 controller, this feature is deactivated and the controller furnishes the external selective high voltage shutdown (HVSD).

- **External Selective high voltage shutdown:** If the battery voltage goes too high, the Lineage® 2000 controllers signal all of the connected rectifiers. This signal causes the rectifier(s) delivering at least 10 percent of rated output current to shut down. The remaining rectifiers continue operating. Straps on the **CM1** option board must be set for List WB. See Table 8-B.

- **Backup high voltage shutdown:** This circuit prevents damage to the rectifier in the event of high battery voltage. Each rectifier senses its own output voltage and when this voltage exceeds a preset value, it shuts down. This circuit operates if the external selective HVSD fails to operate. This backup HVSD operates from an independent voltage source per Bellcore standards.

- **Voltage monitor circuit module:** This circuit monitors the ± 5 and ± 12 biased dc supply voltages on the 205A1 control board. The circuit shuts down the rectifier and issues an RFA alarm when these voltages fall below acceptable levels.

- **Output current limit:** The rectifier provides a constant output voltage up to its rated output current, at which point it provides constant current. When the output current tends to increase above the rated output, the current limit circuit overrides the voltage regulating signal and limits the output current of the rectifier.

- **Back-up current limit:** In addition to the output current limit, the ferroresonant transformers self-limit current output between 125-175 percent of full load, or 156-219 amperes.

- **Isolated output current indication:** When used with a Microprocessor Controlled System controller, the rectifier provides an isolated 2- to 10-volt signal, corresponding to a range of no-load to 125 percent of rated output load, which is used to indicate the rectifier drain on the controller.

- **Safety interlocks:** A series-loop circuit electrically interconnects the control circuit modules and prevents rectifier operation if an open circuit is detected.

- **Fuse alarm circuit:** The low-power control functions shut the rectifier down if a fuse alarm (FA) occurs. One fuse alarm protects each of the regulation leads. When any FA occurs, a Rectifier Failure Alarm **(RFA)** LED lights on the front panel and an RFA signal is generated. The **FA** LED also lights.

- **Man alarm:** This alarm indicates that either the rectifier has been turned off manually or has lost commercial input power.

- **Restart circuit:** The rectifier has an automatic restart feature that is compatible with the Lineage® 2000 controllers and most other controllers. If a rectifier shuts down due to the external selective HVSD, most controllers try at least once to restart it automatically.

- **Remote sense leads:** These leads permit remote regulation of the rectifier if it is installed with a compatible controller and straps on **CM1** option board are set for List WA. See Table 8-B.

- **TR:** This signal remotely shuts down the rectifier.

- **AC voltage monitor circuit:** This circuit monitors the ac input voltage and shuts the rectifier down if the ac goes below the following voltages:

Input	**Low**
208	170
240	195

- **LOA:** The limited output alarm (LOA) signals a controller that the rectifier has lost input voltage.

- **Equalize battery charge:** In association with a Lineage® 2000 MCS controller, the J85502C-1 rectifier allows the batteries to be charged at a voltage that is higher than float voltage to equalize the individual voltages of the cells in the string.

Additional Features

Dynamic Response

For any step load change of 10 to 90 percent, or 90 to 10 percent, or a step change of 10 percent of the input voltage, the sense point voltage remains within 5 percent of its setting, and returns and remains in the 1/2 percent band within 300 milliseconds.

For batteryless operation, for any step load change of 50 to 90 percent, or 90 to 50 percent, or a step change of 10 percent of the input voltage, the sense point voltage remains within 10 percent of its setting, and returns and remains in the 2 percent band within 500 milliseconds.

Electromagnetic Compatibility (EMC)

The J85502C-1, 125-ampere rectifier complies with FCC Docket 20780, Part 15, Subpart J as required for Class A applications. In addition, the rectifier meets all specified operating specifications when subjected to electric fields up to 10 volts per meter over a frequency range of 20 to 1000 MHz.

Circuit Modules

The rectifier's signal processing and control circuitry are located on replaceable circuit modules or packs. Circuit modules are plug-in boards that can be ordered. Table 8-A lists recommended spare parts for the rectifier. All of the circuit modules are accessible by opening the rectifier door. Figure 5-3 shows the location of the circuit modules and other features of the rectifier. Figures 6-2, 6-3, and 7-2 show the **CM1**, **CM2**, and **CM3** board layouts, respectively. A description of each module follows.

- The **CM1** circuit module (ED-83158-30, Group 3) contains circuitry common to several rectifiers in the Lineage® 2000 rectifier family. The factory provides the options required for each application by removing certain wire straps and resistors from the **CM1** board. The factory modification of CM1 is complete when the board is installed in the rectifier. However, ordered spare or replacement **CM1** boards have not been modified. The customer must make this

modification. See Section 8, "Modifying the **CM1** Option Board" for information on parts to be removed and retained.

- The **CM2** circuit module (205A1 control board) contains the following circuits:

  Local power supplies
  Feedback regulator
  Output current
  Walk-in feature
  Backup high voltage shutdown
  Rectifier portion of external selective high voltage shutdown
  Remote shutdown
  Internal selective high voltage shutdown
  Restart feature
  Limited output alarm (LOA)
  Fuse alarm
  Electronic current limit
  Output current isolation circuit

- The Digital Meter Board **CM3** circuit module (207A meter board) controls the digital **Output** meter on the rectifier control panel. The meter displays the rectifier's output current, voltage, or the plant battery voltage depending on the three-position selector switch (see "Front Panel Controls and Indicators" in this section).

- The **CM4** circuit module (ED-83211-30, Group 3) is an option provided with List C rectifiers. The module allows access to alarm and control functions of the rectifier. The module mounts on the floor of the rectifier next to the bus bar assembly on List C rectifiers.

- The **CM5** circuit module (365A ac monitor board) has been replaced on new rectifiers with **CM6**.

- The **CM6** circuit module (434A or B ac monitor board) has ac and dc voltage monitor circuits. When these circuits are activated, they shut down the rectifier. The dc circuit issues an **RFA** and latches the RFA relay. The rectifier must be restarted when the problem has been cleared. When the ac circuit is activated, the rectifier shuts down but automatically restarts when the correct ac voltage level is restored.

The 434B board is the same as the 434A except when the ac circuit is activated, it also issues a **MAN** alarm.

Caution

Circuit modules must not be connected or disconnected with voltages present or equipment damage may occur. See the following topics in Section 8: "Replacing Circuit Modules" for how to replace circuit modules and "Handling Circuit Modules" for proper handling of circuit modules to avoid damage from electrostatic discharge.

Front Panel Controls and Indicators

Figure 2-1 shows the control panel on front of the J85502C-1, 125-ampere rectifier. The following list describes the controls and indicators on the control panel. These features should be observed and manually operated during normal rectifier performance. Bold letters indicate labels that appear on the control panel or inside the rectifier.

- The digital output meter displays (1) the rectifier output current when the selector switch is in the **AMPS** position, (2) the rectifier output voltage when the selector switch is in the **RECT V** position, and (3) the plant battery voltage when the selector switch is in the **BATT V** position. The default display is rectifier output current. Table 2-A gives the accuracy of this meter in the various positions. The output voltage (**RECT V**) accuracy depends on the vintage of the digital meter board, or circuit module CM3, in the rectifier.

Table 2-A: Digital Meter Accuracy

Meter Position	Accuracy
RECT V	±0.5 volt for Series 1 or 2 **CM3** digital meter boards
	±0.2 volt for Series 3 **CM3** digital meter boards*
BATT V	±0.2 volt for any **CM3** digital meter board
AMPS	±2.5 percent of rectifier rating
*Series 3 **CM3** boards can be identified by the designation "AM3" which is stamped on the wiring (noncomponent) side of the board. A partial sketch of the CM3 boards is provided in Figure 7-2.	

The **POWER** (Control) switch turns the rectifier on and off. When the switch is in the **Off** position, the rectifier cannot be turned on by the plant controller. When in the **On** position, an MCS controller can remotely turn the rectifier on or off to satisfy the plant load current requirements. The **POWER ON** LED emits a green light to indicate that the rectifier is on.

- The Fuse Alarm (**FA**) LED lights when the **+V** or **-V** fuse blows, because these alarm fuses are not visible with the door of the rectifier closed.

- The Rectifier Failure Alarm (**RFA**) LED lights and a signal is sent to the plant controller if the rectifier fails because of external or internal high voltages, a blown fuse, an internal unbalance, or problems with the rectifier ±5-volt dc or ±12-volt dc.

- The **RECT TEST** switch provides a manual test of the rectifier regulation by simulating a full load (**FL**) or no load (**NL**) condition. Operating the switch raises or lowers the output voltage setting of the rectifier by 0.25 volt when on battery. When the switch is in the center position, the rectifier is in the normal operating state.

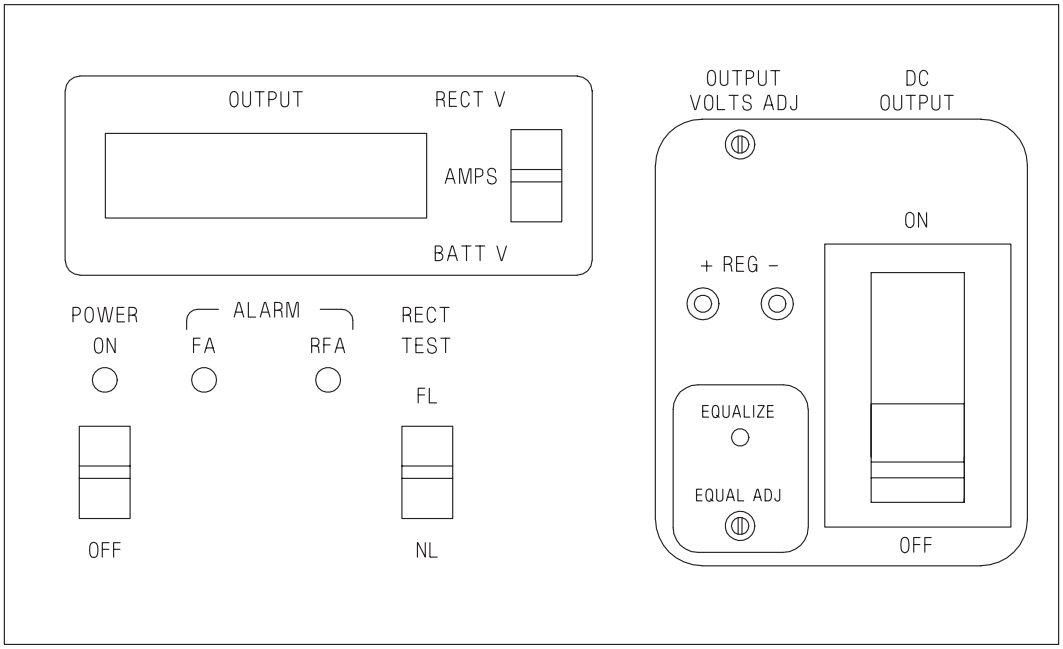


Figure 2-1: Control Panel on the J85502C-1

- The **EQUAL ADJ** potentiometer provides for manual adjustment of the equalize voltage.
- The **EQUALIZE** LED indicates that the equalize mode is in use.
- The **OUTPUT VOLTS ADJ** potentiometer provides for manual adjustment of the output float voltage.
- The **REG** test jacks allow for measuring the plant output voltage at the points where the remote sense leads are connected. This measurement is accurate only when the remote sense leads are connected.
- The **1/2 Amp +V** and **-V** alarm fuses protect the voltage sense leads to the rectifier control and regulation circuits. These fuses are attached to the control panel inside the rectifier door.
- The **DC OUTPUT** circuit breaker protects the plant from rectifier malfunction and excessive current, and may be used to disconnect the rectifier from the battery. An output

circuit breaker alarm issues and the **RFA** LED lights when the circuit breaker trips.

Alarm and Control Flow

The J85502C-1, 125-ampere rectifier is typically installed in a battery plant that is monitored and controlled by a Lucent Technologies Lineage® 2000 controller. The rectifier generates various monitoring and alarm signals and, in this type of installation, sends them to the controller for processing and subsequent action. The action may be local or remote alarm indications or control signals fed back to the rectifier. Refer to the various Lineage® 2000 controller product manuals for a description of rectifier signal processing and resultant action.

Figure 2-2 shows the typical signal flow between a rectifier and a Lucent Technologies controller. The control signals and alarms enter and leave the rectifier via the control circuit module **CM2**. The Lineage® 2000 family of plant controllers also uses replaceable circuit modules which give flexibility to battery plant design.

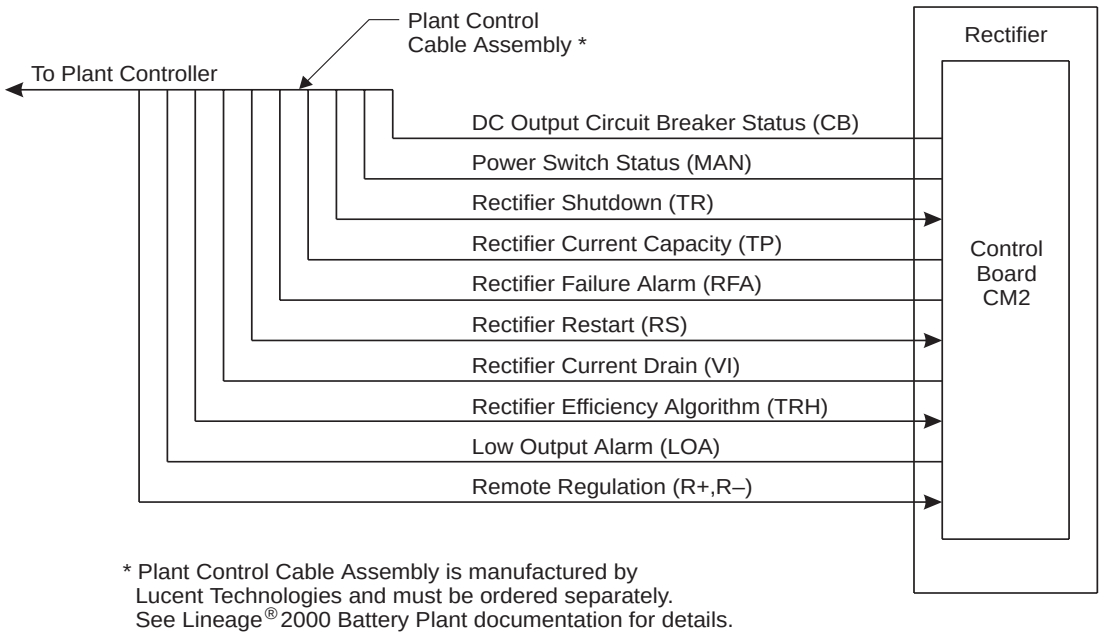


Figure 2-2: Signal Flow Between Rectifier and Lucent Technologies Controller

Physical, Thermal, and Electrical Specifications

Tables 2-B, 2-C, and 2-D give the physical, thermal, and electrical specifications for the Lineage® 2000 J85502C-1, 125-ampere rectifier. Regulation on battery is .5% for the line, load, frequency, and temperature specifications. Regulation off battery is 2% for these specifications.

Table 2-B: Physical and Thermal Specifications of the J85502C-1 Rectifier

	Output DC ±24V	**Output DC –48V**
Dimensions (inches)	23.25 widex17 tallx15 deep	
Weight (lbs)	240	370
Heat Dissipation* BTU/hr at full load	1630	2560
Humidity rating	10 To 95% (non-condensing)	
Operating Altitude	Sea level to 10,000 feet (3048 meters)	
Operating Temperature	35-122° F 1.5-48.8° C	
Audible noise at 5 ft. above floor and 2 ft. in front of rectifier	Less than 64 dBA	
Earthquake rating	Meets Zone 4 per Bellcore TR-EOP-000063 (Issue 3)	
*Measured at 28 Vdc for 24-volt rectifiers and at 54 Vdc for 48-volt rectifiers		

Table 2-C: Input Specifications for the J85502C-1 Rectifier

Input AC (volts		**Nominal Line Current (amps)**		**Frequency (Hz)**
Nominal	**Range**	**±24V**	**–48V**	
208	184-220	22.5	45.1	60±3
240	212-254	19.5	39.1	
Data recorded at full load, 30 Vdc for 24-volt rectifiers and 58 Vdc for 48-volt rectifiers.				

Table 2-D: Output Specifications for the J85502C-1 Rectifier

Nominal Rectifier (amps/volts)	Output Range (amperes)	Output Range (dc volts	Minimum Efficiency* at Full Load (percent)	Minimum Power Factor at Full Load	AC Ripple** (mV peak to peak) Standard Filter	Maximum Noise at Battery
125/24	0-125	21.5-30.0	88	.90	100	32
125/48	0-125	43.0-60.0	90	.85	100	32

* Efficiency measured at nominal line, 28 Vdc or 54 Vdc.

** Measured on 500 amp/hr battery (4 times rectifier capacity), with a 2-volt lead drop for standard and 0.5-volt drop for optional filter.

3 Ordering Information

Equipment Lists

Table 3-A shows the available equipment lists for the Lineage® 2000 J85502C-1 rectifier. List 1 or 2 and List E or F are required. The other four lists are optional.

Table 3-A: Equipment Lists for the J85502C-1 Rectifier

List Number	Input AC (volts)	Output DC (volts)
1	208 or 240	±24
2	208 or 240	–48
	Provides	
E	434A voltage monitor board without ac voltage alarm	
F	434B voltage monitor board with ac voltage alarm	
Optional List Number		
WA	External sensing, required when rectifier is installed with a controller equipped with battery regulation fuses	
WB	External high voltage shutdown (HVSD), required when rectifier is installed with controller that provides signal for external HVSD	

Table 3-A: Equipment Lists for the J85502C-1 Rectifier

List Number	Input AC (volts)	Output DC (volts)
Optional List Number		
C	Bus bar assembly with fused filter capacitors and access to alarm and control functions, –48V rectifier only	
B	Circuit breaker in positive output lead (negative ground system), 24V rectifier only	

Documentation

This document is part of a set of documents developed to assist equipment engineering and installation.

Table 3-B: Document References

Document No.	Document Description
J85502C-1	Assembly, Ordering, and Installation Drawing
T-82659-30	Wiring Drawing
SD-82659-01	Schematic Drawing
169-790-121	Product Manual

4 Safety

Please read this section carefully before installing, maintaining, or repairing the J85502C-1 rectifier.

Admonishments

Always take precautions to protect personal safety as well as the equipment when working on power systems. Throughout this manual, admonishments relating to personal safety are labeled **DANGER** or **Warning**. Those relating to equipment damage are labeled **Caution**. Please read all admonishments carefully and follow safety instructions and warnings.

Safety Statements

- For use only in restricted access areas (dedicated equipment rooms, equipment closets, or the like) in accordance with articles 110-16, 110-17, and 110-18 of the U.S. National Electric Code (NEC), ANSI/NFPA No. 70, and pursuant to applicable local codes.
- This equipment must not be installed over combustible surfaces.
- This equipment is to be used in controlled environments (an area where the humidity is maintained at levels that cannot cause condensation on the equipment, the contaminating dust is controlled, and the steady-state ambient temperature is within the range specified).
- This equipment has been evaluated for use in a continuous ambient temperature of up to 35 degrees Celsius.
- AC branch circuits to this equipment must be protected with either fuses or circuit breakers sized as required by the

National Electric Code (NEC) and/or local codes. The size of the overcurrent protector used must not exceed 80% of the value of the protector chosen.

- An accessible ac disconnect/protection device to remove ac power from the equipment in the event of an emergency must be provided.

- For installations in the United States, UL-listed compression connectors should be used to terminate UL-listed field-wired conductors where required. For all installations, the appropriate connector should be applied only to the correct size conductor as specified by the connector manufacturer using only the connector manufacturer's recommended tooling or tooling approved for that connector.

- If the proper connector for the country of installation is not provided, obtain appropriate connectors and follow manufacturer's and all local requirements for proper connections. All national and local rules and regulations are to be followed when making field connections.

- Torque electrical connections to the values specified on labels or in the product documentation.

Precautions

When working on or using this type of equipment, follow these precautions:

- This unit must be installed, serviced, and operated only by skilled and qualified personnel who have the necessary knowledge and practical experience with electrical equipment and who understand the hazards that can arise when working on this type of equipment.

- Because of the hazardous voltages supplied to and within the equipment, make sure the equipment, all associated framework, and the cable rack are properly grounded per local job instructions before turning on any power to the rectifier.

- For equipment connected to batteries, disconnecting the ac alone will not necessarily remove power to the equipment. Make sure the equipment is not also powered by the

batteries or the batteries are not connected to the output of the equipment.

- AC voltage may be present in the unit even when the **POWER** switch is in the **Off** position.

- Hazardous dc energy (from batteries and rectifier output) and voltages up to 600 volts are present in the unit. Use a voltmeter to insure no voltage, or the expected voltage, is present before contacting any uninsulated conductor surface. Follow the procedures in the order given to minimize dangerous encounters with these voltages. Exercise extreme caution when working near the battery bus bars.

- When servicing the rectifier, disconnect the ac service and the dc battery buses. Use extreme caution when handling the battery bus cables since these cables still contain hazardous currents from the batteries. The disconnected charge battery and charge ground connectors (cables) must be taped adequately to prevent them from contacting each other or any other metal surface. Alternatively, the dc battery cables from the rectifier can be disconnected at the plant charge battery and charge ground buses.

- DC capacitors may be charged even with power disconnected from the rectifier. If filter capacitor fuses have blown, capacitors will be charged. Always check all of the dc capacitor terminals (observe polarity) with a voltmeter before performing this procedure, and discharge capacitors safely, if necessary.

  Wait at least 5 minutes after shutting down ac and circuit breaker before working on capacitors or associated buswork.

- Batteries may be connected in parallel with the output of the rectifiers. Turning off the rectifiers will not necessarily remove power from the bus. Battery voltage may still be present on one side of the output dc circuit breaker even with the circuit breaker off. Make sure the battery power is also disconnected and/or follow safety procedures while working on any equipment that contains hazardous energy/voltage.

- In addition to proper job training and safety procedures, always follow these basic precautions:
  - Use only properly insulated tools.
  - Remove all metallic objects (key chains, glasses, rings, watches, or any other jewelry).
  - Wear safety glasses.
  - Test circuits before touching.
  - Lock out and tag any circuit breakers/fuses when possible to prevent accidental turn on.
  - Be aware of potential hazards in the area you are working before entering the equipment.
  - Identify exposed hazardous electrical potentials on connectors, wiring, etc. (note the condition of these circuits, especially any wiring).
  - Use care when removing or replacing any covers – avoid contacting any circuits.
  - Use gloves when handling thermally hot components inside the rectifier. Transformers are very hot after sustained operation.

Warning Statements and Safety Symbols

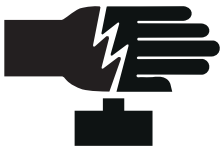
The symbols may sometimes be accompanied by some type of statement, e.g., “Hazardous voltage/energy inside. Risk of injury. This unit must be accessed only by qualified personnel.”

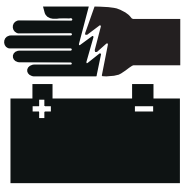
This symbol identifies the need to refer to the equipment instructions for important information.

This symbol (or equivalent) is used to identify the presence of hazardous ac mains voltage.

This symbol (or equivalent) is used to identify the presence of hazardous ac mains voltage.

This symbol is used to identify the presence of hazardous ac or dc voltages. It may also be used to warn of hazardous energy levels.





One of the above two symbols (or equivalent) may be used to identify the presence of rectifier and battery voltages. The symbol may sometimes be accompanied by some type of statement - for example: “Battery voltage present. Risk of injury due to high current. Avoid contacting conductors with uninsulated metal objects. Follow safety precautions.”

This symbol is used to identify the need for safety glasses and may sometimes be accompanied by some type of statement, for example: “Fuses can cause arcing and sparks. Risk of eye injury. Always wear safety glasses.

This symbol is used to identify the presence of a hot surface. It may also be accompanied by a statement explaining the hazard. A symbol like this with a lightning bolt through the hand also means that the part is or could be at hazardous voltage levels.

These symbols are used to identify the safety earth ground or bonding point for the equipment.

5 Installation

Introduction

This section provides information to consider before installing the J85502C-1 rectifier in a Lineage® 2000 Battery Plant. This section also describes the input and output wiring required and the recommended procedure for installing the rectifier from uncrating through startup. Lucent Technologies offers "turn-key" engineering and installation services for the products described in this product manual. Consult your Lucent Technologies representative for details.

Safety

Please read Section 4, *Safety*, thoroughly before installing the J85502C-1 rectifier, and carefully read and follow the admonishments as they are presented throughout this documentation.

Preparing for Installation

Location of the J85502C-1 rectifier and associated equipment must conform to the specific plans of each Lineage® 2000 plant installation. Physical, thermal, and electrical specifications are given in Section 2. These specifications must be considered in the plans for any installation that includes this rectifier.

Handling Equipment

Each J85502C-1 rectifier weighs at least 240 pounds. Therefore, the customer must make prior arrangements for appropriate material handling facilities and equipment to unload, uncrate, and set up the rectifier. Proper handling is necessary to assure personnel safety and protect the equipment. Each rectifier, that is not part of a battery plant when it leaves the factory, is shipped in a tri-walled corrugated cardboard container secured to a wooden shipping skid. The container should be moved by a forklift.

Bay Mounting

J85502C-1 rectifiers that are shipped as part of a battery plant are installed in the battery plant racks before shipment. Rectifiers ordered as individual units are shipped in individual containers.

The rectifiers mount in Lucent Technologies 26-inch wide bays, with 24-5/16 inch mounting centers. The bays have drilled holes on 1-inch centers, in the vertical plane, to accommodate #12-24 threads per inch self-tapping screws. Any restrictions on the location in the bays is specified in documentation for the specific power plant.

Three 3/8-16 eyebolts are provided for lifting the rectifier into position in the plant bay. They should be removed before the rectifier is permanently mounted in the bay. A supplementary bay that contains ONLY rectifiers, should be located so that the backs of the rectifiers are at least three inches from any wall.

Heat Dissipation

Heat dissipated to the environment is another factor in selecting a location for the J85502C-1. The maximum heat exhausted by each 24 and 48-volt rectifier is approximately 1630 BTU/hr and 2560 BTU/hr respectively. The rectifiers use free convective cooling, where cooler air enters the cabinet through perforations in the front door and is exhausted through perforations in the top cover. A minimum of 23 inches in front and 2 inches above the rectifier must be free of obstructions to allow the door to swing free and provide for adequate ventilation. In a side-by-side alignment of rectifiers, the cabinet door opens 90^{o} and projects approximately 23 inches (59 cm) into the front aisle causing no interference with adjacent rectifiers.

Caution

Do not block rectifier ventilation openings or damage may result due to overheating.

AC Input Power

The customer is responsible for providing ac power to the rectifier. Table 5-A gives requirements for the ac power installation. Separate branch circuits must be provided to each rectifier to assure reliability of the system. The wiring method should meet national and local codes. If the codes governing the installation allow it, Armored Cable (AC), also known at BX, makes routing the ac wiring within the bay easier.

Figure 5-1 shows the ac input conduit hole. Figure 5-2 shows termination points for the ac input wires. The "green wire" is the ac equipment ground (**AC EG**), also known as frame ground (**FR GRD**). Its termination point is on the left wall of the rectifier near the ac input conduit hole.

Table 5-A: AC Input Requirements

List	Amps/Volts	Line Fuse Type, Rating	Input Circuit Breaker Size (amps)	Number of Input Wires including AC Ground, and Gauge of Wires*	Armored Cable Trade Size (inches) for Wire Size Shown	Conduit Knockout and Conduit Trade Size** (inches)	Heat Shrink Tubing (inch)	Crimp Connector or Lug for Input Wires, and AC Ground	Crimp Tool and Die from T&B
L1	208/21.2 or 240/18.4	FRN-R, 25	30/25	3, #10 AWG	1/2	1-1/8, 3/4	3/8 x 1	T&B C36	WT 1300
L2	208/42.2	FRN-R, 50	50	2, #8 AWG and 1, #10 AWG			1/4 x 1, 3/8 x 1	T&B 54104 or WP91412L1, T&B C36	TBM 5S or 20S Red, WT 1300
	240/36.7	FRN-R, 45	50						

* #10 AWG wire for List 2 is "green wire" ac ground. Use KS-24194 L3 or 75°C commercial wire.

** Where the trade size of the conduit is smaller than the trade size for which the conduit knockout was sized, use appropriate knockout reducing washers.

Table 5-A shows the recommended customer-supplied fuse size and type for the branch circuit protection in the ac service panel supplying input to the rectifier. The types shown are Bussmann (a trademark of the Bussmann company) fuses. Equivalent UL listed fuses or circuit breakers can be used in lieu of those shown. If circuit breakers are used, they should have trip elements of an equivalent rating to the recommended fuse.

The AC EG or frame ground is normally connected using the mechanical connection provided. Discard this connection if you prefer the T&B crimp connection, which is also provided. Use T&B crimp tool WT1300 on the crimp connection. (See Note 65 on the J85502C-1 drawing.)

DC Output Power

The majority of dc power plants for telecommunication applications are designed to use single conductor cables (in parallel for current capacity or to limit voltage drop) supported

on ladder racks. Experience has shown that the use of flexible cables (welding type cables) makes installation of this type wiring much simpler. The terminals are sized to fit KS-24194 L2 wire, which is very flexible.

Figure 5-1 shows the dc output conduit hole. Figure 5-4 shows the dc output wire termination points for both negative and positive polarity. Table 5-B specifies the dc output cable size, T&B connectors and crimp die. Also see note 57 on J-drawing, J85502C-1.

Table 5-B: DC Output Requirements

Amps	Output Wire Size*	Output Conduit Trade Size (inches)	Connectors Required	T&B Crimp Die
125	1/0 AWG	1-1/2	1 stud with anti-rotation tab, Ground: 5/16" dia., T&B 54158 Battery: 3/8" dia., T&B 54110	Black
*Use KS-24194 L2 wire. It is a flexible, stranded copper wire, rated 600 volts; stranding meets American Society for Testing and Materials (ASTM) B 172 Class I. This non-halogen, insulated wire is rated 90°C. The insulation has a combustibility rating of 28% minimum as determined by ASTM D2863. Wire sizes were chosen to limit the voltage drop to 2 volts where the cable loop is approximately 200 feet.				

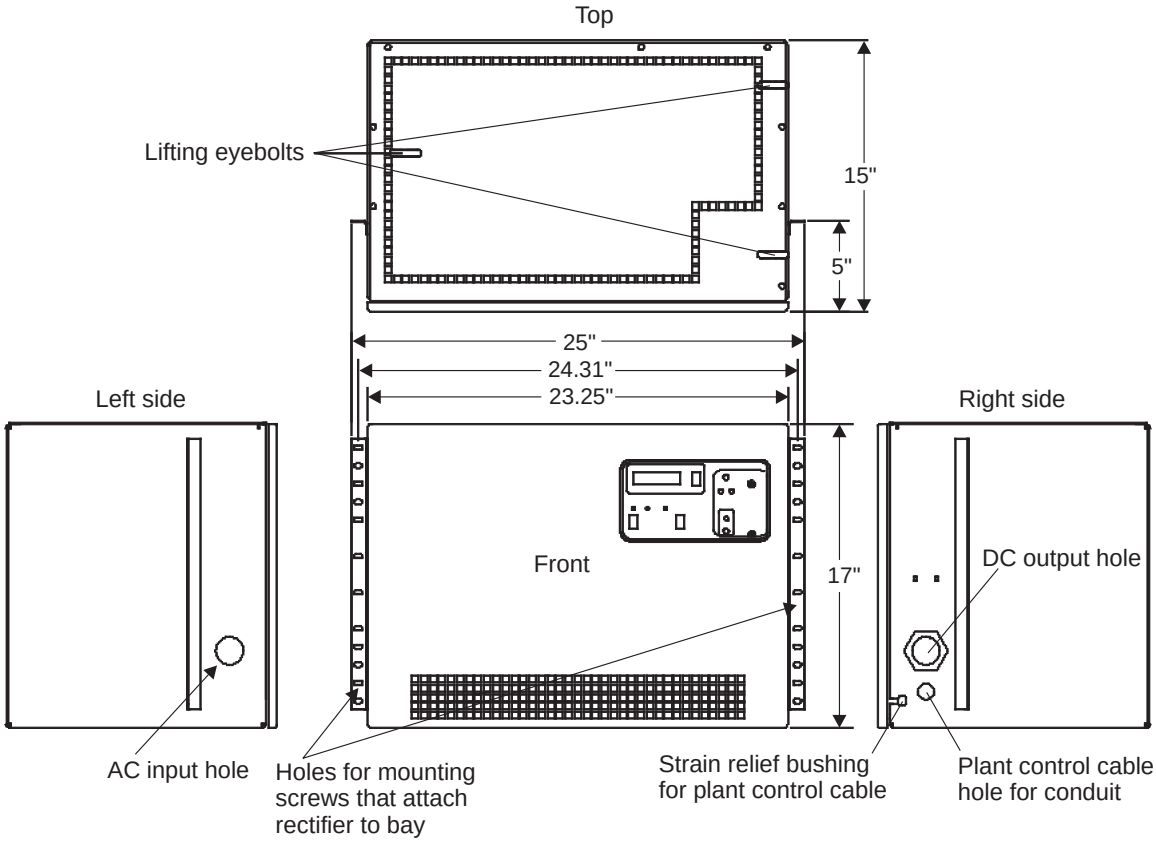


Figure 5-1: Four Views of the J85502C-1 125-ampere Rectifier

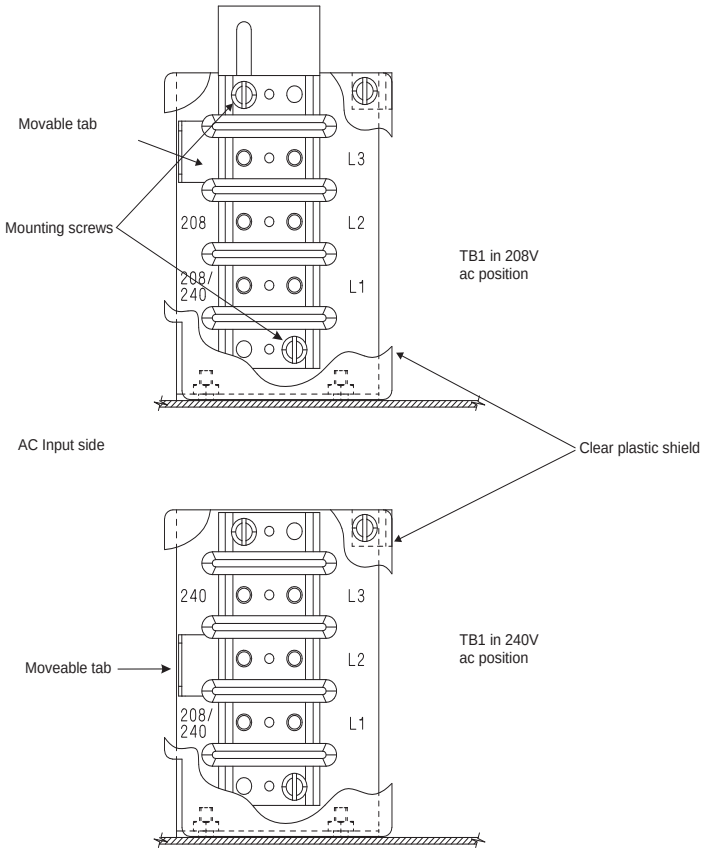


Figure 5-2: Terminal Block 1 (TB1) Where Ac Input Voltage Is Converted on J85502C-1 Rectifier

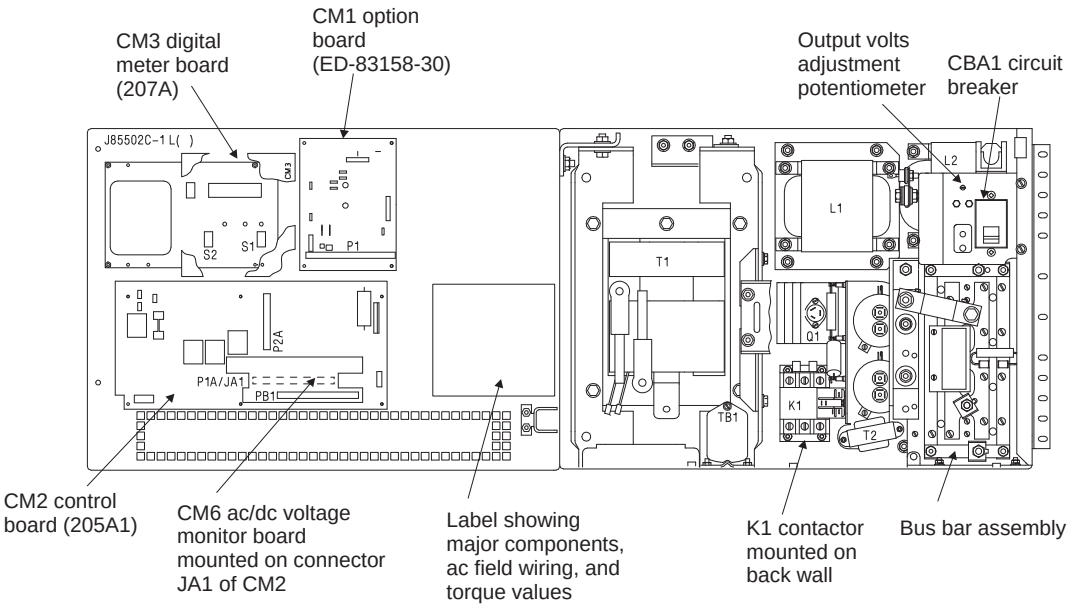


Figure 5-3: Typical J85502C-1 125-ampere Rectifier With Door Open and Diode Heat Sink Removed

Installation Tools The following tools are required for installing rectifiers.

- Material handling equipment to unload rectifiers at site, remove them from shipping containers, and place them in final positions
- Common electrician's hand tools, including jeweler's screwdriver, electrical tape, wire cutters and strippers, 10 AWG to 1/0 AWG wire
- Proper crimping tools and dies for connectors used
- Common mechanic's hand tools, including flat blade screwdriver (.30 inch blade width), socket and torque wrench for 3/8 inch bolts, channel lock pliers for ac conduit tightening, hammer, and crowbar for uncrating
- 5/16" hex Allen wrench for dc output connection at CBA1
- Three 3/8-16 lifting eyebolts
- Digital Multimeter (DMM) Fluke® 8060A or equivalent with ±0.02 percent accuracy on dc scale

Unpacking Move the crated rectifier to a convenient area for uncrating and follow the steps listed below.

1. Remove any shipping bands.

2. Check “tilt” or “shock” indicators. If tripped, contact shipping company and process claims form.

3. Pry off top, then sides of crate.

4. Inspect exposed exterior of rectifier for shipping damage.

5. With rectifier lying on its back, open the front door and visually inspect for shipping damage.

6. If material is damaged, contact shipping company and process claims form.

7. Verify that the main ac voltage at the distribution panel agrees with the List options specified on the label inside the front door of the rectifier. If it does not agree, two possible conditions on the rectifier may be corrected by the customer:

   – Incorrect ac input voltage (see Table 3-A)

   – Incorrect system polarity (circuit breaker in the wrong dc output bus). Positive ground systems have the breaker in the negative output bus, and negative ground systems have the breaker in the positive output bus.

   The customer may decide to correct either type of condition instead of returning the rectifier. The procedure for rewiring the ac input connections to match the customer’s ac supply (208 or 240 volts) is provided in “Converting AC Voltage.” The procedure for placing the **DC OUTPUT** circuit breaker (**CBA1**) in the opposite output bus is provided in “Converting DC Output Polarity.”

8. Verify that the **CM1** option board has straps present or removed according to the options you expect. See Table 8-B in this manual or Tables A and R on J85502C-1 drawing.

Installing or Adding a Rectifier

Before beginning this procedure, read "Preparing for Installation" in its entirety. This procedure is appropriate for installing a rectifier in a new plant or adding a rectifier to an existing plant to increase capacity. The assumption is made, however, that the rectifier is being added to an operating plant.

Observe the safety precautions in Section 4 and those with each procedure whenever working on or near electrically live equipment. Only persons trained and experienced in the installation of power equipment should install this rectifier.

Installing AC Power Cables

Use Figures 5-1, 5-2, and 5-3 as references for this section.

1. Using site drawing information, place the rectifier in the exact position specified for the unit.

2. Disconnect ac power from ac distribution service panel that supplies power to the rectifier.

3. Install fuse holders or circuit breaker for the rectifier in the ac distribution service panel. Leave circuit breaker in **Off** position or remove fuses.

4. Install two phase leads and frame ground at service panel and route conductors to rectifier.

5. Install the connector you prefer onto the frame ground lead (see the section entitled "AC Input Power"). Use the proper crimping tool and die for the crimp connector to prevent damage to equipment. Install the proper heat shrink tubing and terminal lug, per Table 5-A, on the ends of the two phase leads that will be inside the rectifier.

6. Secure phase leads and frame ground lead in rectifier. First, connect the ground lead to its termination point marked **FR GRD** near the ac input hole. Connect the phase leads to **TB1** according to the section entitled "Converting AC Voltage" and torque to 25 in-lb.

7. Verify that the branch circuit breaker to the rectifier in the ac service panel is **Off** or fuses are removed. Reenergize ac service panel. Tag branch circuit breaker or fuse holders to inform others not to close (turn **On**) the breaker or insert fuses. If the branch circuit, (two phase leads and frame

ground), is protected by fuses, physically remove the fuses from the area of the ac service panel.

Installing DC Power Cables

Plant bus bars may carry 52 volts dc. Observe **DANGER** warnings in Section 4.

Use Figures 5-1, 5-3, and 5-4 as references for this section.

1. Turn **DC OUTPUT** circuit breaker on rectifier **Off** (down).

2. Measure the lengths of cable required to run the dc output from the rectifier to its termination point on the charge bus, and to run the dc return from the rectifier to its termination point on the charge ground bus.

3. Cut cables to length and install crimp connectors. Use the proper crimping tool and die for the connector to prevent damage to equipment. See Table 5-B.

4. Tape or otherwise insulate the connectors on the end of each cable that does not terminate in the rectifier.

5. Place dc return cable in cable rack.

6. Thread end of cable through right side of rectifier and terminate connector at the appropriate ground bus bar in the rectifier. The ground bus bar is positive for negative output voltage plants, and negative for positive output voltage plants. Torque connection to 120 in-lb. See Figure 5-4.

7. Remove tape or insulation from connector at other end of cable and terminate on plant charge ground bus bar.

8. Place dc output cable in cable rack.

9. Thread end of output cable through right side of rectifier and terminate connector on **CBA1** circuit breaker in rectifier. Torque to 260 in-lb. See Figure 5-4.

10. Remove tape or insulation from connector at other end of output cable, and terminate connector on (hot) charge bus bar.

Warning

Avoid arc or sparks. Before making contact between connectors and the output bus bar in the next step, use a DMM to verify a true open circuit between connector and known battery plant ground.

Installing Plant Control Cable Assembly for a Lucent Technologies Controller

The Plant Control Cable Assembly has a 24-pin or 16-pin connector on one end and a 40-pin connector on the other end. The 24-pin or 16-pin end terminates on the battery plant controller and the 40-pin end terminates on connector **P2A** of the **CM2** control board located in the rectifier (see Figure 5-3).

1. Route the plant control cable from the controller chassis via the cable racks to the rectifier, then through the opening provided for this cable (see Figure 5-1).

2. Terminate the 40-pin connector on **P2A** of **CM2** and dress cable (using strain relief bushings and cable ties provided) inside rectifier allowing for the door to be opened and closed without putting stress on the cable. After securing the cable, disconnect the cable from **P2A**.

3. Determine the number to be assigned the rectifier in the rectifier lineup, that is, 1, 2, 3, etc.

4. If the controller is an MCS, cut leads TP3 and TP0 (pin numbers 18 and 21) in the controller end of the control cable (see your controller manual). This signals to an MCS that the rectifier is a 125A.

5. The next action depends on the type of plant:

   - For connection to a Galaxy controller, remove the plastic cover on the back of the bay housing the controller. The back of the controller has positions for up to three RIMs (Rectifier Interface Modules) in positions A (G1 to G8), B (G9 to G16), and C (G17 to G24). The RIM required for use with the J85502A-1 rectifier will be the MCS-compatible style, with eight positions of 24-pin jacks and a metal retaining clip.

   - For Microprocessor Controlled System (MCS) plants or Conventional Controlled System (CCS) plants, remove the plastic covers on the back of the bay housing the

controller. The back of the controller has sixteen 24-pin connectors labeled **Rect 1** through **Rect 16**.

- For Expandable Controlled System (XCS) plants, open the front panel and thread the control cable through the hole in the wall of the controller. There are six 16-pin connectors labeled **Rect 1** through **Rect 6**.

- For Evolutionary Control System (ECS) 6U plants, open the front panel and thread the control cable through the slot inside the controller. On the backplane of the lower panel on the controller there are six 40-pin connectors labeled **Rect 1** through **Rect 6**.

Warning

Remove the **REG** fuse associated with the rectifier from the controller.

6. Plug the cable into the connector assigned to the rectifier number determined in Step 4 above. This action will cause a minor alarm in an MCS controller. For a Galaxy controller, the rectifier position used must be programmed per instructions found in the Galaxy controller product manual.

7. Dress and tie down the cable to provide stress relief at the connector.

The rectifier is now installed. The last three sections in this chapter are optional procedures that may be needed at installation. If not, proceed to Section 6, “Testing.”

Converting AC Voltage (Optional)

Converting the ac input voltage to a rectifier is necessary only if the ac wiring is incorrect in the unit or if rectifiers are moved and the input ac voltage is different. Refer to Figure 5-2 during this procedure.

DANGER

This procedure MUST be performed ONLY on a rectifier that is completely disconnected from the battery and plant bus AND with ac power disconnected at the ac service panel.

Note

The clear plastic shield in front of **TB1** must be removed by loosening the two mounting screws.

The J85502C-1 rectifier has a simple 208/240 Vac conversion procedure. No internal wiring changes are required for the conversion. A movable tab slides up or down when the two mounting screws of **TB1** are loosened approximately two or three turns, not enough to dismount **TB1**.

When you loosen the mounting screws and slide the movable tab down so that it covers the 208 marking, the tab blocks entry to the 208 Vac hole on the ac input side of **TB1**. The lower drawing in Figure 5-2 shows the tab in this position that is correct for 240 Vac input to the rectifier.

When you slide the movable tab to the position shown in the upper drawing of Figure 5-2, it covers the 240 marking and blocks entry to the 240 Vac hole on the ac input side of **TB1**. Now the 208 marking shows, indicating that the rectifier is set for 208 Vac input to the rectifier.

When the tab is set to the desired position, connect the ac lead to the unblocked screws, 208 or 240. Put on the flat washer, lockwasher, and nut. Torque to 25 in-lbs. The “green” ac ground wire goes to the **FR GRD/AC EG** point. Retighten the **TB1** mounting screws when finished and replace the clear plastic shield.

Converting DC Output Polarity (Optional)

This section gives conversion procedures for the dc output polarity of the Lineage® 2000 J85502C-1 24-volt rectifier. Polarity is determined by the electrical placement of the output circuit breaker and may be changed in the field. The following steps convert the rectifier from **negative output (positive ground) to positive output (negative ground)**.

DANGER

This procedure MUST be performed ONLY on a rectifier that is completely disconnected from the battery and plant bus AND with ac power disconnected at the ac service panel.

In Figure 5-4, rectifier wiring appears as in the left drawing before the work is started, and appears as in the right drawing

upon completion of the work. Before conversion, remove the label/shield plate at the bottom of **CBA1**.

1. Disconnect lead X, coming from the top of **CBA1**, from point A. Its terminal should be the topmost of the two terminals connected to point A. Replace the nut and tighten down on the remaining terminal.

2. Remove the nut from the stud at point B, left side of rectifier shunt (**R3**), and retain it for Step 3.

3. Place the terminal of lead X, removed in Step 1, on the stud at point A. Replace and tighten the nut.

4. Disconnect lead Y from point C and retain the nut for Step 5.

5. Place the terminal of lead Y on the stud at point D. Install the nut on the connection and tighten.

6. Swap the NEG and POS flags on the two dc output cables. Also, add List B marking on the inside of the door.

7. The bus bar cable connections should now appear as in the right drawing in Figure 5-4. Install the label/shield plate at the bottom of **CBA1**.

To convert from **negative ground to positive ground**, reverse the work (X and Y connections) in the procedure above. Do not forget to swap the POS and NEG flags on the dc output cables and remove any List B markings. When the work is finished, the bus bar connections should appear as in the left drawing of Figure 5-4.

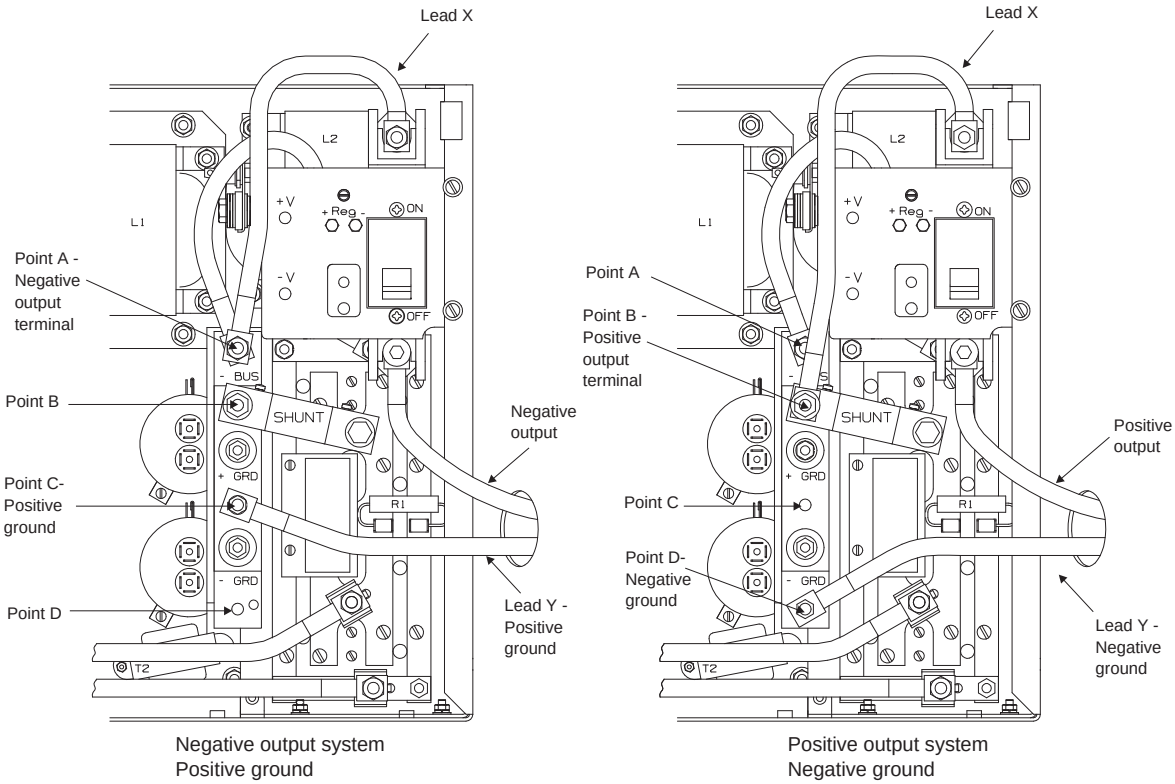


Figure 5-4: Output Polarity Conversion and Bus Bar Assembly of J85502C-1 Rectifier

Initial Battery Charging (Optional)

Initial battery charging should be planned as part of the plant installation. If initial battery charging is desired with the current rectifier installation, **the rectifier should be tested before following this procedure (see Section 6, "Testing")**.

The J85502C-1 rectifier is capable of supplying a new battery string with its initial charge. Since the voltage levels recommended by battery manufacturers for initial battery charging are considerably above the normal plant voltage, neither the battery nor the rectifier used to supply its initial charge should be connected to the rest of the plant during this procedure. One rectifier should be sufficient to supply the charge. However, the high voltage shutdown levels must be raised to accomplish the initial charge. The following procedure describes how to raise the high voltage shutdown levels.

1. Set the ac supply and rectifier controls as shown in Table 5-C.

Table 5-C: Rectifier Control Settings for Initial Battery Charge

Controls	Position/Status
Rectifier **POWER** switch	**Off** (down)
Rectifier **DC OUTPUT** circuit breaker	**Off** (down)
OUTPUT VOLTS ADJ potentiomneter	Fully counterclockwise
Plant control connector **J2A** on **CM2** control board mounted on inside of door	Disconnected from **P2A** on **CM2**

2. Move the strap P14 and the straps provided for options "Q" and "T" on the **CM1** option board from normal position to initial charge position as shown in Figure 6-2.

Warning

Do not remove the ZJ option strap on the **CM1** option board when the rectifier is equipped with a 205A1 control board.

3. At the ac service panel supplying power to the rectifier, insert the input fuses assigned to the rectifier or turn the circuit breaker **On**.

4. Close the rectifier door and turn the **POWER** switch **On**. The green Power LED must light. (If not, do not attempt to turn **On** the circuit breaker. Troubleshoot the problem per Section 7.) Wait 10 seconds.

Note

If the rectifier continues to operate, proceed to Step 5. If the rectifier shuts down due to initial high voltage, monitor the **RECT V** voltage. When this reading reaches 26 volts for 24-volt plants, or 52 volts for 48-volt plants, turn **On** the circuit breaker. If the rectifier shuts down for any other reason, such as component failure, see Section 7, *Troubleshooting and Adjustments*.

5. Hold the meter selector switch in the **RECT V** position, and use a small screwdriver to turn the **OUTPUT VOLTS ADJ** potentiometer clockwise until the digital meter reads approximately battery voltage, typically 26 volts for 24-volt plants or 52 volts for 48-volt plants.

6. Turn the **DC OUTPUT** circuit breaker **On** (up).

Warning

In the following step, DO NOT set the rectifier output voltage to exceed 62 volts (48-volt rectifier) or 31 volts (24-volt rectifier) or damage to the unit may result.

7. Adjust the **OUTPUT VOLTS ADJ** potentiometer to obtain the desired initial charge voltage within the limits specified in the preceding caution.

8. After completing the initial charge, turn the rectifier **POWER** switch **Off** and the **DC OUTPUT** circuit breaker **Off** (down).

9. If the rectifier has List WB (external high voltage shutdown option), leave straps Q and T on CM1 in the charge position (pins 1 and 2). If the rectifier is not equipped with List WB, place Q and T in the normal position (pins 2 and 3). Always move P14 back to its normal pin 1-2 position when the initial charge is completed.

10. Turn the **OUTPUT VOLTS ADJ** potentiometer fully counterclockwise.

11. To restore the rectifier to service, follow the procedure in Section 7 entitled “Restoring a Rectifier to Service.”

6 Testing

Introduction

This section gives test procedures for newly installed and/or operating rectifiers. If the plant in which a rectifier is being installed has never been operational, the plant and controller tests must be performed before the rectifier tests. Consult the plant and controller product manuals for their installation test procedures.

Rectifiers can be tested on or off line. “On line” means a battery string and/or office load is connected to the rectifier. A dummy test load and a Battery Plant Simulator Test Set are required for testing off line. See “Tools and Test Equipment” in this section for a description of these items. For troubleshooting and diagnostic procedures, see “Diagnostics and Troubleshooting” in Section 7. Those unfamiliar with the function of rectifier controls and indicators should read “Front Panel Controls and Indicators” in Section 2.

Precautions

When working on power systems, observe the safety precautions described in Section 4 and those within each procedure.

- The ac input voltage powers certain control relays, the Rectifier Failure Alarm (**RFA**), and the ac contactor. Voltage is available to these circuits whenever the ac service is available to the rectifier.

- See Figure 5-4. Verify that the cables are connected correctly for the desired output. Rectifiers that deliver -48Vdc output require **positive** ground. Verify that the dc output circuit breaker is open (off). For more complete discussion of related issues, see “Converting DC Output Polarity (Optional)” in Section 5.

- Remote sensing of rectifier output occurs via the plant control cable connected **P2A** on control board **CM2**. This cable must be disconnected when internal sensing is desired, as when testing off line, using a test load.

Warning

Do not turn the **DC Output** circuit breaker **On**, close an external charge circuit breaker, or install an external charge fuse until told to do so.

Tools and Test Equipment

The following items are needed for testing the rectifier.

- DMM (Digital Multimeter) Fluke 8060A or equivalent meter having 0.02 percent accuracy on dc scale
- Battery Plant Simulator Test Set, customer constructed, or equivalent (see Figure 6-1)
- DC dummy test load, 26-volt (24-volt rectifier) or 52-volt (48-volt rectifier) with adjustment to provide a load of 150 amperes, 120 percent of the rectifier's rating
- Jeweler's screwdriver for adjusting potentiometers
- Straightened paper clip inserted in eraser of wooden pencil

Battery Plant Simulator Test Set

The Battery Plant Simulator Test Set is a convenient tool used to isolate communication troubles between the plant controller and the rectifier. It simulates the plant controller relative to receiving signals from, and sending signals to, the rectifier. If there is a problem and the rectifier works properly with the test set, the problem is either at the controller or in the interface wiring (plant cable). Figure 6-1 shows how to construct a test set and cable.

Test Load Connection

The following procedures are used to connect a test load when called for in a test or other procedure. Refer to the rectifier control panel in Figure 2-1. Test load connections are made on the internal bus of the rectifier. Therefore, to isolate the rectifier from the batteries and plant bus, the rectifier **DC OUTPUT** circuit breaker must be left open (**Off**) while the test load is connected.

1. At the ac service panel, remove ac power to the rectifier.

2. Turn **Off** (down) the rectifier **DC OUTPUT** circuit breaker.

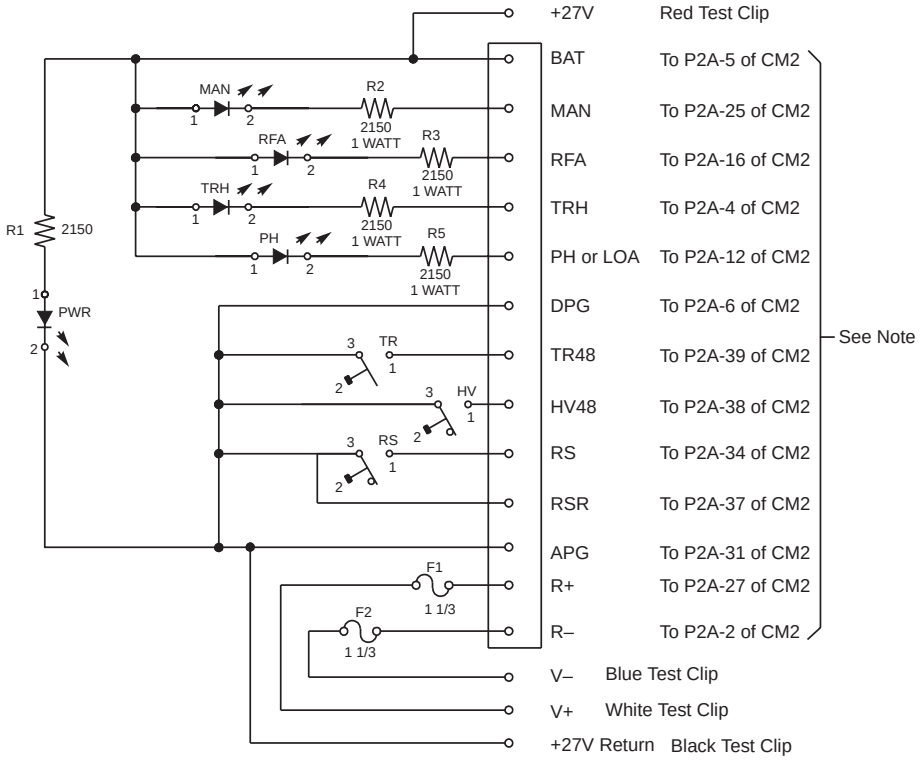
Caution

Support the **CM2** control board when disconnecting the cable leads or damage to the control board may result.

Do NOT disconnect plant control cable connector **J2A** from control board **CM2** by pulling the cable.

3. Disconnect J2A from CM2 by unlatching first, then pulling the cable connector.

4. Refer to Figure 5-4 and connect the test load between the + and – output buses marked on the rectifier.



Note:
Use 24 AWG multiconducting wire and 40-pin female connector from Amp, Inc., Harrisburg, PA. Cable will then plug into **P2A** connector on **CM2** board. For example, the wire coming from PH, shown above, must be terminated on pin 12 of the new connector, and RS on pin 34, etc. The suggested Amp hardware part numbers are:

1-102398-8 (housing)
1-102537-8 (cover)
1-102536-8 (cover)

For the remaining 4 extension wires outside the brace, terminate in miniature alligator clips color coded as shown.

Figure 6-1: Battery Plant Simulator Test Set

Preparation for Testing Off Line

The following steps establish initial conditions for the equipment before testing.

1. Verify that the ac supply and rectifier controls are as shown in Table 6-A.

Table 6-A: Rectifier Control Settings for Testing Off Line

Controls	Position/Status
Associated ac circuit breaker or fuses at the ac service panel	**Off** or fuses removed and holders tagged “Out of Service”
Rectifier **POWER** switch	**Off** (down)

Table 6-A: Rectifier Control Settings for Testing Off Line

Controls	Position/Status
Rectifier **DC OUTPUT** circuit breaker	**Off** (down)
OUTPUT VOLTS ADJ potentiometer	Fully counterclockwise (20 turns to stop)
Connector J2A on plant control cable	Disconnected from P2A on CM2

2. Use the documentation for the particular battery plant to perform all the preliminary checks on the plant prior to the rectifier tests. If the rectifier is in a microprocessor-controlled plant with an efficiency algorithm feature, disable this feature. (See the controller product manual for instructions.)

3. Using the digital multimeter (DMM) on the dc volts scale, make the following checks:

   a. Before the **REG** fuse is installed in the plant controller, verify that battery voltage is **not** present between the rectifier output charge terminal and dc output return (see Figure 5-4).

   b. Install the regulation (**REG**) fuse associated with the rectifier in the plant controller.

   c. Check for battery voltage between pins 27 and 2 of control cable connector **J2A**. The **J2A** connector is at the rectifier end of the plant control cable. Pin 27 should be positive with respect to pin 2.

Note

On **J2A**, pins 1, 5, 10, 15, and 20 are marked on the connector. Pin 21 is in the row across from pin 1. Pin 40 is across from pin 20.

   d. As an extra precaution, check for battery voltage between ground and pin 2 (negative plant) or pin 27 (positive plant). If no voltage exists, there is a wiring problem associated with the control cable or controller. The problem must be found and repaired before proceeding with testing.

e. With the BAT fuse installed in the plant controller, check for battery voltage between pin 5 of **J2A** and ground.

f. If the plant is equipped with a MCS Controller, again on **J2A**, check for 15-20 volts dc between pins 35 and 31. Pin 35 should be positive with respect to pin 31.

4. Place the Battery Plant Simulator Test Set (Figure 6-1), at a convenient location near the rectifier. Connect **J2A**, on the other end of the cable from the test set, to connector **P2A** on the **CM2** control board mounted on the inside of the rectifier door. Connect the red, black, blue, and white test clips from the test set to the **CM1** and **CM2** boards in the rectifier as detailed in Table 6-B. Refer to Figures 6-2 and 6-3.

Table 6-B: Test Set Connections

Test Clip	Connection	Figure No.	Voltage
Red	Positive side of capacitor **C1** on **CM2** (205A or 205A1) board	6-3	+27
Black	Negative side of capacitor **C1** on **CM2** (205A or 205A1) board	6-3	GRD
Blue	Test point E8 on CM1 (ED-83158-30) board	6-2	–V
White	Test point **E3** on **CM1** (ED-83158-30) board	6-2	+V

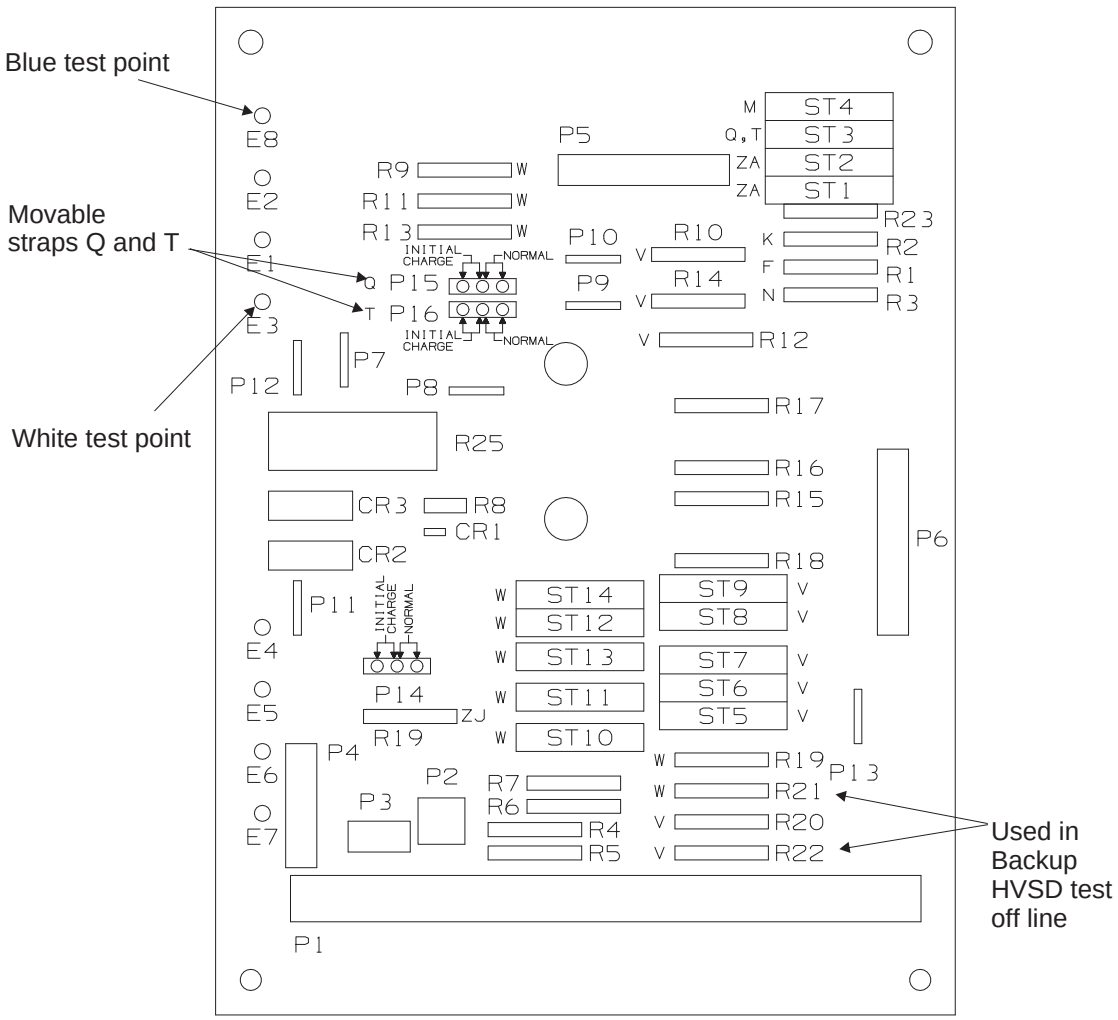


Figure 6-2: CM1 Option Board Showing Test Clip Connections and Movable Straps

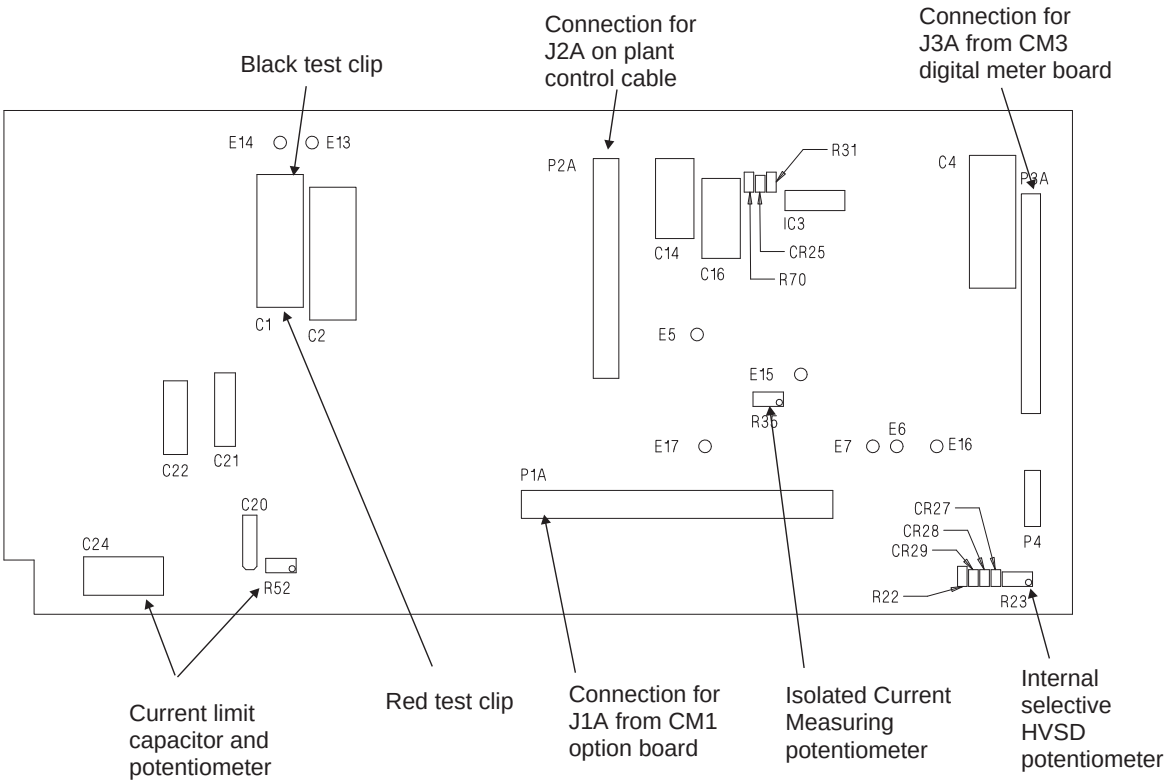


Figure 6-3: CM2 Control Board Showing Test Clip Connections and Other Component Detail

Testing Off Line

The following tests involve use of the test load and a Battery Plant Simulator Test Set. Refer to the section entitled "Test Load Connection" for the procedure to connect a test load and to the "Initial Conditions for Testing Off Line" section for a Battery Plant Simulator Test Set.

If the rectifier fails any of the following tests, replace the CM2 control board (see "Replacing CM2 Control Board" in Section 8) **and begin testing again:**

- Regulation (NL/FL) Test (Off Line)
- Rectifier Failure Alarm/Fuse Alarm Test (Off Line)
- Current Limit Test (Off Line)
- Backup High Voltage Shutdown (HVSD) Test (Off Line)
- Control (TR) Test
- Selective High Voltage Shutdown (SHVSD) and Restart

Startup

1. Turn **On** the ac supply to the rectifier. The PWR lamp on the test set should light brightly. If it does not light properly, check the connection of the two small red and black clip leads. They may be reversed or otherwise incorrectly connected. These leads provide the operating voltages in the test set, and the red lead should be approximately +27 volts dc with respect to the black lead.
2. The PWR lamp should remain lit during the remaining tests as long as the ac supply is turned on.
3. Set the test meter to the 100 volts range, and connect it to the **REG** jacks on the bracket of **CBA1**. These jacks are the same as on the rectifier control panel when the door is closed (see Figure 2-1).
4. Adjust the test load so that when the rectifier is turned **On**, it will deliver 6-25A, 5 to 20 percent of full load.
5. Turn the **POWER** switch **On**. The rectifier should start. The test meter should indicate 20-25 volts (24-volt rectifier) or 40-50 volts (48-volt rectifier). The MAN lamp

on the test set should light and remain lit as long as the rectifier is turned **On**.

Regulation (NL/FL) Test (Off Line)

1. Hold the meter selector switch in the **RECT V** position. Watch the test meter and move the **RECT TEST** switch to **NL**. In the **NL** position, the voltage should drop between 0.3 and 0.6 volt.

2. Repeat Step 1 with the **RECT TEST** switch in the **FL** position. The voltage should increase between 0.1 and 0.4 volt.

Rectifier Failure Alarm/Fuse Alarm Test (Off Line)

1. Insert a piece of bare wire or the end of a paper clip into a pencil eraser. Holding the pencil, insert the wire next to the alarm indicator of the **+V** fuse on the control panel. Note that the rectifier shuts down and the **RFA** lamps on the control panel and test set light. The **FA** LED on the control panel should also light.

2. Turn the **POWER** switch **Off**, then back **On**. The **RFA** light should go off.

3. Repeat Steps 1 and 2 at the **-V** fuse.

Current Limit Test (Off Line)

Read the following notes before proceeding.

Notes

Adjust the current limit only after verifying that a current limit problem exists. V_{out} is the voltage reading between the rectifier output terminal and return, see Figure 5-4.

1. Connect the test meter to the input conductor at the top of **CBA1** and the rectifier ground bus.

2. Strap a short across capacitor **C24** on **CM2**, see Figure 6-3.

3. At I_{load} = 125-126A, 100 to 101 percent of rated output current, use the **OUTPUT VOLTS ADJ** potentiometer to adjust V_{out} to

52.08 volts (48-volt rectifier)
26.04 volts (24-volt rectifier)

4. Remove strap from capacitor **C24** on **CM2**. Observe that V_{out} is

   51.98 - 52.03 volts (48-volt rectifier)
   25.99 - 26.01 volts (24-volt rectifier)

   If not, see "Adjust Current Limit" in Section 7.

5. Increase the load to 136-139A, 110 ± 1 percent. V_{out} should be below

   51.58 volts (48-volt rectifier)
   25.79 volts (24-volt rectifier)

   If not, see "Adjust Current Limit" in Section 7.

6. Decrease the load to 120-123A, 96 to 98 percent of the rectifier rating. Observe that V_{out} is greater than

   52.03 volts (48-volt rectifier)
   26.01 volts (24-volt rectifier)

Backup High Voltage Shutdown (HVSD) Test (Off Line)

1. If the **DC OUTPUT** circuit breaker is On, turn it Off (down).
2. Disable the internal selective shutdown by moving the Q (**P15**) or T (**P16**) movable straps on **CM1** to the Charge position. (See Figure 6-2 and refer to Table 8-B for options.) Verify that moveable strap P14 remains in the 2-3 (NOT the Charge) position for this test and after the rectifier is placed into service. The P14 Charge position is only used to raise the Backup HVSD level of the rectifier when it is being used for applying the initial charge to connected batteries.
3. Slowly turn the **OUTPUT VOLTS ADJ** potentiometer clockwise until the rectifier shuts down. This should occur between 32.25 and 33.50 volts (24-volt rectifier) or between 63 and 66 volts (48-volt rectifier). The **RFA** on the rectifier and the RFA on the test set should light.
4. Turn the **OUTPUT VOLTS ADJ** potentiometer counterclockwise.

Note

To increase the upper range of the voltage adjustment, do one or both of the following:

- Temporarily open the R– lead on the test box. (The lead goes to **P2A**-2 on **CM2**.)
- Short resistor **R22** (24-volt version) or **R21** (48-volt version) on the **CM1** board.

When this step is completed restore the original conditions to straps Q and T and restore **R21** or **R22**.

5. Restart the rectifier using the RS switch on the test set.
6. Adjust the voltage to approximately 26.0 volts (24-volt rectifier) or 52.0 volts (48-volt rectifier). The **RFA** lamps on the rectifier and the test set should go out.

Control (TR) Test

1. Press and hold the transfer rectifier (TR) switch on the test set for 5 seconds. The rectifier should turn off simulating a remote shutdown from the controller. The **POWER ON** light should go off. The digital meter on the rectifier should go off, and the TRH lamp on the test set should light.
2. Release the switch. The rectifier should restart and the TRH lamp should go out.
3. Press the HV switch on the test set. The rectifier should continue to operate.

Selective High Voltage Shutdown (SHVSD) and Restart

1. Adjust the test load so that the rectifier delivers 12-19A, 10 to 15 percent of its rated amperage.
2. Momentarily press the HV switch on the test set. The rectifier should shut down and the **RFA** lamps on the rectifier and the test set should light.
3. Momentarily press the RS switch on the test set. The rectifier should restart and both **RFA** lamps should go off.

Meter Calibration Test (Off Line)

1. Connect the test meter between the input conductor (top) of **CBA1** (see Figure 5-4) and the rectifier ground bus.

2. On the rectifier, hold the meter selector switch in the **Rect V** position. The digital display should agree with the test meter within 0.02 volt for Series 3 **CM3** boards or within 0.5 volt for Series 1 or 2 **CM3** boards.

3. Hold the meter selector switch in the **BATT V** position. The digital display should agree with the test meter within 0.01 volt. If the display and test meter do not agree, the 207A digital meter board needs adjustment (see "Calibrate CM3 Digital Meter" in Section 7).

Float Equalize Setup and Test - Optional (Off Line)

The float equalize feature of the J85502C-1 rectifier provides a battery charge that is higher than float voltage in order to return the batteries to the correct voltage faster than they would otherwise recover after a power outage. To equalize the battery charge in this manner, your plant controller must support the float equalize feature, and your battery manufacturer must provide an equalize procedure for your plant batteries.

The Lineage® 2000 MCS and other controllers with certain options, support the float equalize feature. Ask whether your battery manufacturer recommends the equalize battery charge for your batteries, and if so, for a procedure. If your plant meets both these requirements, proceed with the following setup and test.

1. Adjust the test load so that the rectifier delivers 20-30A.

2. Turn the rectifier **POWER** switch **Off**.

3. On the **CM2** control board, short test points **E16** and **E17** using a clip lead.

4. Turn the **POWER** switch **On**. The float **Equalize** LED should light.

5. Using the **EQUAL ADJ** potentiometer on the control panel, set the voltage per the battery/load requirement.

6. Hold the meter selector switch in the **RECT V** position and observe whether the meter reading agrees with the

equalize voltage you just established. If not, use the **EQUAL ADJ** potentiometer to correct the voltage.

7. Turn the **POWER** switch **Off**.

8. Remove strap on test points **E16** and **E17**.

9. Turn the **POWER** switch **On**. The **EQUALIZE** LED should be off and voltage should be at float.

Test for 434A or 434B Circuit Module

1. Turn the rectifier **On/Off** switch to **On**. Adjust the load about 20-30% of rectifier rated current capacity. The green LED should be on.

2. Using the clip lead, momentarily short E1 and E14 (+12V). The rectifier should shut down, and the red **RFA** LED should be on.

3. Restart the rectifier by cycling the front **On/Off** switch.

4. Using a clip lead, momentarily short E3 and E14 (-12V). The rectifier should shut down, and the red **RFA** LED should be on.

5. Restart the rectifier by cycling the front **On/Off** switch.

Off-Line Test Completion

1. Reduce load so the rectifier delivers 25-38A, 20-30% of its rated current.

2. Adjust the **OUTPUT VOLTS ADJ** potentiometer to between 52.02 and 52.13 (or 26.01 and 26.06) volts read on the **OUTPUT** meter, or to float voltage as determined in “Adjusting Rectifiers to Float Voltage” in this section.

3. Turn the **POWER** switch **Off**.

4. Reduce the load to zero.

5. Turn **Off** the ac power at the ac service panel.

6. Disconnect and remove the Battery Plant Simulator Test Set, the DMM (Digital Multimeter), and the test load.

7. If the reason for performing the rectifier tests was to affirm the operation of the rectifier, and was not part of total plant testing, restore the rectifier to service by following the procedures in "Restoring a Rectifier to Service" in Section 7. If this is part of total plant testing, leave the plant control cable disconnected at this time, until directed to reconnect it as part of another plant procedure.

Bringing the Rectifier On Line

The following steps bring the rectifier into service in preparation for testing on line. The term "on line" means a battery string and/or office load is connected to the rectifier.

Perform all the preliminary checks on the plant before testing the rectifiers. The same precautions for personal safety and equipment protection should be taken as when testing off line (see "Precautions" in this section).

1. Verify the ac supply and rectifier controls are as shown in Table 6-C.

Table 6-C: Rectifier Control Settings Prior to Testing On Line

Controls	Position/Status
Associated ac circuit breaker or fuses at the ac service distribution panel	**Off** or fuses removed and holders tagged "Out of Service"
Rectifier **POWER** switch	**Off** (down)
Rectifier **DC OUTPUT** circuit breaker	**Off** (down)
OUTPUT VOLTS ADJ potentiometer	Fully Counterclockwise
Associated **REG** fuse in plant controller	Removed

2. If the rectifier is in a microprocessor-controlled plant with an efficiency algorithm feature, disable this feature. (See the controller product manual for instructions.)

3. At the ac service panel supplying power to the rectifier, insert the input fuses assigned to the rectifier or turn the circuit breaker **On**.

Warning

DO NOT turn **On** the **DC OUTPUT** circuit breaker without first turning the rectifier **On**, then **Off**.

4. To bring the rectifier into service,

   a. Turn the rectifier **POWER** switch **On**. The green Power LED must light. Wait 10 seconds.

Note

If the rectifier continues to operate, proceed to Step b. If the rectifier shuts down due to initial high voltage, monitor the **Rect V** voltage. When this reading reaches 26 volts for 24-volt plants, or 52 volts for 48-volt plants, turn **On** the circuit breaker. If the rectifier shuts down for any other reason, such as component failure, see Section 7, *Troubleshooting and Adjustments*.

   b. Hold the meter selector switch in the **RECT V** position, and use a small screwdriver to turn the **OUTPUT VOLTS ADJ** potentiometer clockwise until the digital meter reads approximately battery voltage, typically 26 volts for 24-volt plants or 52 volts for 48-volt plants.

   c. Turn the **DC OUTPUT** circuit breaker **On** (up).

   d. Turn the **POWER** switch **Off**.

5. For testing with a controller, connect plant control cable **J2A** to **P2A** on **CM2**, then replace **REG** fuse in the controller. For a controllerless application, leave **J2A** disconnected, and replace **REG** fuse in the remote bay.

6. Turn rectifier **POWER** switch **On**.

Testing On Line

On and off-line testing require different procedures, although most tests can be performed in either situation. The Control (TR) and Selective HVSD Tests are omitted from this section because these signals originate in the plant controller or a remote location, and the test procedure depends on that device. (See your controller product manual.) Also, straps on the **CM1** option board must be set for List WB to enable the external selective HVSD. Straps must be set for List WA to enable external sensing. Check **CM1** and Table 8-B or Tables A and R on J-drawing, J85502C-1 if you expect to have these features.

If you have just tested the rectifier off line, it is not necessary to repeat the tests on line.

If the rectifier fails any of the tests in the following sections, replace the CM2 control board (see "Replacing CM2 Control Board" in Section 8) **and begin testing again**.

Regulation (NL/FL) Test (On Line)

Read the following note before proceeding.

Note

At least two rectifiers must be operating when this test is done, and the load requirement must be greater than 12A, 10% of the rated output for the rectifier under test.

1. If the rectifier is delivering less than 12A, turn the **OUTPUT VOLTS ADJ** potentiometer clockwise until it delivers 12A.

2. Observe the amperes reading on the **OUTPUT** meter. Hold the **RECT TEST** switch in the **NL** position. The output amperes should decrease.

3. Repeat from Step 1, and in Step 2 hold the **RECT TEST** switch in the **FL** position. The output current should increase.

Rectifier Failure Alarm/Fuse Alarm Test (On Line)

Read the following notes before proceeding.

Notes

This procedure causes the rectifier to fail. When the procedure is performed on line, sufficient rectifiers must be operating to assume the load of the rectifier being tested.

This test causes the rectifier to issue alarms to the plant controller.

1. Insert a piece of bare wire or the end of a paper clip into a pencil eraser. Holding the pencil, insert the wire next to the alarm indicator of the **+V** fuse inside the door on the control panel. Note that the rectifier shuts down and the **RFA** lamp on the control panel lights.

2. Turn the **POWER** switch **Off**, then back **On**. The **RFA** light should go off.

3. Repeat Steps 1 and 2 at the **-V** fuse.

Current Limit Test (On Line)

Read the following notes before proceeding.

Notes

Adjust the current limit only after verifying that a current limit circuit problem exists.

There must be two or more rectifiers with a plant load of at least 25 percent higher than the capacity of the largest rectifier.

This method applies to a working plant. If the conditions in the following note cannot be met, the unit must be tested off line.

In a working plant, the current limit set point can be found by adjusting the **OUTPUT VOLTS ADJ** potentiometer on the rectifier under test to obtain approximately 3/4 load and a battery voltage of 52.08 volts.

1. Connect a DMM to the **REG** test jacks to verify the battery voltage.

2. Hold the **RECT TEST** switch in the full load (**FL**) position to raise the rectifier output current to current limit. The output current should indicate 125-126A, 100 to 101 percent of the rated output current.

3. If the output current is not within 125-126A, the current limit needs adjustment. See "Adjust Current Limit" in Section 7.

Note

At the rated output current of the rectifier, the shunt voltage is 40 millivolts.

Isolated Current Measuring (VI) Test (MCS or Galaxy Controller)

This procedure checks the isolated current measuring circuit (voltage proportional to current adjustment) on the rectifier's **CM2** control board. The procedure is required only when **CM2** is installed as part of a Lineage® 2000 Battery Plant with an MCS (Microprocessor Controlled System) or Galaxy (Intelligent only) controller and when the output current reading on the rectifier does not agree to within 2.5 percent of the MCS or Galaxy Controller reading. This procedure must be performed

while connected to an MCS or Galaxy controller and a battery.

Refer to Figure 6-3 for components on the **CM2** control board. Plant control cable connector **J2A** MUST be connected to **P2A** on **CM2** for this procedure.

1. Connect a DMM across the rectifier shunt (see Figure 5-4).

2. Increase the load so the rectifier delivers approximately 63A, 50 percent of its rated current capacity.

3. Observe the DMM and record the rectifier's shunt voltage.The shunt is rated $\frac{156.25A}{50mV} = \frac{3.125A}{mV}$, which means that each millivolt of voltage drop across the shunt indicates 3.125A of output current.

4. Convert the DMM's shunt voltage reading to amperes. For example, if the DMM reads 40mV, then $40mV \times \frac{3.125A}{mV} = 125A$ of output current. As this calculation indicates, the rectifier is operating at full load, and the rectifier shunt voltage is 40mV at full load.

5. Compare the amperes calculated in Step 4 with the rectifier drain indication on the MCS or Galaxy Controller.

6. If the rectifier drain indication is between 0 and 2% **higher** than the amperes calculated in Step 4, this procedure is completed.

7. If the rectifier drain indication is between 0 and 2% **lower** than the amperes calculated in Step 4, adjust potentiometer **R35** on **CM2** control board to obtain a rectifier drain reading that is between 0 and 2% higher than the amperes calculated in Step 4.

8. If the rectifier drain indication was not within the limits specified in Steps 5 or 6, the isolated current measuring circuit needs adjustment. See "Adjust Isolated Current Measuring Circuit (VI)" in Section 7.

Backup High Voltage Shutdown (HVSD) Test (On Line)

If the **DC OUTPUT** circuit breaker is **On**, turn it **Off** (down).

1. Disable the internal selective HVSD by moving the Q (**P15**) or T(**P16**) movable straps on **CM1** to the Charge position (see Figure 6-2). Verify that moveable strap P14 remains in the 2-3 (NOT the Charge) position for this test and after the rectifier is placed into service. The P14 Charge position is only used to raise the Backup HVSD level of the rectifier when it is being used for applying the initial charge to connected batteries.

2. Set the DMM to measure 27 or 54 volts, and connect it to the input conductor (top) of **CBA1** and the rectifier ground bus (see Figure 5-4). This bus is the + filter capacitor bus for positive ground plants, and the – filter capacitor bus for negative ground plants.

3. Slowly turn the **OUTPUT VOLTS ADJ** potentiometer clockwise until the rectifier shuts down. This should occur between 29 and 31.25 volts (24-volt rectifier) or between 58 and 62.5 volts (48-volt rectifier). The **RFA** lamp on the rectifier should light.

   To increase the upper range of the voltage adjustment, short resistor **R22** (24-volt version) or **R21** (48-volt version) on the **CM1** board.

   When this step is completed, restore **R21** or **R22**. If the rectifier has List WB (external HVSD option), leave straps Q and T on **CM1**, in the charge position, pins 1 and 2. If the rectifier is not equipped with List WB, place Q and T in the normal position, pins 2 and 3.

4. Turn the **OUTPUT VOLTS ADJ** potentiometer counterclockwise.

5. Restart the rectifier by turning the **POWER** switch **Off** then back **On**.

6. Adjust the voltage to approximately 26.0 volts (24-volt rectifier) or 52.0 volts (48-volt rectifier). The **RFA** lamp on the rectifier should go out.

Meter Calibration Test (On Line)

Check calibration of the digital meter annually as preventive maintenance.

1. Verify the conditions shown in Table 6-D.

Table 6-D: Controls for Meter Calibration Test On Line

Controls	Position/Status
Rectifier **REG** test jacks	Connected to DMM (Digital Multimeter)
Rectifier **POWER** switch	**On** (up)
Rectifier must be connected to battery. Rectifier DC output circuit breaker	**On** (up)
Plant control connector J2A on CM2 control mounted on inside of door	Connected to P2A on CM2

2. Hold the meter selector switch in the **BATT V** position. Observe and record the voltage readings on the DMM and the rectifier **OUTPUT** meter.

3. If the rectifier **OUTPUT** meter is not within 0.02 volts of the reading on the DMM, refer to "Calibrate CM3 Digital Meter" in Section 7 to calibrate the **OUTPUT** meter.

4. Connect the DMM to the rectifier output terminal and ground, see Figure 5-4.

5. Hold the meter selector switch in the **RECT V** position. Observe and record the voltage readings on the DMM and the **OUTPUT** meter.

6. The **OUTPUT** meter reading should agree with the test meter within 0.02 volt for Series 3 **CM3** boards or within 0.5 for Series 1 and 2 **CM3** boards. If the reading is not within these limits, refer to "Calibrate CM3 Digital Meter" in Section 7 to calibrate the **CM3** digital meter and repeat this procedure from Step 1.

Note

Series 3 **CM3** boards can be identified by the designation "AM3" (or greater than 3) which is stamped on the wiring (noncomponent) side of the board. A partial sketch of the **CM3** boards is provided in Figure 7-2.

7. If the rectifier meter cannot be calibrated, replace the rectifier **CM3** digital meter board per "Replacing CM3 Digital Meter Board" in Section 8 and repeat this procedure from Step 1.

8. Disconnect the DMM from the rectifier.

Float Equalize Test - Optional (On Line)

If you have previously set the equalize voltage per "Float Equalize Setup and Test–Optional (Off Line)" in this section, proceed with the following test. If you have not previously set the equalize voltage, you must do so before testing the controller/rectifier equalize circuit.

1. At the controller, raise the external selective high voltage shutdown (ESHVSD) level by the amount the equalize voltage exceeds float voltage. (See you plant controller product manual for instructions.) Example: If equalize voltage is 2 volts above float voltage, raise the ESHVSD level by 2 volts. (Normally ESHVSD is .5 volt above float for 24-volt rectifiers and 1 volt above float for 48-volt rectifiers.)

2. Put the plant controller in Equalize mode. (Consult your controller manual.)

3. Hold the meter selector switch on the rectifier in the **RECT V** position, and observe whether the meter reading agrees with the equalize voltage you established. If not, use the **EQUAL ADJ** potentiometer to correct the voltage.

4. Return the controller to Float mode. (Consult your controller product manual.)

Adjusting Rectifiers to Float Voltage

Float voltage is the optimum voltage level at which a battery string gives maximum life and full capacity. This voltage depends on the type and number of batteries in a plant.

Float voltage per cell x number of cells = battery string float voltage

Traditionally, 2.17 volts per cell is the float voltage for flooded lead-acid batteries such as the Round Cell. For a 24-cell configuration of Round Cells, string voltage is

2.17 x 24 = 52.08 volts

Traditionally, 2.27 volts per cell is the float voltage for starved electrolyte batteries such as VR cells. For a 12-cell configuration of VR cells, string voltage is

$$2.27 \times 12 = 27.24 \text{ volts}$$

To adjust rectifiers to the pre-determined float voltage, the rectifiers must be on line with plant cables connected and **REG** fuses installed in the plant controller or a remote bay.

Adjusting Rectifiers Individually

The fastest way to adjust a group of rectifiers to float voltage is to adjust them individually, turning each one **Off** after adjustment, and turning them all **On** after the last adjustment. In order to use this method, however, the load requirement at the time of the adjustments must be **less than** the capacity of the smallest rectifier.

1. Measure the battery voltage by holding the meter selector switch in the **BATT V** position.
2. If the battery voltage is not the pre-determined float voltage or the desired battery float voltage, perform the following:
   a. If the voltage is too high, turn the **OUTPUT VOLTS ADJ** potentiometer counterclockwise.
   b. If the voltage is too low, turn the **OUTPUT VOLTS ADJ** potentiometer clockwise.
   c. Check the battery voltage and repeat Steps a and b above until the battery voltage is within the required tolerance of the desired float voltage.
3. Turn the rectifier **Off** and repeat this procedure for each rectifier in the group.
4. Turn all rectifiers **On** after the last rectifier is adjusted.

Adjusting Rectifiers as a Group

If the load requirement is always **greater than** the capacity of the smallest rectifier, adjust the rectifiers to float voltage using the following procedure. Rectifiers must be on line with plant cables connected and **REG** fuses installed in the plant controller or a remote bay.

1. Measure the battery voltage by holding the meter selector switch in the **BATT V** position.

2. If the battery voltage is not the pre-determined float voltage or the desired battery float voltage, perform the following:

    a. If the voltage is too high, turn the **OUTPUT VOLTS ADJ** potentiometer counterclockwise on the rectifier with the highest output current.

    b. If the voltage is too low, turn the **OUTPUT VOLTS ADJ** potentiometer clockwise on the rectifier with the lowest output current.

    c. Check the battery voltage and repeat Steps a and b above until the battery voltage is within the required tolerance of the desired float voltage.

3. If all rectifiers are not carrying some load current (between 5 percent and 95 percent of rated load):

Note

Rectifiers are not required to share load current equally.

    a. Turn **Off** all spare rectifiers, but leave enough rectifiers **On** to handle the load current.

    b. Turn up (clockwise) the **OUTPUT VOLTS ADJ** potentiometer on rectifiers carrying less than 5 percent rated load till they carry more than 5 percent rated load, and

    c. Turn down (counterclockwise) the **OUTPUT VOLTS ADJ** potentiometer on rectifiers carrying more than 95 percent rated load until they carry less than 95 percent rated load.

    d. Repeat from Step 2 (battery voltage check and adjustment) until all rectifiers are carrying between 5 and 95 percent rated load and the battery voltage is within the required tolerance of the desired float voltage.

    e. Turn **On** one of the spare rectifiers, and turn **Off** one of the previously loaded rectifiers (same number of rectifiers **On**).

    f. Repeat Steps b through d.

g. Repeat for each rectifier that has not been adjusted.

h. Upon completion, turn all rectifiers **On**.

7 Troubleshooting and Adjustments

Introduction

This section provides troubleshooting information and adjustment procedures for the Lineage® 2000 J85502C-1 rectifier. Whenever working on or near electrically live equipment, observe all safety precautions given in "Safety Precautions" in Section 4 and within each procedure.

For tools and test equipment required for certain adjustments, refer to "Tools and Test Equipment" in Section 6. For technical assistance at any time, call Lucent Technologies at 1-800-CAL-RTAC (1-800-225-7822).

Removing a Rectifier from Service

In general, adjustments should be made to a rectifier while it is removed from service. If a problem is suspected with a rectifier, find the problem in Table 7-A. Then follow this procedure for removing the rectifier from service before making the adjustments.

1. Observe and record the rectifier output voltage.
2. Turn the rectifier **POWER** switch **Off**.
3. Turn the rectifier **DC OUTPUT** circuit breaker **Off** (down).
4. At the ac service panel supplying power to the rectifier, remove the input fuses assigned to the rectifier or turn the circuit breaker **Off**.

5. At the plant controller, remove the **REG** fuse associated with the rectifier.

6. At the rectifier, loosen the locking screws and open the door.

7. Locate the **CM2** control board.

Caution

The **REG** fuse associated with the rectifier in the plant controller must be removed before cable connector **J2A** is disconnected or damage to the rectifier circuit pack may result. Support the **CM2** control board with your hands when disconnecting the cable leads or damage to the control board may result. Do NOT disconnect plant control cable connector **J2A** from control board **CM2** by pulling the cable.

8. Disconnect **J2A** from **CM2** by unlatching first, then pulling the cable connector.

9. If the rectifier voltage was NOT at the desired float voltage before it was turned **Off**, rotate the rectifier **OUTPUT VOLTS ADJ** potentiometer fully counterclockwise.

10. At the ac service panel supplying power to the rectifier, insert the input fuses assigned to the rectifier or turn the circuit breaker **On**.

11. Turn the rectifier **POWER** switch **On**, and wait approximately 30 seconds for the voltage to stabilize. The rectifier is now ready to be tested off line.

Diagnostics and Troubleshooting

Table 7-A lists possible problems, causes, and solutions that may occur with the rectifier subsystems. Schematic Drawing, SD-82659-01, referred to in the table, is shipped with the J85502C-1 rectifier.

Table 7-A: Troubleshooting

Problem	Probable Cause	Probable Corrective Action
1. Rectifier will not start. (**J2A** should be disconnected. If not, the controller could be shutting the rectifier down.)	1. No ac input to rectifier. 2. **CM2** board is defective.	1. Check for ac input voltage to rectifier. 2. Check for ac voltage on secondary of **T2**. See SD. 3. Check for +27 Vdc (±5 V) across **C1** on **CM2**. If not present, but ac is present on all secondaries of **T2**, check the connection **P1**/**J1** on **CM1**. If the connection is okay, replace the **CM2** board per "Replacing CM2 Control Board" in Section 8. 4. Check wiring associated with coil of **K1**, and contacts **4-7** of **K2**.
2. Rectifier attempts to start, but **K1** contactor does not operate, (make "clunk" sound) and **RFA** lights.	1. Fuses **F1.1- F1.8, FA1.1-FA1.8,** and/or **+V**, **-V** blown. 2. **CM2** board is defective.	1. Check fuses per "Clear Rectifier Failure Alarm (RFA)" in this section. 2. Measure output voltage while rectifier is powering up. If the output voltage exceeds 29 or 58 volts, the rectifier is shutting down due to high output voltage. See Probable Causes associated with Problem 4.
3. Rectifier goes to high voltage at turn-on.	1. **Output Volts Adj** potentiometer is set too high. 2. **CM2** board is defective. 3. Open triac.	1. Turn potentiometer counterclockwise. 2. Replace **CM2** per "Replacing CM2 Control Board" in Section 8. 3. Replace triac per "Thyristor (Q1)" in Section 8.

Table 7-A: Troubleshooting

Problem	Probable Cause	Probable Corrective Action
4. Control panel digital meter does not light.	1. Defective wiring to **CM3** digital meter board. 2. **CM3** board is defective. 3. **CM2** board is defective.	1. Check wiring to **CM3** board. Check connectors **J1B** on **CM3** and **J3A** on **CM2** for proper insertion. 2. Replace **CM3** per "Replacing CM3 Digital Meter Board" in Section 8 and then calibrate per "Calibrate CM3 Digital Meter Board" in this section. 3. Replace **CM2** per "Replacing CM2 Control Board" in Section 8.
5. **POWER** LED is on; ac is good; rectifier output voltage is zero.	1. Open ac contactor coil or contactor not making contact.	1. Turn **Off** power at ac service panel and measure contactor coil resistance. If it is open, replace contactor/coil.
6. Rectifier output voltage is low, not adjustable, and power is **On**.	1. Defective **CM2**. 2. Shorted triac.	1. Replace **CM2** per "Replacing CM2 Control Board" in Section 8. Verify that output voltage is adjustable. If not, replace triac per "Thyristor (Q1)" in Section 8.

Adjustments

This section includes procedures to check fuses (Clear RFA), calibrate the digital meter, adjust the isolated current measuring circuit, and adjust the current limit.

Clear Rectifier Failure Alarm (RFA)

Refer to Figures 5-4 and 7-1.

1. Observe and record the status of the fuses in the plant controller.
2. Turn the rectifier **POWER** switch **Off**.
3. If any fuses are blown, replace them with one of the same type and capacity. Check and **-V** fuses located on the control panel inside the rectifier door. On List C rectifiers,

check **F1.1- F1.8** and **FA1.1-FA1.8** on the bus bar assembly.

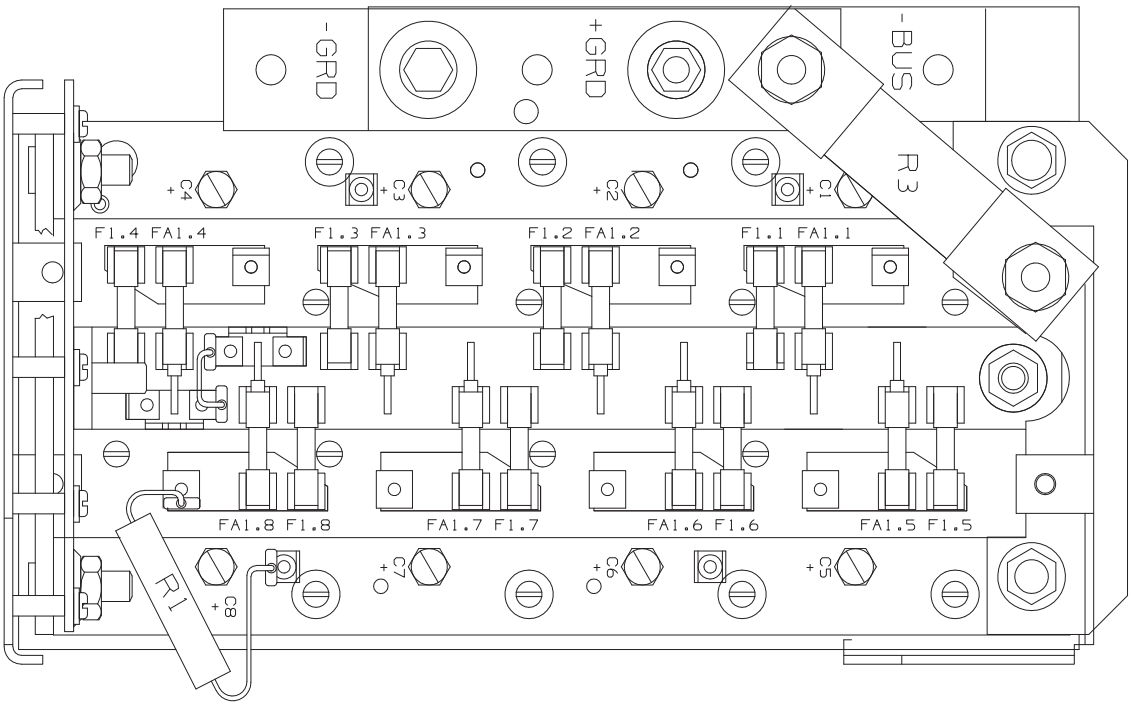


Figure 7-1: Bus Bar Assembly with Output Capacitor Fusing on 125-ampere Rectifiers with List C Option

4. Turn the rectifier **POWER** switch **On**.

5. If the rectifier started, minor alarm on controller cleared, and the rectifier **RFA** LED extinguished, then the RFA problem has been cleared. Otherwise, continue with the following procedures.

6. Observe and record the rectifier output voltage.

7. If the rectifier output voltage is **greater than** the plant float voltage, then use the following procedure:

   a. Turn the **OUTPUT VOLTS ADJ** potentiometer counterclockwise to lower the output voltage to the correct value.

   b. If the rectifier **OUTPUT VOLTS ADJ** potentiometer can adjust the voltage to the correct level, then the RFA

problem has been cleared. Otherwise, continue this procedure.

8. If the rectifier output voltage is the plant voltage and/or all rectifiers shut down, then use the following procedures.

   a. If the **CM2** control board has not been replaced, then replace it at this time per "Replacing CM2 Control Board" in Section 8.

   b. If the rectifier started, minor alarm on the controller cleared, and the rectifier **RFA** LED went out, then the RFA problem has been cleared. Otherwise, continue the procedure.

   c. If replacing the **CM2** control board does not clear the problem, then windings 11 and 12 of **T1** may be open. Try the following:

      – Check the wiring to the thyristor. (See Figure 5-3.)

      – Check for defective thyristor. Replace, if defective, per "Thyristor (Q1)" in Section 8.

Clear Fuse Alarm (FA)

1. Check to see if the **DC OUTPUT** circuit breaker (**CBA1**) tripped **Off** (down). If so, turn the **POWER** switch **Off** and then back **On**. Then turn **CBA1** back **On** (up).

2. If **CBA1** did not trip off, check fuses **+V** and **–V**. These fuses, accessible by opening the door of the rectifier, are located to the left of the **OUTPUT VOLTS ADJ** and **EQUAL ADJ** potentiometers.

3. If the **+V** or **–V** fuse is blown, check for possible trouble and replace the fuse.

Calibrate CM3 Digital Meter

Refer to Figures 5-3 and 7-2.

Note

Calibration is not feasible unless the DMM test meter has an accuracy of ±0.02 percent or better.

1. Loosen the locking screws and open the door of the rectifier.

2. Locate the **CM3** digital meter board on the inside of the door.

Caution

For Series 1 or 2 **CM3** boards, use extreme care when removing the board from the support standoffs (see notes below).

Notes

A Series 3 **CM3** board can be calibrated without removing the board from the support standoffs. A Series 1 or 2 **CM3** board must be removed from the support standoffs to calibrate the meter.

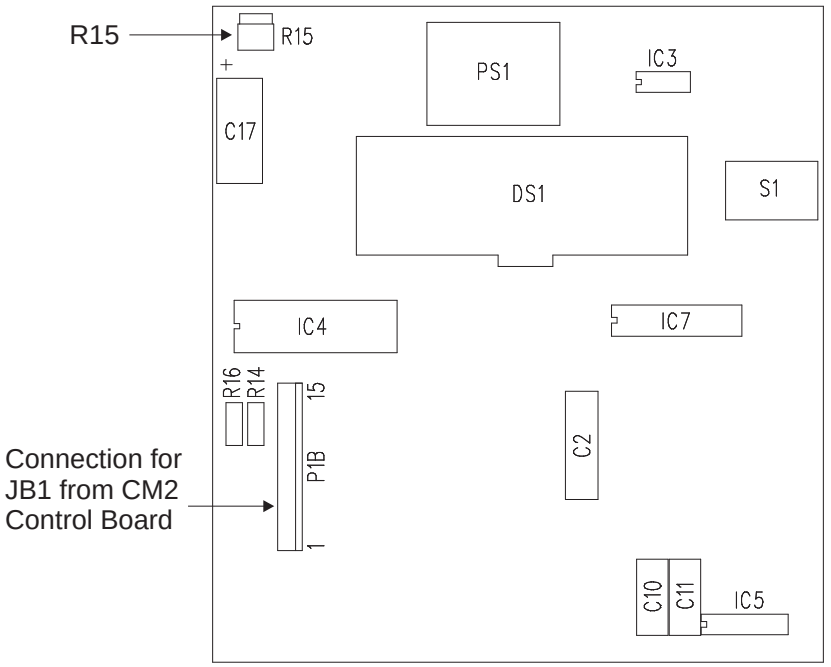
Series 3 **CM3** boards can be identified by the designation "AM3" which is stamped on the wiring (noncomponent) side of the board. A partial sketch of the **CM3** boards is provided in Figure 7-2.

3. If a Series 3 **CM3** board is provided, skip to Step 5.

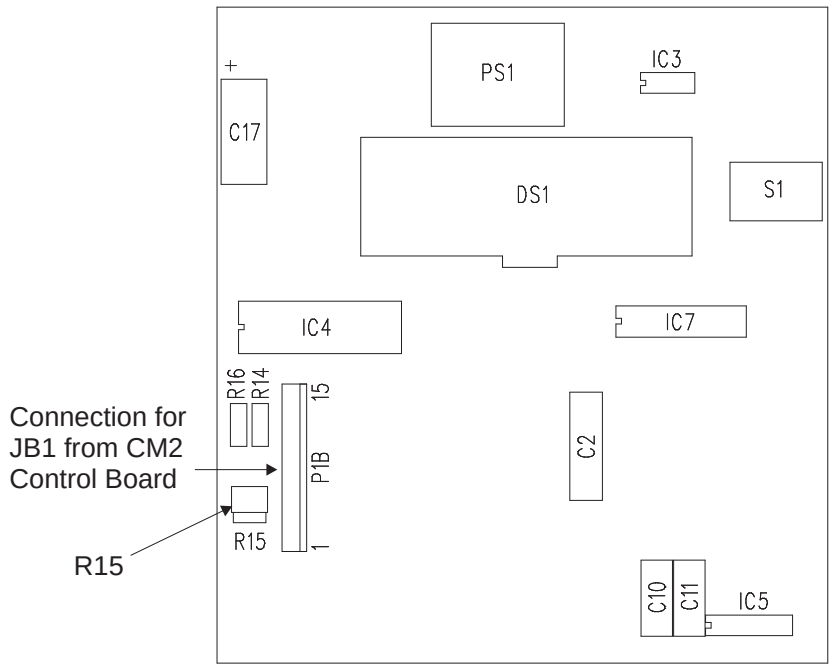
4. For Series 1 or 2 **CM3** boards, remove the board from the two support standoffs and the switch bezel by using a small flat-bladed screwdriver to unlatch the bezel clips from the switch and push in the latches on each standoff. Do not disconnect any connector(s) leading to the control board. Pull the **CM3** board a short distance away from the door so that the board may be turned over with the component side facing you.

5. Locate the **R15** potentiometer on the meter board (see Figure 7-2). For Series 3 **CM3** boards, **R15** is easily accessible on the component side of the board. For Series 1 or 2 **CM3** boards, **R15** is located under the wires of the cable connected to **P1B**. The wires will probably have to be pulled aside carefully or separated a small amount in order to access the screwdriver adjustment on **R15**.

6. Connect a DMM (Digital Multimeter) to the rectifier **REG** test jacks.



Series 3 Digital Meter Board



Series 1 or 2 Digital Meter Board

Figure 7-2: Partial Sketch of CM3 Digital Meter Boards

7. While holding the meter selector switch in the **BATT** V position, use a jeweler's screwdriver to adjust **R15** potentiometer so that **CM3** meter and the DMM connected to the rectifier test points agree within ±0.02 volts.

8. Release the meter selector switch. The switch should automatically return to the **AMPS** (center) position.

9. Disconnect the DMM from the rectifier **REG** test points.

10. Connect DMM to the rectifier output terminal and ground, see Figure 5-4.

11. Observe and record the voltage indications on the DMM and the rectifier meter as the meter selector switch is moved to the indicated positions as shown in Table 7-B.

Table 7-B: Digital Meter Tolerance

Meter Position	Tolerance
RECT V	±0.5 volt for Series 1 or 2 CM3 boards.
	±0.2 volt for Series 3 CM3 boards.
AMPS	± percent of rectifier rating.*

Notes:

To compare, measure the shunt voltage. 1mV of shunt voltage indicates 3.125A of output current. Example: the shunt voltage should be 40 mV at full load, 125A. At 125 percent of full load, the shunt voltage should be 50 mV. (See "Backup High Voltage Shutdown (HVSD) Test (On Line)" in Section 6.

To verify CM3 digital meter's accuracy, measure the shunt voltage between E1 and E2 on CM1. 1mV of shunt voltage is equivalent to 0.625 ampere of output current; i.e., at 12.5 ampere or 25 ampere load, the shunt voltage should read 20mV or 40mV respectively (20 x 0.625 = 12.5; 40 x 0.625 = 25). If CM3 does not display the current within ±2.5% of the actual measured and calculated current, adjust R15 on CM3.

12. If the rectifier meter does NOT meet the tolerances, replace the **CM3** meter board per "Replacing CM3 Digital Meter Board" in Section 8. Repeat this procedure from Step 1.

13. If the rectifier can be calibrated and the **CM3** board is a Series 1 or 2 board, reposition the board over the support standoffs. Verify that the latches and switch bezel clips snap to lock the board in place.

14. Close the door of the rectifier and secure it with the locking screws.

Adjust Isolated Current Measuring Circuit (VI)

This procedure adjusts the isolated current measuring circuit (voltage proportional to current adjustment) on the rectifier's **CM2** control board (205A1). Use the test in "Isolated Current Measuring (VI) Test (MCS or Galaxy Controller)" in Section 6 to verify that the circuit needs adjustment before following this procedure. The procedure must be performed in a working plant with the rectifier connected to an MCS or Galaxy (Intelligent only) controller and to a battery.

Figure 6-3 shows test points and components on the **CM2** control board. Other "E" test points are always positive with respect to either **E14** or **E15** for all voltage measurements. The plant control cable connector **J2A** MUST be connected to **P2A** on **CM2** for this procedure.

1. Connect a DMM across the rectifier shunt and a test load across the output of the rectifier. (See "Test Load Connection" in Section 6.) The rectifier must be delivering approximately 63A, 50 percent of its rated output current.

2. At the **CM2** control board, use the DMM to measure the voltage between test points **E7** and **E15**. (**E7** is more positive.) The voltage should be:

   2 volts + 160 x (millivolts of shunt voltage*)

   *The tolerance is –0 lower and +0.7% higher.

   If so, this procedure is completed If not, continue with Step 2.

3. Reduce the load current to zero by opening the test load. Using the DMM, measure the voltage between test points **E5** and **E14**. (**E5** is more positive.) This voltage must be less than 0.5 volt.

4. Connect the DMM between test points **E7** and **E15** and adjust potentiometer **R35** until the DMM indicates the voltage that was calculated in Step 1.

5. Recheck the results by performing the procedure again from Step 1.

Adjust Internal Selective HVSD (Battery Plant Without Controller)

This procedure is only for rectifiers in battery plants without a plant controller. Perform the procedure with the rectifier disconnected from the battery to avoid overvoltage conditions on the actual battery plant loads. A portable test load is required that can supply at least 138A, 10 percent above the rectifier's current rating.

1. Remove the rectifier from service per "Removing a Rectifier from Service" in this section. Connect the test load between the + and – buses marked on the rectifier. Then complete the steps listed.

2. Turn the rectifier **POWER** switch **Off**.

3. Turn the **DC OUTPUT** circuit breaker **Off** (down).

4. Adjust the test load to 138A, 10 percent, or more, above the rectifier's current rating. Read the load current on the **OUTPUT** meter.

5. Adjust the **OUTPUT VOLTS ADJ** potentiometer to obtain a rectifier voltage of 27.5 ± 0.2 volt (24-volt rectifier) or 55.0 ± 0.2 volt (48-volt rectifier). Hold the meter selector switch in the **RECT V** position and read the voltage on the meter.

6. Using a jeweler's screwdriver, rotate potentiometer **R23** on **CM2** (205A1) control board until the rectifier shuts down.

7. Set the rectifier controls according to Step 1 in "Restoring a Rectifier to Service" in Section 7. Disconnect the test load and complete the steps listed in the section.

Adjust Current Limit

Off Line Adjustment: Use "Current Limit Test (Off Line)" in Section 6 to verify that the current limit circuit needs adjustment, before continuing with this procedure.

In Steps 4 and 5 of "Current Limit Test (Off Line)," if V_{out} is not within the required range, adjust **R52** on **CM2**, (see Figure 6-3), until a correct voltage reading is obtained.

On Line Adjustment: Use "Current Limit Test (On Line)" in Section 6 to verify that the current limit circuit needs adjustment, before continuing with this procedure.

1. Hold the **RECT TEST** switch in the full load (**FL**) position and observe the output current.

2. If the output current is not within 125-126A, hold the **RECT TEST** switch in the full load (**FL**) position and adjust the current limit potentiometer **R52** on **CM2**, (see Figure 6-3), until the rectifier delivers 125-126A.

Restoring a Rectifier to Service

1. Set the ac supply and rectifier controls as shown in Table 7-C.

Table 7-C: Control Settings Prior to Restoring Rectifier to Service

Controls	Position/Status
Associated ac circuit breaker or fuses at the ac service distribution panel	**Off** or fuses removed and holders tagged "Out of Service"
Rectifier **POWER** switch	**Off** (down)
Rectifier **DC OUTPUT** circuit breaker	**Off** (down)
Rectifier **REG** fuse in the plant controller	Removed

2. If the rectifier voltage was NOT at the desired float voltage before it was turned **Off**, rotate the **OUTPUT VOLTS ADJ** potentiometer fully counterclockwise.

3. At the ac service panel, install the ac fuses or turn the ac input circuit breaker **On**.

4. To bring the rectifier into service,

a. Turn the rectifier **POWER** switch **On.** The green Power LED must light. Wait 10 seconds.

Note

If the rectifier continues to operate, proceed to Step b. If the rectifier shuts down due to initial high voltage, monitor the **RECT V** voltage. When this reading reaches 26 volts for 24-volt plants, or 52 volts for 48-volt plants, turn **On** the circuit breaker. If the rectifier shuts down for any other reason, such as component failure, see Section 7, *Troubleshooting and Adjustments*.

b. Hold the meter selector switch in the **RECT V** position, and use a small screwdriver to turn the **OUTPUT VOLTS ADJ** potentiometer clockwise until the digital meter reads approximately battery voltage, typically 26 volts for 24-volt plants or 52 volts for 48-volt plants.

c. Turn the **DC OUTPUT** circuit breaker **On** (up).

d. Turn the **POWER** switch **Off**.

5. At the rectifier, connect the control cable connector **J2A**.

6. At the plant controller, install the **REG** fuse associated with the rectifier that is being restored to service.

7. Turn the rectifier **POWER** switch **On**.

8. Close the rectifier front door and secure the locking screws.

9. Adjust the rectifier to float voltage per "Adjusting Rectifiers to Float Voltage" in Section 6.

10. If the rectifier is installed in a microprocessor-controlled plant that has an efficiency algorithm feature, enable this feature. (See the controller manual for instructions).

8 Spare Parts and Replacement Procedures

Introduction

This section gives information on spare parts for the J85502C-1 rectifier, including circuit modules, fuses, how to modify spare **CM1** option boards, and handling precautions. This section also provides complete disassembly procedures for replacing components.

Ordering Circuit Modules

Lucent Technologies combines into spare parts kits **CM1, CM2,** and **CM3** circuit boards, described in "Circuit Modules" in Section 2. Kit number H569-358 L13 contains these replaceable boards for the J85502C-1 rectifier. Table 8-A shows the contents of this kit along with the part numbers. **CM4** and **CM6** boards must be ordered separately.

Table 8-A: Spare Circuit Modules

Order	Lucent Technologies Comcode	Part Number	Description
Kit Number H569-358 L13	601177140	CM1 (ED-83158-30 G3)	Option Board
	104428735	CM2 (205A1)	Control Board
	104032693	CM3 (207A)	Digital Meter Board
Order Separately	200370658	CM4 (ED-83211-30 G3)	Alarm and Control Functions (List C only)
	106641129	CM5 (365A)	AC Voltage Monitor
	107087850	CM6 (434A)	AC/DC Voltage Monitor
	107368060	CM6 (434B)	AC/DC Voltage Monitor with ac alarm

Handling Circuit Modules

The following guidelines describe how to prevent electrostatic discharge (ESD) and properly handle and protect circuit packs (modules) in a central office or outside plant environment. These guidelines satisfy the minimum requirements for all three ESD-sensitive classifications (I, II, III) and, therefore, all circuit packs in these classes are handled in the same manner, regardless of sensitivity. Factory packaging provides shielding in the rare instances when it is necessary.

Electrostatic Discharge

- Assume all circuit packs containing electronic (solid-state) components can be damaged by ESD.
- When handling circuit packs (storing, inserting, removing, etc.) or when working on the backplane, always use the appropriate grounding procedure: either a wrist strap connected to ground or, when standing, a heel strap with a grounded dissipative floor mat.
- A grounded person must never hand an unprotected circuit pack to an ungrounded person. A static discharge from the ungrounded person through the circuit pack to the grounded

Electrostatic Discharge Warning

Grounded antistatic wrist straps must be worn for all circuit pack handling. The alligator clip connector of the wrist strap must be connected to a bare metal frame ground. The wrist strap must contact the skin and is not to be worn over clothing. At least once every week of use, verify that the resistance between the wrist strap and its connector plug is 1MΩ±10 percent. If a static-sensitive pack has already been found faulty, do not ignore requirements for handling static-sensitive packs. Continued mishandling may create other, more serious, problems with the pack.

person could cause an electrostatic discharge failure. All persons and equipment at a work location must be at the same common ground potential to be static safe.

- Handle all circuit packs by the faceplate or latch and by the top and bottom outermost edges. Never touch the components, conductors, or connector pins.

- Do not rub or wipe circuit packs to clean them unless you and the circuit pack are at the same ground potential.

- Observe warning labels on bags and cartons. Whenever possible, do not remove circuit packs from antistatic bags or cartons until ready to insert into the rectifier. Otherwise, open all circuit packs at a static-safe work position with wrist straps and dissipative table mats.

- Upon removal from the rectifier, immediately put circuit packs into antistatic packages. Always store and transport circuit packs in antistatic packaging. Shielding is not required unless specified.

- Keep all static-generating materials away from circuit packs. These materials include common plastics such as food wrappers, clear plastic bags, styrofoam containers, packing material, drinking cups, notebooks, and nonconductive plastic solder suckers. The insulation on small hand tools does not represent a static hazard.

- Keep adhesive tape (Scotch, masking, etc.) away from static-sensitive devices.

- When soldering static-sensitive semiconductor devices, the soldering iron must be grounded to the work table which must also be earth grounded.
- Do not wax the equipment aisles in central offices.
- Whenever possible, maintain relative humidity above the 20-percent level.

Modifying the CM1 Option Board

As described in schematic drawings SD-82659-01, replacement **CM1** option boards are supplied with all wire straps and resistors in place. The same wire straps and resistors that were removed from the original board must be removed from replacement boards in order for the rectifier to operate properly.

Table 8-B and Figure 6-2 show the straps and resistors to keep and to remove from the **CM1** board for each option on the J85502C-1 rectifier. The plug-in type wire straps are removed completely from a 2-hole jack. The other wire straps shown are soldered in and are never replaced once they are removed.

Table 8-B: Modifications for the CM1 Option Board

Feature	List/Option	Keep Straps or Resistors Marked with	Remove Straps or Resistors Marked with	Stamping Added on ED-83158-30
24V	1	F, V, Q, ZA	K, N, W, T, M	Mod CA
24V, Ext Reg	1 and WA	F, V, Q	K, N, W, T, M, ZA	Mod CB
24V, Ext HVSD	1 and WB	F, V, M, ZA	K, N, W, T, Q	Mod CC
24V, Ext Reg and HVSD	1, WA and WB	F, V, M	K, N, W, T, Q, ZA	Mod CD
48V	2	F, W, T, ZA	K, N, V, M	Mod CE
48V, Ext Reg	2 and WA	F, W, T	K, N, V, M, Q, ZA	Mod CF
48V, Ext HVSD	2 and WB	F, W, M, ZA	K, N, V, T, Q	Mod CG
48V, Ext Reg and HVSD	2, WA and WB	F, W, M	K, N, V, T, Q, ZA	Mod CH
Note: Remove Straps P15 (Option Q) and P16 (Option T) if the rectifier is not equipped with Options Q and T.				

Spare Fuses

Table 8-C provides spare fuse information for the J85502C-1 rectifier. A commercial equivalent fuse and the appropriate SD sheets are referenced.

Table 8-C: Spare Fuse Information

List	Fuse Designation in SD Drawing	Lucent Technologies Part Code	Rating (amperes)	Commercial Equivalent	Shown on SD Sheets
All	FA1 (+V) FA2 (-V)	70G	1/2	BUSSMAN 70G*	B1, C1
List C	F1.1-F1.8	KS-19780, L6	30	SOC** Type SKM4	B1, C4
	FA1.1-FA1.8	70G	1/2	BUSSMAN 70G	
* BUSSMAN is a trademark of the BUSSMAN Company ** SOC is a trademark of SAN-O Industrial Corporation					

Replacing Circuit Modules

This section gives step-by-step instructions for replacing circuit modules **CM1, CM2**, and **CM3**.

Caution

Follow instructions in "Handling Circuit Modules" in this section to minimize electrostatic discharge when handling circuit modules.

Do not connect or disconnect circuit modules with voltages present or equipment damage may occur.

Replacing CM1 Option Board

1. Turn the rectifier Power switch **Off**.
2. Turn the rectifier (**CBA1**) **DC OUTPUT** circuit breaker **Off** (down).
3. At the ac service panel supplying power to the rectifier, remove the input fuse assigned to the rectifier, or turn the circuit breaker **Off**.

4. At the plant controller, remove the fuse **REG** fuse associated with the rectifier.

5. At the rectifier, loosen the locking screws and open the rectifier door.

6. Locate the **CM1** option board. Using a drawing of the option board like that in Figure 6-2, record where each cable connects to the board.

7. Remove all cables from **CM1** by unlatching first, then pulling the cable connector.

Caution

Support the **CM1** option board with your hands when connecting and disconnecting the cables, or damage to the board may result. Do NOT disconnect cables by pulling the cable.

8. Remove all cables from **CM1** by unlatching first, then pulling the cable connector.

9. Remove **CM1** from its four support standoffs by using a small flat-bladed screwdriver to push in the latches on each standoff.

10. Verify that the new option board has the correct straps and resistors in place. If not, modify the board according to "Modifying the CM1 Option Board" in this section.

11. Position the new **CM1** board over the four support standoffs. Verify that each latch snaps and locks in place.

12. Reconnect all cables that were disconnected in Step 8.

13. If the rectifier is to be restored to service, refer to "Restoring a Rectifier to Service" in Section 7.

Replacing CM2 Control Board

Follow instructions in "Handling Circuit Modules" in this section to minimize electrostatic discharge when handling circuit modules.

1. Turn the rectifier **POWER** switch **Off**.

2. Turn the rectifier (**CBA1**) **DC OUTPUT** circuit breaker **Off** (down).

3. At the ac service panel supplying power to the rectifier, remove the input fuse assigned to the rectifier, or turn the circuit breaker **Off**.

4. At the plant controller, remove the fuse **REG** fuse associated with the rectifier.

5. At the rectifier, loosen the locking screws and open the rectifier door.

6. Locate the **CM2** control board.

Caution

Support the **CM2** control board with your hands when connecting and disconnecting the cables, or damage to the board may result. Do NOT disconnect cables by pulling the cable.

7. Disconnect **J2A** from **CM2** by unlatching first, then pulling the cable connector.

8. If the **CM6** AC Monitor card is not in place, disconnect the **J1A** connector on the cable from the **CM1** option board. If **CM6** is in place, remove it and the Y, R, and S leads for it from points E2, E4, and E9, respectively, on **CM2**. The ribbon cable may remain connected to **CM6**. (If BK and W leads of **CM6** are connected to E1 and E3 of **CM2**, remove them also but then cut off and discard.)

9. Disconnect the **J3A** connector on the cable from the **CM3** digital meter board.

10. Remove the **CM2** control board from the six support standoffs by using a small flat-bladed screwdriver to push in the latches on each standoff.

11. Position the new **CM2** control board over the six standoffs. Verify that each latch snaps and locks in place.

12. Connect **J3A** to **P3A** on the new **CM2** control board.

13. If the **CM6** AC Monitor card is not used, connect **J1A** to **P1A** on the new **CM2** board. If **CM6** is used, replace it with the ribbon cable to **CM1**. Attach and reconnect the Y, R, and S leads of **CM6** onto points E2, E4, and E9, respectively. The BK and W leads of **CM6**, if present, are not to be reconnected.

14. If the rectifier is to be restored to service, refer to "Restoring a Rectifier to Service" in Section 7.

Replacing CM3 Digital Meter Board

Follow instructions in "Handling Circuit Modules" in this section to minimize electrostatic discharge when handling circuit modules.

1. Turn the rectifier **POWER** switch **Off**.

2. Turn the rectifier (**CBA1**) **DC OUTPUT** circuit breaker **Off** (down).

3. At the ac service panel supplying power to the rectifier, remove the input fuse assigned to the rectifier or turn the circuit breaker **Off**.

4. At the plant controller, remove the fuse **REG** fuse associated with the rectifier.

5. At the rectifier, loosen the locking screws and open the door.

6. Locate the **CM3** digital meter board.

7. Remove the **CM3** meter board from the two support standoffs and **S3** switch bezel by using a small flat-bladed screwdriver to unlatch the bezel clips from the switch and push in the latches on each standoff.

Caution

Support the **CM3** digital meter board with your hands when connecting and disconnecting the cables or damage to the board may result. Do NOT disconnect cables by pulling the cable.

8. Disconnect **J1B** from **CM3** by unlatching first, then pulling the cable connector.

9. Connect **J1B** to **P1B** on the new **CM3** meter board.

10. Position the new digital meter board over the two support standoffs. Verify that the latches on each standoff and **S3** switch bezel clips snap to lock the meter board into place.

11. Check calibration of rectifier meter per "Meter Calibration Test (Off Line)" in Section 6.

12. If the rectifier is to be restored to service, refer to "Restoring a Rectifier to Service" in Section 7.

General Information on Replacing Components

Only disassembly procedures are given in this section. Reinstallation procedures are usually the exact reverse of removal procedures (i.e., follow the removal procedures in reverse to reinstall the component). Specific instructions are given when this does not apply exactly, or where special considerations or precautions must be taken during reinstallation. Applicable portions of Section 5, *Installation*, may be helpful. Portions of Section 6, *Testing*, can be used after reinstallation to verify proper operation of the rectifier. Some points are common to all rectifier disassembly work. Please read this section before using the rectifier disassembly procedures.

Take precautions against accidental personal injury or damage to equipment. Observe warnings given in "Safety Precautions" in Section 4, in addition to the following admonishment, while undertaking any disassembly or reinstallation procedure on a rectifier.

DANGER

The following disassembly or reinstallation procedures MUST be performed only on a rectifier completely disconnected from the plant battery buses, AND with no input from the ac service panel connected to the rectifier. The plant control cable **J2A** should also be disconnected from the **CM2** board.

The ac service and dc battery buses can be safely disconnected from the rectifier by following the first eight steps of "Disconnecting a Rectifier" in this section, but all work must be done carefully because you are working with live cables at

battery bus potentials and current capabilities. The disconnected charge battery and charge ground connectors must be taped adequately to prevent them from contacting each other or any other metal surface. Alternatively, the dc battery cables from the rectifier can be disconnected at the plant charge battery and charge ground buses.

Always make note of the lead connection points (termination points) before unsoldering or disconnecting them to insure trouble-free reinstallation. This includes potentiometer leads, or the solderless, quick-disconnect type connections used on circuit boards, relays, inductors, transformers, and wire bundles.

Always disconnect quick-disconnect connections by pulling straight apart with pliers to avoid bending or breaking the tabs. Do not pull on wire. Always remember to save hardware, thermal pads, and other items necessary for reassembly.

Heat-generating semiconductor components, such as diodes and thyristors (triacs), employ heat-conductive devices for heat sinking such as thermal grease or thermal pads. The thermal grease used should be KS-21343, L1. Diode thermal pads used in new rectifiers are comcode 406506907. Triac **Q1** uses DP102, comcode 403208242.

DC capacitors can be examined to see if they have “blown” (i.e. vented) due to voltage breakdown failure. A small hole in the capacitor top, called a “blowhole,” is plugged in a new or good capacitor, but is empty (blown out) in a failed unit. Some capacitor blowholes cannot be viewed directly until removed, or almost removed, from the rectifier. A dental-type mirror aids in viewing these capacitors' blowholes before disassembly. Lucent Technologies recommends that all dc capacitors in a rectifier be replaced whenever any one of them blows.

Procedures for testing and replacing individual rectifier diodes are provided in “Rectifier Diode Test and/or Replacement” in this section. Also provided in “Heat Shrink Removal” in this section is the procedure for taking apart bolted and insulated connections, such as those used on large transformer leads.

Table 8-D: Torque and Minimum Yield Strength for Mechanical Connections (Using Hex Head Cap Screws)

Cap Screw Diameter (Inch)	Min. Yield Strength (PSI)	Torque (Ft-Lb) UNC
1/4	57,000	6
5/16	57,000	12
3/8	57,000	22
7/16	57,000	35
1/2	57,000	54
9/16	57,000	77
5/8	57,000	107
3/4	57,000	190
7/8	36,000	193
1	36,000	290
1-1/8	36,000	410
1-1/4	36,000	580
1-3/8	36,000	760
1-1/2	36,000	1010

All removal and replacement procedures are easier to perform on bay-mounted rectifiers that have been removed from the bay.

Most component removals are straightforward and obvious. Therefore, these procedures can be used as a guide by qualified service personnel, rather than as step-by-step procedures. For example, you may prefer to remove a part not called for in order to make more room for access to a component being replaced.

Tables 8-D and 8-E provide the reassembly torquing requirements for the electrical and mechanical connections in the rectifier. Use these values unless otherwise directed in the procedures.

Table 8-E: Minimum Torque for all Electrical Connections

Screw Size	Torques for In-Lb or (Ft-Lb)					
	Wire Connections		Head Tightened		Nut Tightened	
	Slotted Machine	Hex or Socket Cap	Slotted Machine	Hex or Socket Cap	Slotted Machine or Hex Cap	Socket Cap
8-32	15	15	19	19	19	23
10-24	21	21	27	27	27	33
1/4-20	50	50	65	65	65	80
5/16-18	—	100	—	135	135	165
3/8-16	—	180	—	240	240	290
7/16-14	—	280	—	385	385	465
1/2-13	—	500	—	585	585	710
5/8-11	—	(71)	—	(97)	(97)	(118)
3/4-10	—	(125)	—	(172)	(172)	(209)

Table 8-E: Minimum Torque for all Electrical Connections

Notes:

1. Slotted machine screws should be the pan-head type.
2. Slotted machine and hex cap screws should be SAE Grade 2 steel or equivalent.
3. Socket cap screws should have 100,000 psi minimum tensile strength.
4. Steel flat washers should be furnished under heads of socked cap screws.
5. Ferrous screws and washers should have a corrosion protective finish.
6. Locking means is only required for connections subject to vibration. Belleville type washers or jam nuts are the preferred means.
7. For less that 1/4 inch thick tapped copper bars, use slotted No. 8, No. 10, or 1/4-inch machine screws to minimize applicable torque. When larger size screws are required, provide captive-type steel nuts or reduce torques.
8. Torque recommendations are also suitable for all non-ferrous fasteners, except aluminum.
9. Where application permits, hex cap screws should be used.

Replacing Components

DANGER

The following disassembly or reinstallation procedures MUST be performed only on a rectifier completely disconnected from the plant battery buses, AND with no input from the ac service panel connected to the rectifier. The plant control cable **J2A** should also be disconnected from the **CM2** board.

Disconnect the rectifier as described in “Disconnecting a Rectifier” in this section. Refer to Figures 5-3 and 8-1 for component locations and to the diagram on the inside of the rectifier door.

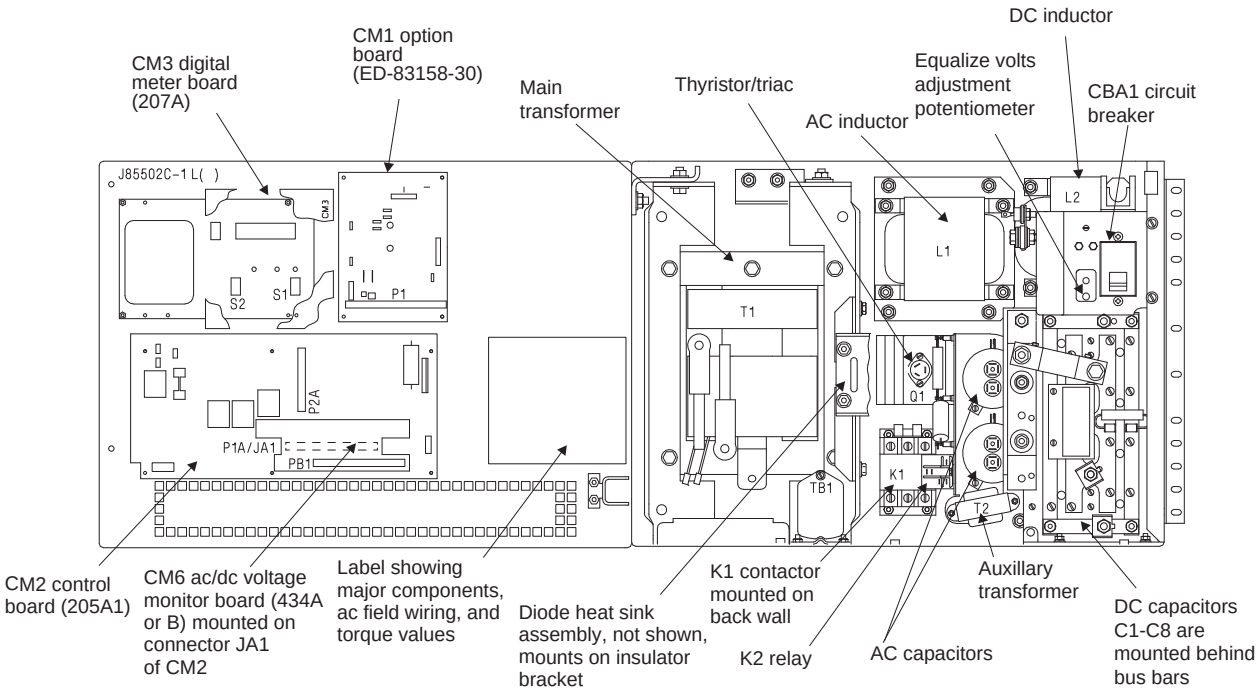


Figure 8-1: Typical J85502C-1 125-ampere Rectifier with Door Open and Diode Heat Sink Removed

Volts Adjust Potentiometers: Output Volts (R4) and Equalize Volts (R5)

1. Note that the potentiometer mounting bracket is attached to the **CBA1** bracket assembly with two screws located above and below the **+V** and **–V** fuses. (The **+V** and **–V** fuses can only be seen with the door open). Remove the two screws to separate the potentiometer mounting bracket from the **CBA1** bracket.

2. Noting their positions for reassembly, unsolder the wires from the potentiometer (**R4** or **R5**) being replaced.

3. Remove nut to free the potentiometer.

CBA1 Bracket Assembly

1. Disconnect the cable from the top of the – bus or from the top of shunt **R3** that is connected to the top of the circuit breaker.

2. Remove the two screws that hold the **CBA1** bracket to the rectifier cabinet.

3. Rotate the **CBA1** bracket to the right and remount to the outside of the cabinet flange. This will provide access to

the rear of the circuit breaker and the components mounted on the bracket.

DC Output Circuit Breaker (CBA1)

1. Remove the bracket per "CBA1 Bracket Assembly" in this section.
2. Remove the cable from the top terminal of **CBA1** by opening the bolted connection. (The bottom output BATT cable should have already been disconnected and taped per "Disconnecting a Rectifier" in this section.
3. Remove the two quick-disconnect connectors from the rear of **CBA1** (pull straight out).
4. In the front, free **CBA1** by removing the two screws that hold **CBA1** to its bracket.

DC Inductor (L2)

1. Perform the instructions in "CBA1 Bracket Assembly" in this section to move the **CBA1** bracket out of the way.

Note

All of the following steps should be read before attempting to perform this procedure.

2. Disconnect the cables from the inner and outer tabs of **L2**. While doing this, small flyback diodes (**CR3** and **CR4** with red and blue leads) and their mounting tabs will also come off the inner and outer **L2** tabs. Note their positions for proper subsequent reassembly.
3. Remove both of the left-side mounting nuts of **L2**. While supporting the weight (approximately 30 lbs.) of **L2**, loosen both of the right-side nuts and slide **L2** to the left until it is free.
4. Remember to remount **CR3** (red lead) and **CR4** (blue lead) tabs during reassembly.

DC Filter Capacitors (C1-C8)

The dc filter capacitors are located below the **CBA1** circuit breaker.

DANGER

DC capacitors may be charged even with power disconnected from the rectifier. This would be true if the main bus bar fuses are open. Always check all of the dc capacitor terminals (observe polarity) with a voltmeter before performing this procedure, and discharge capacitors in a safe manner, if necessary.

1. Perform the instructions in "CBA1 Bracket Assembly" in this section to move **CBA1** bracket out of the way. Support the bracket in such a way as not to overstress the blue wire to the inner tab of **L2** (wire may be removed).

2. Remove all five of the large cables (noting their positions for reassembly) from the bus bar assembly.

3. Remove the three small wires from the rectifier shunt and note their positions for reassembly.

4. Remove the three mounting nuts that hold the dc filter assembly to the chassis.

5. Slide the entire dc filter assembly to the left along the floor of the rectifier. Then, lift the assembly up and out with the dc capacitors (**C1-C8**) attached.

6. To remove an individual capacitor:

   a. Remove the two terminal mounting screws from the bus bar side of the capacitor.

   b. On the capacitor side, loosen the clamp screw at the capacitor base and remove the capacitor.

7. During reinstallation, put the capacitor terminal screws in first, and tighten. Then tighten the clamp screws. Verify that the capacitor polarity is correct during installation. The capacitor blow (vent) holes should be visible through the holes in the insulator plate after installation is completed.

Diode Heat Sink Assembly

The J85502C-1 rectifier has a specially designed feature that permits the diode heat sink assembly to be relocated, allowing some access to the components behind without having to disconnect any leads. Note that the heat sink is mounted to a red,

rectangular-shaped insulator bracket by four screws. The insulator bracket is, in turn, mounted to a metal bracket (attached to main transformer **T1**) by two screws at the extreme left of the bracket. The metal bracket has a rounded tab with a threaded hole that protrudes through an oval hole in the insulator bracket, just to the right of its two mounting screws. This tab can be used to mount the heat sink sideways (its left side will face to the rear of the unit) in order to access the rectifier diode mounting nuts and common (center-tapped) cable. Full access to the components behind can be gained by disconnecting the common cable and moving the heat sink out of the way (in front of **T1**).

To relocate the diode heat sink assembly, proceed as follows:

1. While supporting the heat sink, remove the two insulator bracket mounting screws. Then, pull the bracket off of the tab and rotate the heat sink 90^o clockwise (from looking down on the unit).

2. Using one of the two mounting screws just removed, mount the insulator bracket and heat sink to the **T1** metal bracket by passing the screw through the oval-shaped tab hole, from the right. Then, turn the screw into the threaded hole in the tab of the **T1** metal bracket. Tighten the screw securely. The diode mounting nuts and common heat sink nut can now be accessed. The diodes can be either tested or removed. See "Rectifier Diode Test and/or Replacement" in this section.

3. If the heat sink is to be moved completely out of the way, disconnect the heat sink common lead from its connection point on the bus bar assembly (note the position for subsequent reconnection) and safely support it in front of **T1**.

AC Inductor (L1)

Note

Steps 1 and 2 of this procedure apply to both (24- and 48-volt) versions of the rectifier.

1. Perform the steps in "Diode Heat Sink Assembly" in this section to move the diode heat sink assembly completely out of the way.

2. Disconnect the two quick-disconnect leads coming from **L1.** One goes to ac capacitor **C10**, and the other is on thyristor **Q1**, pin 2.

3. In the 24-volt rectifier, **L1** is physically smaller and mounts to a plate that mounts to the rear of the rectifier. In the 48-volt rectifier, **L1** mounts directly to the rear of the rectifier using slotted mounting tabs. In either case, the weight of **L1** must be supported during removal (approximately 30 lbs. for the 48-volt **L1**, and less for the 24-volt unit).

   For 24-Volt Rectifier: Remove the two upper nuts that secure the plate (attached to **L1**) to the rear wall of the rectifier. Then loosen the two lower nuts that secure the plate to the wall. Lift up the **L1**/plate assembly and then pull forward to remove.

   For 48-Volt Rectifier: Remove the topmost two nuts of **L1** and loosen the bottom two nuts. Slide **L1** up, and then pull forward to remove.

AC Capacitors (C10 or C11)

Note

The ac capacitors are mounted under, and to the right of, the ac inductor (**L1**) on the ac capacitor bracket. The upper capacitor is **C10** and the lower capacitor is **C11**.

1. Perform the steps in "Diode Heat Sink Assembly" in this section to move the diode heat sink completely out of the way.

2. Remove the quick-disconnect connectors from the capacitor tabs.

3. Loosen the screws of the desired capacitors mounting strap by inserting screwdriver blade, from the left, through access hole in capacitor bracket, opposite screw.

4. Slide the capacitor out (toward front) and then slightly to the left to avoid the dc filter assembly.

Thyristor (Q1)

Note

Thyristor (**Q1**) is mounted on the heat sink attached to the ac capacitor bracket to the left of **C11**.

1. Perform the steps in "Diode Heat Sink Assembly" in this section to move the diode heat sink completely out of the way.

2. Note their positions and remove the quick-disconnect connector tabs from the **Q1** terminals.

3. Remove the screws that secure **Q1** to the heat sink. Save the thermal pad for reinstallation.

Relay (K2)

Note

Relay (**K2**) is mounted on the ac capacitor bracket to the left of **C10**.

1. Perform the steps in "Diode Heat Sink Assembly" in this section to move the diode heat sink assembly completely out of the way.

2. Noting their positions, remove the quick-disconnect connectors from the **K2** terminal tabs.

3. Using a rachet-type socket wrench (with an extension and a 1/4-inch socket) loosen the rear mounting nut (behind **K2**) and remove the front mounting nut. Then, remove **K2** by pulling forward.

Contactor Relay (K1)

Note

Contactor relay (**K1**) is mounted below and to the left of ac capacitor **C10** and left of **K2**.

1. Perform the steps in "Diode Heat Sink Assembly" in this section to move the diode heat sink completely out of the way.

2. Loosen all six of the terminal screws on contactor **K1**. (Note that in addition to the six cables to be removed, there are three terminals that are attached to quick-disconnect connectors. Do not disconnect the quick-disconnect connectors, just remove the three terminals from **K1**). Noting their positions, remove the six cables and the two other leads to the coil tabs at the top of the contactor.

3. To remove **K1**, completely remove all four of the corner mounting nuts from the rear wall studs.

Transformer (T2)

Note

Transformer (T2) is mounted on the ac capacitor bracket, just below **C11**.

1. Perform the steps in "Diode Heat Sink Assembly" in this section to move the diode heat sink completely out of the way.

2. Remove the three quick-disconnect connectors coming from ac input leads #1, #2, and #3 terminal tabs on the top of the **K1** contactor.

3. Remove the other three quick-disconnect connectors (leads #4, #5, and #6) from their connection points in the wiring harness.

4. Remove the two mounting nuts to free **T2**.

Main Transformer (T1)

This procedure assumes that the rectifier has been removed from the bay and that the top cover of the rectifier has been removed.

The first seven steps of this procedure apply to both 24-volt and 48-volt versions of the J85502C-1 rectifier. Steps 8 through 11 are additional steps required only for the 48-volt version. Step 12 is the procedure to actually remove the disconnected transformer (**T1**) from the rectifier cabinet.

1. Remove the insulation tape from leads 6 and 8 on the secondary winding of the **T1** transformer. Remove the bolted connections from the exposed connection point of these leads to the flexible leads from the rectifying diodes

CR1 and **CR2**. Remove the tape and unbolt the cable connected to the center tap (lead #7) at the bottom of the secondary winding. Disconnect the shielded cable leads (#11 and #12) that have quick-disconnect terminals from the harness leads that project through the square hole of the local cable guard bracket.

2. Remove the rectifying diode heat sink assembly as described in "Diode Heat Sink Assembly."

3. Remove the bolted connection between the top, right, rear transformer bracket and the upper support bracket to the rear cabinet wall. Remove the two nuts that fasten the upper support bracket to the rear cabinet wall.

4. Remove the bolted connections between the (**T1**) transformer lifting bracket and the upper-left, front/rear bracket flanges on the transformer. Remove the two nuts that attach the lifting bracket to the mounting studs on the left cabinet wall near the upper cabinet flange.

5. Remove the two nuts that attach the lower, front mounting feet of the transformer brackets to the studs on the bottom surface of the cabinet.

6. Remove the following electrical connections:

   – Three primary winding leads (#1, #2, and #3) to the load side (bottom) of contactor (**K1**).

   – Four ac filter capacitor leads (two #9 and two #10 leads).

7. This completes the disconnection of transformer **T1** for 24-volt rectifiers. Proceed to Step 12 to remove **T1** from the cabinet. For 48-volt rectifiers, continue with Step 8.

8. Remove inductor **L1** per "AC Inductor (L1)."

9. Remove inductor **L2** per "DC Inductor (L2)."

10. Remove contactor **K1** per "Contactor Relay (K1)."

11. Remove the ac capacitor bracket as a complete assembly (with the thyristor heat sink, ac capacitors, **K2** relay, and **T2** transformer attached) by removing the three nuts,

moving the assembly to the right and then forward (away from the cabinet rear wall), and then lifting the assembly vertically out of the cabinet.

Note

It is not necessary to remove the **CBA1** bracket assembly or the dc filter assembly in order to remove the ac bracket assembly (provided the top cover is removed and there is space above the top of the cabinet.

12. Actual T1 Removal for 24-Volt or 48-Volt Rectifiers:

a. Attach two eyebolts (3/8-16 x 1-1/4) to diagonally opposite slots at the top of the transformer brackets using two flat washers, one lockwasher, and one nut for each eyebolt.

b. With chain sling and two hooks for attachment to the eyebolts, use lifting equipment (of at least 500 lbs. capacity) to first raise the transformer slightly above the bottom surface of the cabinet. Then, slide the transformer to the right until the left side of it is clear of the flange at the top of the cabinet. Now the transformer can be lifted out of the cabinet.

Rectifier Diode Test and/or Replacement

If not already done, perform the diode heat sink assembly procedure.

1. Remove the nut from the stud that replace secures the diode to the heat sink. The stud can be anode or cathode of diode, see the rectifier SD to determine. Lift the diode body from the heat sink by the “pigtail” side, opposite of stud side, and save the removed thermal pad for reinstallation.

2. The diode is now electrically isolated for test purposes.

3. If this procedure is being performed to test a diode, skip to Step 8. To replace a diode that is known to be defective, continue with Step 4.

4. Refer to the next section to remove any heat shrink tubing and tape on the pigtail connection.

5. With the actual connection exposed, remove the nut and bolt that holds the connection together. Save the hardware for reinstallation. Discard the defective diode.

6. Connect the pigtail lead of the replacement diode by reversing the work done in the previous two steps, Step 5 first and then Step 4. Use the hardware saved in Step 5. When reversing Step 4, use heavy duty (thick wall) heat shrink tubing rated at 300 volts minimum at 105 degrees Celsius. See the next section for a recommended type of heat shrink tubing. If electrical tape is used, it should be identically rated.

7. Install the stud of the replacement diode through the mounting hole in the heat sink. Use the thermal pad, comcode 406506907, which was saved in Step 1. Install the new stud nut and torque to 275-325 in/lbs. This completes the rectifier diode replacement procedure. If maintenance is completed, reinstall the diode heat sink assembly according to "Contactor Relay (K1)".

8. **Testing a Rectifier Diode:** Use a meter with a diode test function, or measure the forward and backward resistances of the diode, to determine if the diode is good. A good diode should measure at least 50 ohms in both directions, and one direction should measure at least 50 times the other. The larger resistance is, of course, the back resistance, and the smaller is the forward resistance.

   Most diodes that fail do so by shorting (i.e., they measure shorted or almost shorted in both directions). The pigtail side of the diode can be electrically accessed, with a clip lead or probe, by pushing the insulating tubing and/or tape approximately 1/4 to 1/2-inch away from the point where the pigtail lead enters the diode body.

9. If the diode checked bad, proceed to Step 4 of this procedure to remove and replace it. If the diode checked good, proceed to Step 7 of this procedure to reinstall.

Heat Shrink Removal

This information is applicable to both rectifier diode "pigtail" lead insulation and some main transformer lead insulation in J85502C-1 rectifiers.

Remove heavy duty (thick wall) heat shrink insulation by carefully cutting it away with a sharp knife. Any electrical tape used to reinforce the connection must be removed. The heavy duty heat shrink tubing recommended is rated at 300 volts minimum at 105 degrees Celsius. A recommended heat shrink tubing is T&B HS4-30L, comcode 402696306.

Disconnecting a Rectifier

This section gives the procedure for disconnecting a rectifier from an operating plant. Before performing the procedure, personnel should be familiar with "Installing or Adding a Rectifier" in Section 5.

1. At the rectifier control panel, turn the **POWER** switch **Off**, and the **DC OUTPUT** circuit breaker **Off** (down).

2. At the ac distribution service panel, remove the fuses or open the circuit breaker supplying the rectifier with ac power. Tag fuse holders or circuit breaker to instruct all personnel to leave the circuit deenergized.

3. Remove associated **REG** fuse from plant controller.

4. Disconnect the plant control cable from the rectifier **CM2** control board, at connector **P2A**. Remove the cable from the cable tie anchors to permit its withdrawal through the conductor opening in the cabinet. The cable tie anchors, while providing a secure physical support of the cable assembly, protect the cable assembly from undesirable abrasion and bending.

5. The rectifiers' output filter capacitor must be completely discharged. Verify by connecting a DMM directly to the capacitor bus bars inside the rectifier. It will take several minutes to completely discharge the capacitors, after the **DC OUTPUT** circuit breaker is turned **Off** in Step 1.

6. One at a time, disconnect the battery plant end of the dc output and output return conductors from the battery plant charge and charge ground bus bars. Insulate the connector ends and label the conductors for easy identification when reconnecting.

7. One at a time, disconnect the dc output conductors from the rectifier "hot" and return bus bars. Insulate the

connector ends and label the conductors for easy identification when reconnecting.

8. One at a time, disconnect the ac input conductors from their terminations and the ac equipment ground (green) conductor from the cabinet. Insulate the connector ends and label the conductors for easy identification when reconnecting.

9. Unfasten the ac conduit that is structurally attached to the rectifier. Place the disconnected conduit to the side, and, if necessary, tie the conduit to an adjacent structure to prevent interference with the rectifier removal.

10. Withdraw all disconnected conductors from the rectifier cabinet and place them aside so as not to interfere with the rectifier removal or cause a personnel hazard.

11. Baffles between rectifiers in bays may have to be removed.

12. Size 3/8-16 lifting eyebolts may be fastened into the threaded holes in the top of the rectifier for removal by a forklift, or the rectifier may be attached to the lifting device of your choice before the mounting screws on each side of the unit are removed. **Remember that the unit weighs at least 300 pounds.**

13. When the rectifier is supported by the lifting device of your choice, remove the mounting screws that attach the unit to the bay.

14. The rectifier is now both electrically and physically disconnected and may be safely lifted from the bay.

9 *Product Warranty*

A. Seller warrants to Customer only, that:

1. As of the date title to Products passes, Seller will have the right to sell, transfer, and assign such Products and the title conveyed by Seller shall be good;
2. Upon shipment, Seller's Manufactured Products will be free from defects in material and workmanship, and will conform to Seller's specifications or any other agreed-upon specification referenced in the order for such Product;
3. With respect to Vendor items, Seller, to the extent permitted, does hereby assign to Customer the warranties given to Seller by its Vendor of such Vendor Items, such assignment to be effective upon Customer's acceptance of such Vendor Items. With respect to Vendor items recommended by Seller in its specifications for which the Vendor's warranty cannot be assigned to Customer, or if assigned, less than Sixty (60) days remain of the Vendor's warranty or warranty period when the Vendor's items are shipped to Customer or when Seller submits its notice of completion of installation if installed by Seller, Seller warrants that such Vendor's items will be free from defects in material and workmanship on the date of shipment to Customer. In such an event, the applicable Warranty Period will be sixty (60) days.

B. The Warranty Period listed below is applicable to Seller's Manufactured Products furnished pursuant to this Agreement, unless otherwise stated:

Warranty Period

Product Type	New Product	Repaired Product or Part*
Central Office Power Equipment	24 Months	6 Months

* The Warranty Period for a repaired Product or part thereof is as listed or, in the case of Products under Warranty, is the period listed or the unexpired term of the new Product Warranty Period, whichever is longer.

** The Warranty Period for Products ordered for Use in Systems or equipment Manufactured by and furnished by Seller is that of the initial Systems or equipment.

C. If, under normal and proper use during the applicable Warranty Period, a defect or nonconformity is identified in a Product and Customer notifies Seller in writing of such defect or nonconformity promptly after Customer discovers such defect or nonconformity, and follows Seller's instructions regarding return of defective or nonconforming Products, Seller shall, at its option attempt first to repair or replace such Product without charge at its facility or, if not feasible, provide a refund or credit based on the original purchase price and installation charges if installed by Seller. Where Seller has elected to repair a Seller's Manufactured Product (other than Cable and Wire Products) which has been installed by Seller and Seller ascertains that the Product is not readily returnable for repair, Seller will repair the Product at Customer's site.

   With respect to Cable and Wire Products manufactured by Seller which Seller elects to repair but which are not readily returnable for repair, whether or not installed by Seller, Seller at its option, may repair the cable and Wire Products at Customer's site.

D. If Seller has elected to repair or replace a defective Product, Customer shall have the option of removing and reinstalling or having Seller remove and reinstall the defective or nonconforming Product. The cost of the removal and the reinstallation shall be borne by Customer. With respect to Cable and Wire Products, Customer has the further responsibility, at its expense, to make the Cable and Wire Products accessible for repair or replacement and to restore the site. Products returned for repair or replacement will be accepted by Seller only in accordance with its instructions and procedures for such returns. The transportation expense associated with returning such Product to Seller shall be

borne by Customer. Seller shall pay the cost of transportation of the repair or replacing Product to the destination designated by Customer within the Territory.

E. The defective or nonconforming Products or parts which are replaced shall become Seller's property.

F. If Seller determines that a Product for which warranty service is claimed is not defective or nonconforming, Customer shall pay Seller all costs of handling, inspecting, testing, and transportation and, if applicable, traveling and related expenses.

G. Seller makes no warranty with respect to defective conditions or nonconformities resulting from actions of anyone other than Seller or its subcontractors, caused by any of the following: modifications, misuse, neglect, accident, or abuse; improper wiring, repairing, splicing, alteration, installation, storage, or maintenance; use in a manner not in accordance with Seller's or Vendor's specifications or operating instructions, or failure of Customer to apply previously applicable Seller modifications and corrections. In addition, Seller makes no warranty with respect to Products which have had their serial numbers or month and year of manufacture removed, altered, or with respect to expendable items, including, without limitation, fuses, light bulbs, motor brushes, and the like.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND ARE IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S SOLE AND EXCLUSIVE REMEDY SHALL BE SELLER'S OBLIGATION TO REPAIR, REPLACE, CREDIT, OR REFUND AS SET FORTH ABOVE IN THIS WARRANTY.