Lucent Technologies
Bell Labs Innovations

Lineage® 2000 50-Ampere, 60-Hertz Ferroresonant Rectifier J85502B-1

Product Manual
Select Code 169-790-123
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Issue 6
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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 169-790-123) describes the J85502B-1 50-ampere ferroresonant rectifier. The J85502B-1 rectifier converts commercial 208 or 240 volts ac input power at 60 hertz 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 J85502B-1 rectifier is an excellent choice for any telecommunications battery plant.

The J85502B-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 domestic warranty service worldwide, contact your Warranty Service Manager (WSM). For international warranty service, contact your sales representative.

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. Each option requires different equipment that Lucent

Technologies has organized into numbered lists to simplify ordering.

Ferroresonant Technology

The J85502B-1 rectifier is a member of the Lucent Technologies family of Lineage® 2000 ferroresonant 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 J85502B-1, 50-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 must be 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 controller signals 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.

- **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 shuts down when this voltage exceeds a preset value. This circuit operates if the external selective HVSD fails to operate. This backup HVSD operates from an independent voltage source per Bellcore standards.

- **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.

- **Voltage monitor circuit:** This circuit monitors the ±5 and ±12 volt dc bias voltage on the control board. This circuit shuts down the rectifier and issues an RFA alarm when those voltages fall outside acceptable levels.

- **Backup current limit:** In addition to the output current limit, the ferroresonant transformers self-limit current output between 125-175 percent of full load, or 62.5-87.5 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 occurs.

- **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.

- **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 the straps on the **CM1** option board are set for List WA.

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

- **LOA:** The low output alarm signals a controller that the rectifier input voltage is below the lower limit of the rectifier operating voltage.

- **AC voltage monitor circuit:** This circuit monitors the ac input voltage and shuts the rectifier down if the ac voltage drops below 170 volts for plants with 208-volt ac input and 195 volts for plants with 240-volt ac input.

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

The J85502B-1, 50-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 characteristics 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 separately. Table 8-A lists recommended spare parts for the rectifier. All circuit modules are accessible by opening the rectifier door. Figure 5-2 shows the location of the circuit modules and other features of the rectifier. Figures 6-2, 6-3, and 7-1 show the **CM1**, **CM2**, and **CM3** board layouts, respectively. A description of each module follows.

- The **CM1** circuit module (ED83158-30 Group 2, A) 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 for information on parts to be removed and retained.

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

  Local power supplies
  Feedback regulator
  Walk-in feature
  Backup high voltage shutdown (HVSD)
  Rectifier portion of external selective HVSD
  Remote shutdown
  Internal selective high voltage shutdown
  Restart feature

Limited output alarm (LOA)
Fuse alarm
Electronic current limit
Output current isolation circuit

- The **CM3** circuit module (207A meter board) controls the digital **Output** meter on the control panel of List 10 rectifiers. The meter displays the rectifier's output current, voltage, or the plant battery voltage depending on the three-position selector switch (see Figure 2-1).

- The **CA1** circuit module (ED83156-30 Group 1) contains a triac/thyristor snubber network. Refer to schematic drawing SD-82604-01 for further information.

- The **CM5** circuit module (434A or B) has ac and dc voltage monitor circuits. When activated, these circuits shut down the rectifier. The dc circuit issues an RFA alarm. 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 corrected ac voltage is restored.

Caution

Equipment damage may occur if circuit modules are connected or disconnected with voltages present. See Section 8 for how to replace circuit modules and 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 the front of the J85502B-1 50-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.

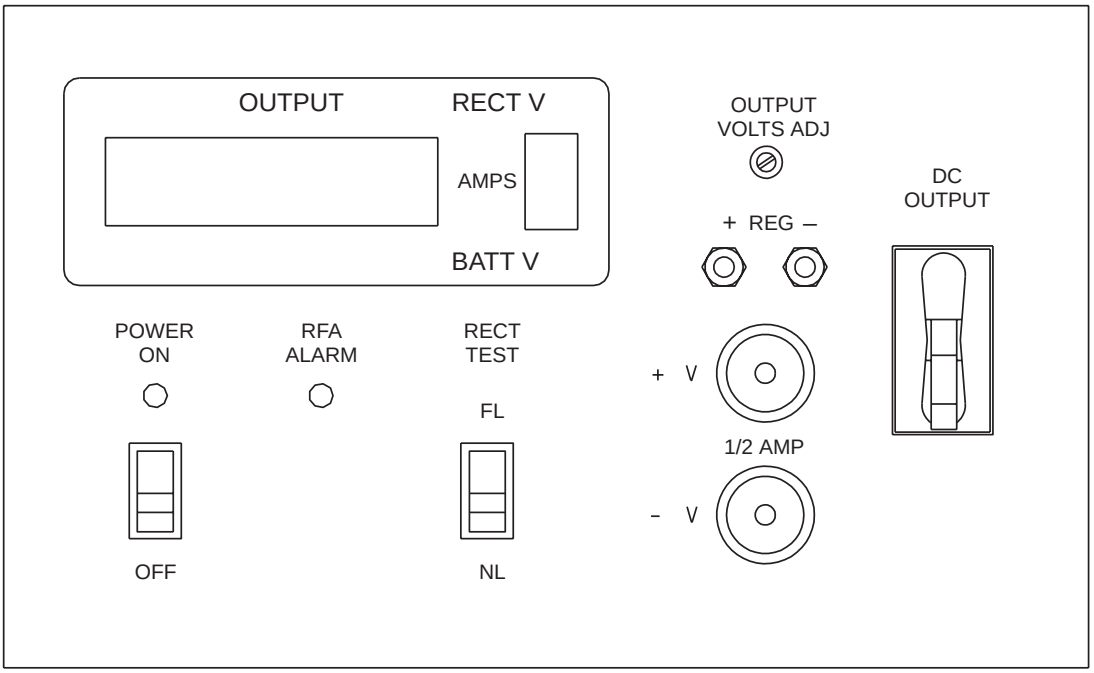


Figure 2-1: Control Panel of J85502B-1 Rectifier

Table 2-A: Digital Meter Accuracy	
Meter Position	**Accuracy**
RECT V	±0.5 volt for Series 1 or 2 **CM3** digital meter boards
	±0.02 volt for Series 3 **CM3** digital meter boards*
BATT V	±0.02 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" stamped on the wiring (noncomponent) side of the board. See Figure 7-1 for a partial sketch of **CM3** boards.	

- The digital output meter is optional on the J85502B-1 rectifier. The 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

accuracy of the reading depends on the vintage of the digital meter board (**CM3**) in the rectifier.

- The **POWER** 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 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 voltage, a blown **+V** or **-V** fuse, or an internal unbalance.

- 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.

- 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 internal voltage sense leads to the rectifier control and regulation circuits. These fuses are located on 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 when the circuit breaker trips.

Alarm and Control Flow

The J85502B-1, 50-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 CM2 control board. The Lineage® 2000 family of controllers also uses replaceable circuit modules that give flexibility to battery plant design.

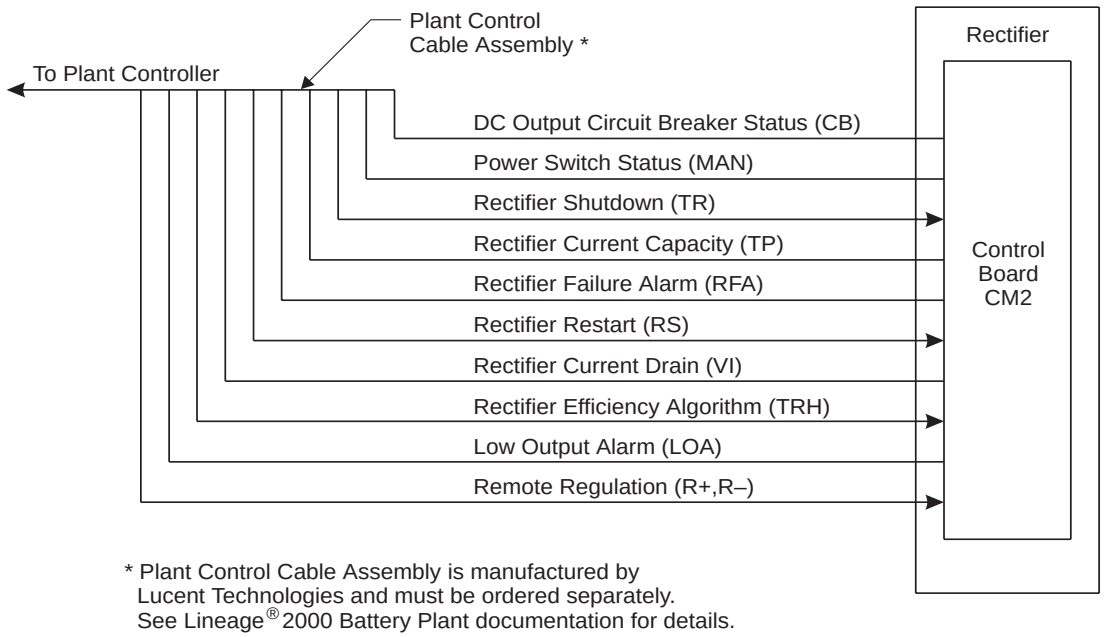


Figure 2-2: Signal Flow between Rectifier and Lucent Technologies Controller

Physical, Thermal, and Electrical Specifications

Tables 2-B, 2-C, and 2-D give the physical, thermal, and electrical specifications for the Lineage® 2000 J85502B-1, 50-ampere rectifier. Regulation on battery is 0.5% for the line, load, frequency, and temperature specifications. Regulation off battery is 2% for these specifications.

Table 2-B: Physical and Thermal Characteristics of the J85502B-1 Rectifier		
	Output DC ±24V	**Output DC ±48V**
Dimensions (inches)	23.25 wide x 10 tall x deep	
Weight (pounds)	160	180
Heat dissipation* BTU/hr at full load	845	1025
Humidity rating	10% to 95% (non-condensing)	
Operating altitude	Sea level to 10,000 feet (3048 meters)	
Operating temperature	35° to 122°F 1.5° to 48.8°C	
Audible noise at 5 feet above floor and 2 feet in front of rectifier	Less than 65 dBA	
Earthquake rating	Meets Zone 4 per Bellcore TR-EOP-000063 (Issue 3)	
*Measured at 28 Vdc (24-volt rectifiers) and 54 Vdc (48 volt rectifiers).		

Table 2-C: Input Specifications for the J85502B-1 Rectifier				
Input AC (Volts)		**Nominal Line Current (Amps)**		**Frequency (Hz)**
Nominal	**Range**	**±24V**	**±48V**	
208	184-220	8	15	60±3
240	212-254	7	13	
Data recorded at full load, 28 Vdc for 24-volt rectifiers and 54 Vdc for 48-volt rectifiers.				

Table 2-D: Output Specifications for the J85502B-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** (dBrnc) Standard Filter**
50/24	0 - 50	21.5 - 28.0	85	.97	100	32
50/48	0 - 50	43.0 - 56.0	90	.95	100	32
*Efficiency measured at nominal line, 28 Vdc or 54 Vdc. **Measured 200 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 J85502B-1 rectifier. List E or F and List 1 or 2 are required depending on output voltage and controller used with the rectifier. The other six lists are optional.

Table 3-A: Equipment Lists for the J85502B-1 Rectifier

List Number	Input Voltage (AC)	Output Voltage (DC)
1	208 or 240	±24
2	208 or 240	±48
E	434A voltage monitor board without ac voltage alarm	
F	434B voltage monitor board with ac voltage alarm	
Optional List Number	**Provides**	
10	Digital meter	
20	Inrush current controlling unit	
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	
B	Circuit breaker in positive output lead (negative ground system)	
C	Batteryless power plant	

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
J85502B-1	Assembly, Ordering, and Installation Drawing
T-82604-31	Wiring Drawing
SD-82604-01	Schematic Drawing
169-790-123	Product Manual

4 Safety

Please read this section carefully before installing, maintaining, or repairing the J85502B-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.

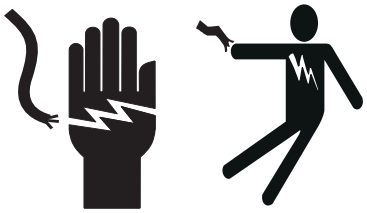
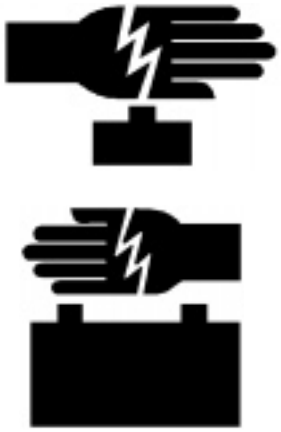
  Wait at least 5 minutes after shutting down ac and circuit breaker before working on capacitors or associated buswork.

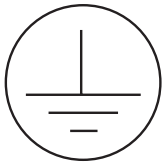
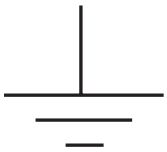
- Batteries may be connected in parallel with the output of the rectifiers. Turning off the rectifiers will not necessarily remove power from the bus. Battery voltage may still be present on one side of the output dc circuit breaker even with the circuit breaker off. Make sure the battery power is also 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.
	These symbols (or equivalent) are 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 these 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 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.

	This symbol may also be used to identify the presence of a hot surface. The marked item should not be touched without taking care.
	This symbol is used to identify the protective safety earth ground for the equipment.
	This symbol is used to identify other bonding points within the equipment.
	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.”

5 Installation

Introduction

This section provides information to consider before installing the J85502B-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 J85502B-1 rectifier, and carefully read and follow the admonishments as they are presented throughout this documentation.

Preparing for Installation

Location of the J85502B-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 J85502B-1 rectifier weighs at least 160 pounds. The customer should make prior arrangements for appropriate material handling facilities and equipment to unload, uncrate, and install the rectifier. Proper handling is necessary to assure personnel safety and protect the equipment. Each rectifier (unless it is 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

J85502B-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 restriction on the location in the bays is described in the documentation for the specific power plant.

Two 3/8-16 eyebolts are provided for lifting the rectifier into position in the plant bay. They should be removed before the rectifier is mounted permanently 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 J85502B-1. The maximum heat exhausted by each rectifier is approximately 845 BTU/hr (24-volt rectifier) or 1025 BTU/hr (48-volt rectifier). The rectifiers use free convective cooling, where air enters the cabinet through perforations in the bottom of the rectifier and escapes through perforations in the top cover. A minimum of 10 inches in front of the rectifier must be free of obstruction to allow the door to open horizontally and provide for adequate ventilation.

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 provides 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.

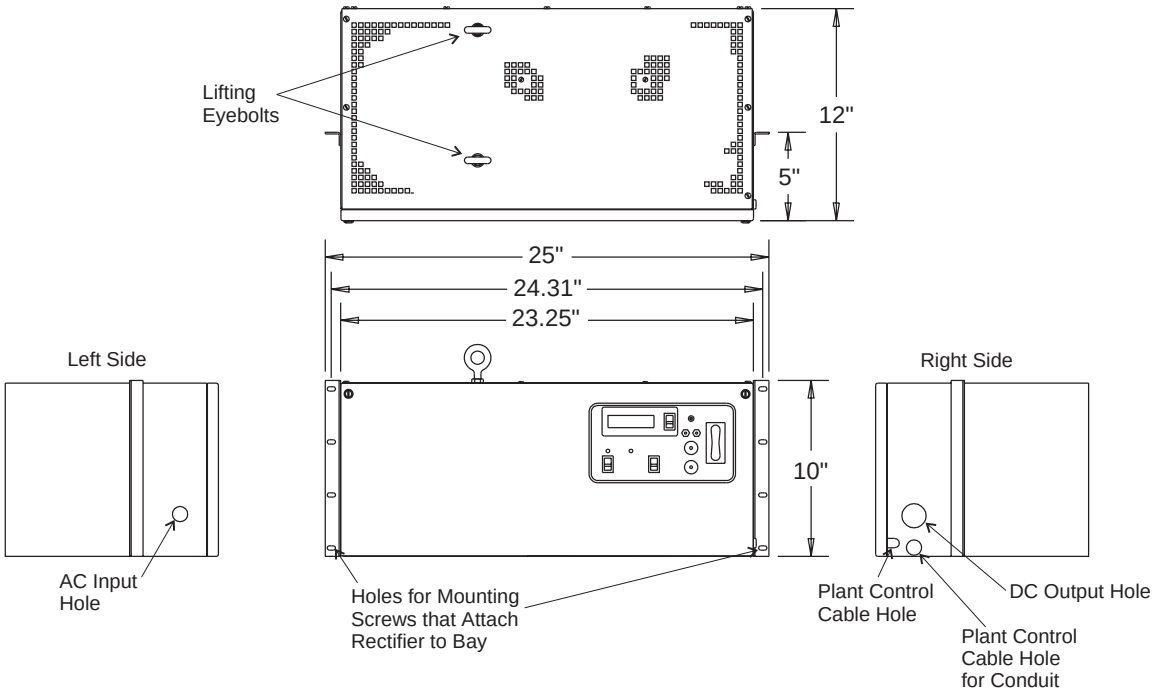


Figure 5-1: Four Views of the J85502B-1 50-ampere Rectifier

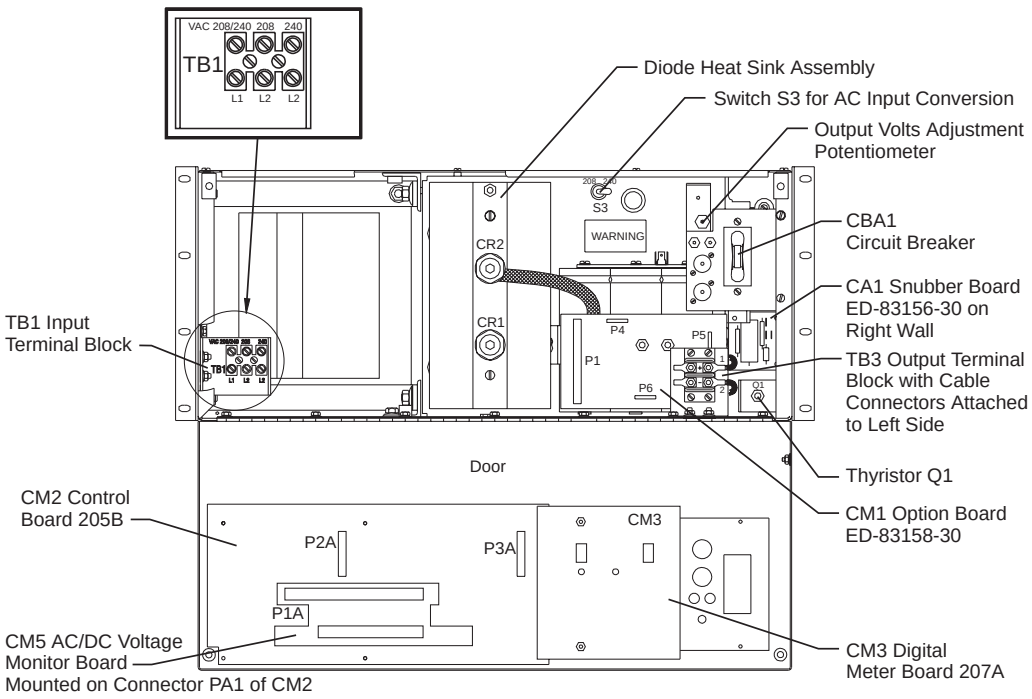


Figure 5-2: J85502B-1 Rectifier with Door Open

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. To avoid nuisance tripping at rectifier turn on, the breaker instantaneous trip rating should be at least 1000 amperes. The instantaneous trip rating can be obtained upon request from the breaker manufacturer.

The **AC EG** or frame ground is normally connected using the mechanical connection that is provided. Discard this connection if you prefer the T&B (a trademark of the Thomas & Betts Company) crimp connection, which is also provided. Use T&B crimp tool WT1300 on the crimp connection. See note 57 on J85502B-1 drawing.

Table 5-A: AC Input Requirements

List	Volts	Amps	Line Fuse Type, Rating	Input Circuit Breaker Size (amps)	Number Of Input Wires, Gauge*	Armored Cable Trade Size (inches) for Wire Size Shown	Max Input Wire Gauge	Conduit Knockout and Conduit Trade Size** (inches)	Terminal Supplied on Rectifier
L1	208 or 240	8.0 or 7.0	FN, 15	15	3, #14 AWG	1/2	12 AWG	7/8, 1/2	Screw type
L2	208 or 240	15.0 or 13.0	FN, 20	20	3, #12 AWG				

*Input wire includes “green wire” ground. Use KS24194 L3 or 90°C commercial wire.
**Where the trade size of the conduit used is smaller than the trade size for which the conduit knockout was sized, use appropriate knockout reducing washers.

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 KS24194 L2 wire, which is very flexible.

Figure 5-1 shows the dc output conduit hole. Figure 5-2 shows the dc output wire termination points for both negative and

positive polarity. Table 5-B specifies the dc output cable and conduit sizes.

Table 5-B: DC Output Requirements

Amps	Output Wire Size*	Output Conduit Trade Size (Inches)	Connectors Required	T&B Crimp Die
50	**#6 AWG**	**1**	**T&B 54134****	**T&B TBM5-S Blue**

*Use KS24194 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 minimum Oxygen Index of 28% as determined by ASTM D2863. Wire sizes were chosen to limit the voltage drop in the output leads to 2 volts maximum where the cable loop is approximately 100 feet.

**Provided with rectifier, attached to left side of TB3, output terminal block

Installation Tools The following tools are required for installing rectifiers.

- Material handling equipment to unload rectifiers at site, uncrate them, and place them in final positions
- Common electrician's hand tools, including jeweler's screwdriver, electrical tape, wire cutters and strippers, 12 AWG to 6 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
- 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, the customer may decide to correct the problem 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 Section 5.

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 J-drawing, J85502B-1.

Installing or Adding a Rectifier

Before beginning this procedure, read the “Preparing for Installation” section 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 and 5-2 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 input conductors and frame ground conductor at the ac service panel, and route the conductors to the rectifier.

5. Strip the ends of conductors that will be installed in the rectifier.

6. Secure conductors and frame ground in rectifier. First, connect the ground lead to its termination point marked **FR GRD** near the ac input hole. Connect the input conductors to **TB1** according to the section on "Converting AC Voltage" and torque to 16 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 ac breaker or insert ac fuses. If the branch circuit (two input conductors 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 and 5-2 as references for this section.

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

2. Measure the lengths required for the two dc output cables: one to run the output from the rectifier to its termination point on the plant charge bus bar, and one to run the dc return (ground) from the rectifier to its termination point on the plant ground bus bar.

3. Cut cables to length and strip the ends of cables that will be installed in the rectifier.

4. Tape or otherwise insulate connectors on the ends of cables that do not terminate in the rectifier.

5. Place dc return cable in cable rack.

6. Thread end of return cable through the right side of rectifier and attach connector to the appropriate terminal on **TB3** in the rectifier. DC return (ground) is positive for negative output voltage plants, and negative for positive output voltage plants. Torque connection to 30 in-lb.

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

8. Place dc output cable in cable rack.

9. Thread end of output cable through right side of rectifier and attach connector to the remaining terminal on **TB3** in rectifier (negative terminal for negative output, positive terminal for positive output). Torque to 30 in-lb.

Warning

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

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

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.

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

1. Route the plant control cable from the controller via the cable racks to the rectifier and through the opening provided for this cable in the right side of the unit.

2. Terminate the 40-pin connector on **P2A** of **CM2** and dress cable (using strain relief bushings and cable ties provided) inside the 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 to the rectifier in the rectifier lineup, that is, 1, 2, 3, etc.

4. If the controller is an MCS, cut leads TP0 and TP1 (pin numbers 21 and 20) in the controller end of the cable (see your controller manual). This signals to an MCS that the rectifier is a 50A.

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 J85502B-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) 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 3 above. This action will cause a minor alarm in an MCS controller. For a Galaxy controller, the rectifier position used must be programmed according to 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 two sections in this chapter are optional procedures that may be needed at installation. If not, proceed to Section 6, *Testing*.

Converting AC Voltage (Optional)

This section provides 208 to 240-volt ac and 240 to 208-volt ac conversion procedures for the J85502B-1 rectifier. These procedures are 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.

For 208 Vac Input to Rectifier: Connect one ac input wire to the **L1** (208/240) terminal on **TB1**, the ac input terminal block. Connect the other input wire to the **L2** (208) terminal on **TB1**. Connect the "green" ground wire to the **FR GRD** termination point next to **TB1**. Place switch **S3**, mounted on the inside rear wall of the rectifier, in the **208**-volt position.

For 240 Vac Input to Rectifier: Connect one ac input wire to the **L1** (208/240) terminal on **TB1**, the ac input terminal block. Connect the other input wire to the **L2** (240) terminal on **TB1**. Connect the "green" ground wire to the **FR GRD** termination point next to **TB1**. Place switch **S3,** mounted on the inside rear wall of the rectifier, in the **240**-volt position.

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)**.

The J85502B-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 Settings for Initial Battery Charge

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

2. Move the straps provided for options "Q" and "T" (P15 and P16) on the **CM1** option board from normal position to charge position as shown in Figure 6-2.

Warning

Do not remove the ZJ optional 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 as described in 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 **DC OUTPUT** circuit breaker on the rectifier. If the rectifier shuts down for any other reason, such as component failure, see Section 7, *Troubleshooting and Adjustments*.

5. Holding the meter selector switch in the **RECT V** position, 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).

Caution

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 described in “Restoring a Rectifier to Service” in Section 7.

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” below for a description of these items. For troubleshooting and diagnostic procedures, refer to “Preparation for Testing Off Line,” below. If you are unfamiliar with the function of rectifier controls and indicators, read Section 2 of this manual.

Precautions

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

- Voltages required for the control relays, the Rectifier Failure Alarm (RFA), and the ac contactor are derived from the ac input voltage. Voltage is available to these circuits whenever the ac service is available to the rectifier.

- Remote sensing of rectifier output occurs via the plant control cable connected to **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.

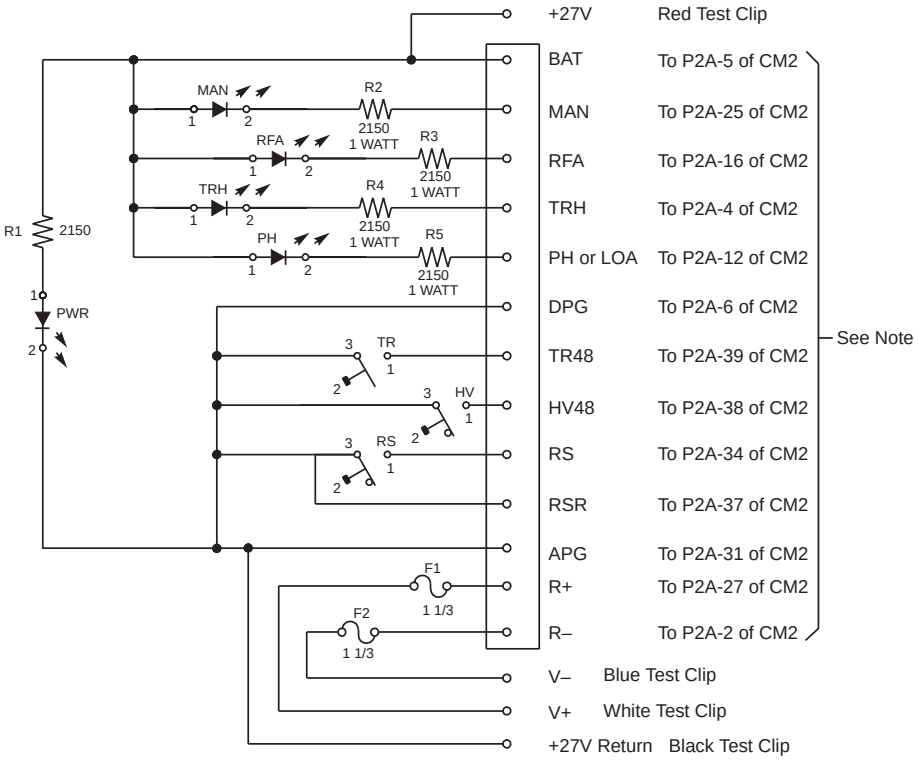
Tools and Test Equipment

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 60 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.



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

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 output terminal block of the rectifier, after the **DC OUTPUT** circuit breaker. Therefore, the rectifier must be disconnected from the plant charge and charge ground bus bars in order to isolate the unit from the batteries.

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

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

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

4. Disconnect the rectifier's “hot” output lead from the plant charge bus bar. Tape the loose connector.

5. Disconnect the rectifier’s ground output lead from the charge ground bus bar. Tape the loose connector.

6. Disconnect the + and - output leads from the left side of **TB3**, the rectifier ends of cables disconnected in Steps 3 and 4. Tape loose connectors.

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.

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

8. Connect the test load to the + and - output terminals on **TB3** in the rectifier.

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

10. When you are ready to power the test load, you must restore ac to the rectifier at the ac service panel, turn **On** the rectifier **POWER** switch, and turn **On** the **DC OUTPUT** circuit breaker. If this is initial testing, check the control cable first (see “Preparation for Testing Off Line”).

Preparation for Testing Off Line

The following steps check the plant control cable and prepare the equipment for 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	**Status/Position**
Associated ac circuit breaker or fuses at the service 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 (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 manual for instructions.)

3. Using the digital multimeter (DMM) on the dc volts scale, check the plant control cable:

   a. Verify that battery voltage, via the controller, is present between positions 1 and 2 on **TB3** (see Figure 5-2).

   b. 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.

   c. 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.

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

e. If the plant is equipped with an 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, which is 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** (205A1 or 205B) board	6-3	+27
Black	Negative side of capacitor **C1** on **CM2** (205A1 or 205B) 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

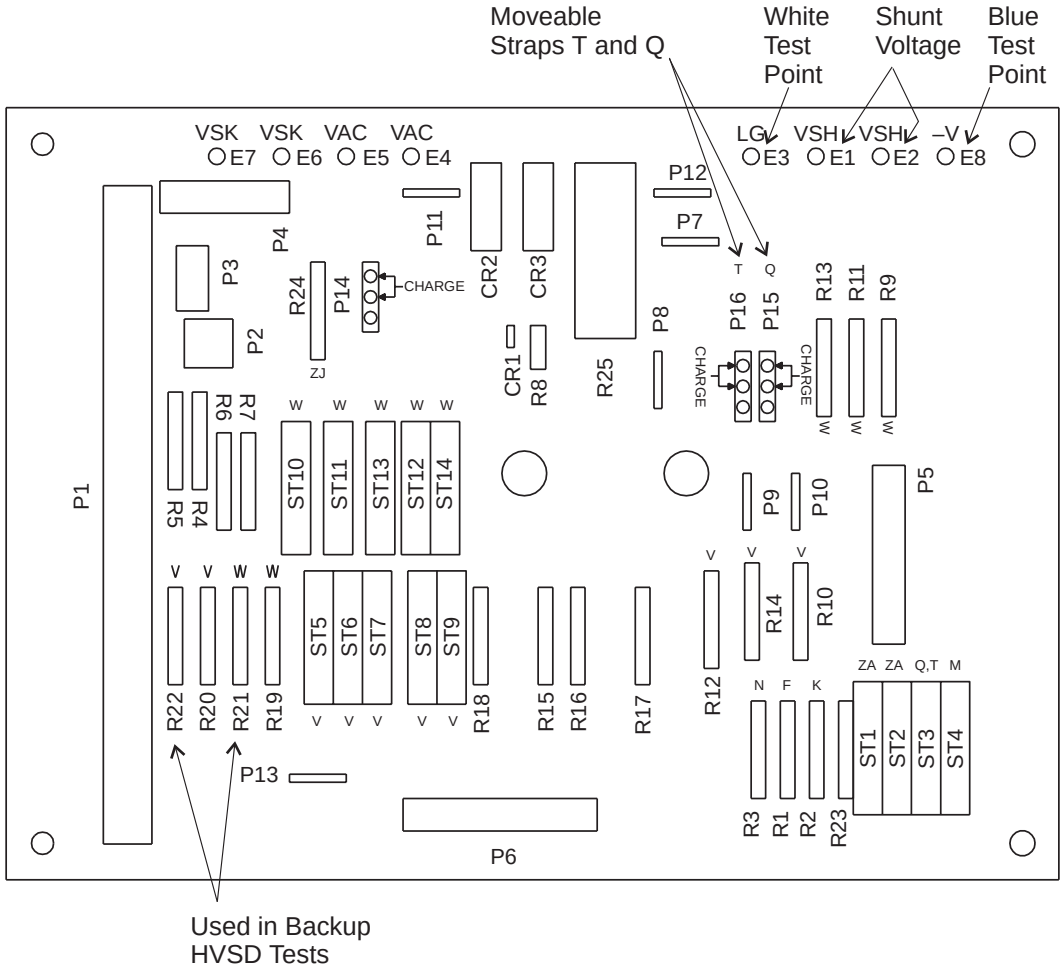


Figure 6-2: CM1 Option Board (ED83158-30 Grp 2, A)
Showing Test Clip Connections and Movable Straps "Q" and "T"

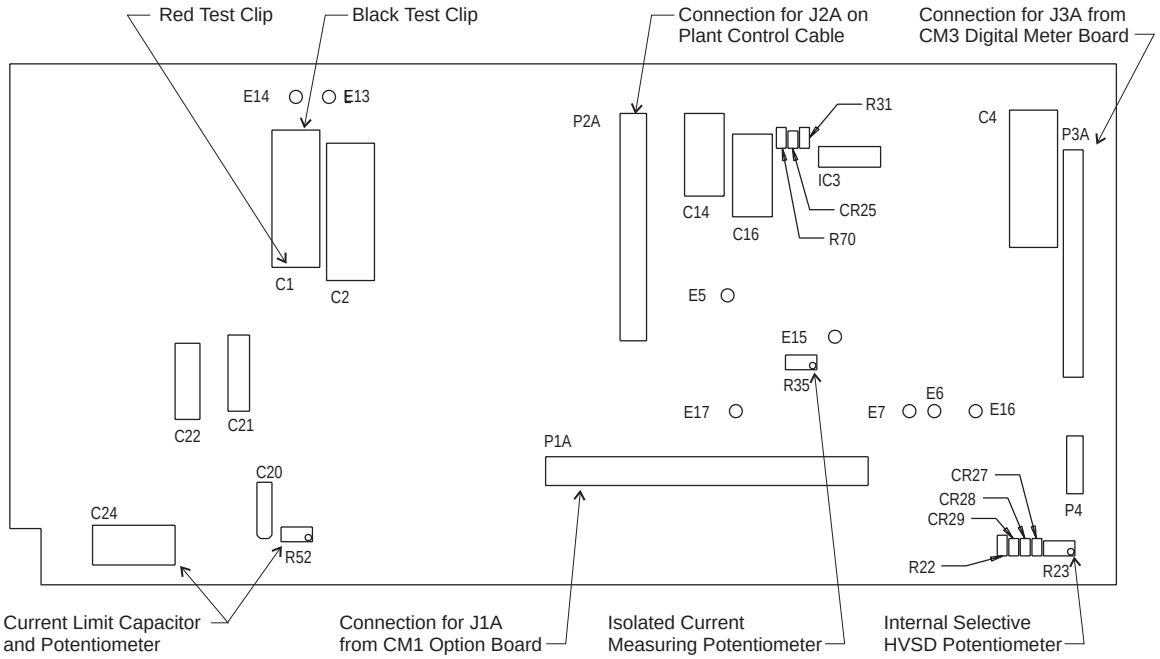


Figure 6-3: CM2 Control Board Showing Test Clip Connections and Other Component Detail

Testing Off Line

The following tests involve use of the test load and a Battery Plant Simulator Test Set. Refer to the paragraphs above headed "Battery Plant Simulator Test Set," "Test Load Connection," and "Preparation for Testing Off Line" for the procedure to connect a test load and for a Battery Plant Simulator Test Set.

Note

If the rectifier fails any of the tests described below, replace the CM2 control board (see Section 8) and begin testing again.

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 2.5-10A (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**.

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

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.

2. Turn the **POWE**R switch **Off**, then back **On**. The **RFA** LED should go off.

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

4. Using clip lead, momentarily short between **E14** and **E1** on 205 control board. The rectifier shuts down and the **RFA** LED lights on the rectifier.

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

6. Repeat Steps 4 and 5 for **E14** and **E2**, **E14** and **E3**, and **E14** and **E4**.

Current Limit Test (Off Line)

Notes

Adjust the current limit only after verifying that a current limit problem exists. V_{out} is the voltage reading between the rectifier dc output terminal and dc output return (ground). See Figure 5-2.

1. Connect the test meter to positions 1 and 2 on **TB3**.

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

3. At I_{load} = 50-51A, 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 54-56A, 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 48-49A, 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). 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.

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.

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** LED on the rectifier and the **RFA** lamp on the test set should light.

   When this step is completed, restore **R21** or **R22**. 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 normal position (pins 2 and 3).

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

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. Reduce load to zero (0).

4. 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 5-8A, 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 positions 1 and 2 on **TB3** (see Figure 5-2).

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).

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 10-15A, 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, follow 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 that a battery string and/or office load is connected to the rectifier.

Perform all the preliminary checks on the plant before testing the rectifiers. Take the same precautions for personal safety and equipment protection as when testing off line.

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	Status/Position
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)
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 manual for instructions.)

3. Reconnect the + and - output leads to **TB3** in the rectifier.

4. Remove the tape and reconnect the rectifier's ground output lead to the plant charge ground bus bar.

5. Remove the tape and reconnect the rectifier's "hot" output lead to the plant charge bus bar.

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

7. 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 the next paragraph. 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**.

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

9. 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 plant 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 in this manual or Tables A and R on J-drawing, J85502B-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 following tests, replace the **CM2** control board (see Section 8) and begin testing again:

- Regulation (NL/FL) Test (On Line
- Rectifier Failure Alarm/Fuse Alarm Test (On Line)
- Current Limit Test (On Line)
- Isolated Current Measuring (VI) Test (MCS or Galaxy Controller)
- Backup High Voltage Shutdown (HVSD) Test (On Line)

Regulation (NL/FL) Test (On Line)

Note

At least two rectifiers must be operating when this test is done, and the load requirement must be greater than 5A, 10% of the rated output for the rectifier under test.

1. If the rectifier is delivering less than 5A, turn the **OUTPUT VOLTS ADJ** potentiometer clockwise until it delivers 5A.
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)

Note

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

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** LED on the control panel lights.

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

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

4. Using clip lead, momentarily short between **E14** and **E1** on 205 control board. Rectifier shuts down and RFA lights on rectifier.

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

6. Repeat Steps 4 and 5 for **E14** and **E2**, **E14** and **E3**, and **E14** and **E4**.

Current Limit Test (On Line)

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 50-51A, 100 to 101 percent of the rated output current.

3. If the output current is not within 50-51A, 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 or Galaxy 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 between **E1** and **E2** on **CM1** (see Figure 6-2).

2. Increase the load so the rectifier delivers approximately 25A, 50 percent of its rated current capacity.

3. Observe the DMM and record the rectifier's shunt voltage. The shunt is rated 62.5A/50mV = 1.25A/mV, which means that each millivolt of voltage drop across the shunt indicates 1.25A of output current.

4. Convert the DMM's shunt voltage reading to amperes. For example, if the DMM reads 40mV, then 40mV x 1.25A/ mV = 50A 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 Step 5 or 6, the isolated current measuring circuit needs adjustment. See "Adjusting Isolated Current Measuring Circuit (VI)" in Section 7.

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

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

2. 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.

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

3. Set the DMM to measure 27 or 54 volts, and connect it to test points **E2** and **E8** on **CM1** (see Figure 6-2).

4. 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** LED on the rectifier should light.

   When this step is completed, restore **R21** or **R22**. 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.

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

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

7. Adjust the voltage to approximately 26.0 volts (24-volt rectifier) or 52.0 volts (48-volt rectifier). The **RFA** LED 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	Status/Position
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 board 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 5-2.

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 volt 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 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 7-1.

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

8. Disconnect the DMM from the rectifier.

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 × 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

$2.17 \times 24 = 52.08$ 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

$2.27 \times 12 = 27.24$ 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

   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.

c. 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.

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

e. Repeat Steps b through d.

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

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

7 Troubleshooting and Adjustments

Introduction

This section provides troubleshooting information and adjustment procedures for the Lineage® 2000 J85502B-1 rectifier. Whenever working on or near electrically live equipment, observe all safety precautions given in Section 4 and within each procedure.

For tools and test equipment required for certain adjustments, refer to Section 6. For technical assistance, refer to Section 1, "Technical Support."

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. However, for many off-line tests, like those in the first half of Section 6, you will need a test load connected and the circuit breaker closed. In this case, follow the procedure in "Test Load Connection" in Section 6.

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.

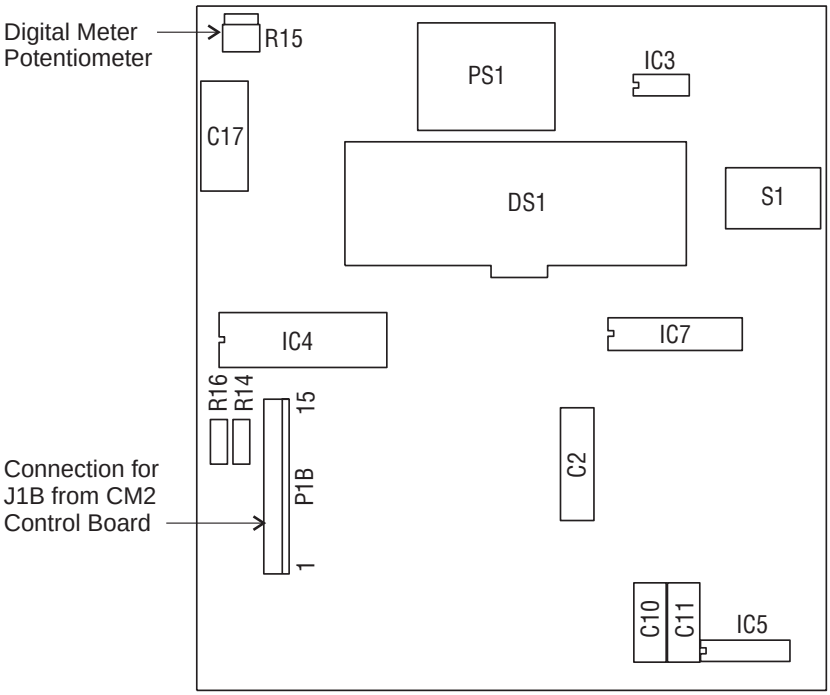
10. At the ac service panel supplying power to the rectifier, insert the input fuses assigned to the rectifier or turn the circuit breaker **On**.

11. Turn the rectifier **POWER** switch **On**, and wait approximately 30 seconds for the voltage to stabilize. The rectifier is now off line. To connect a test load for off-line testing, see Section 6.

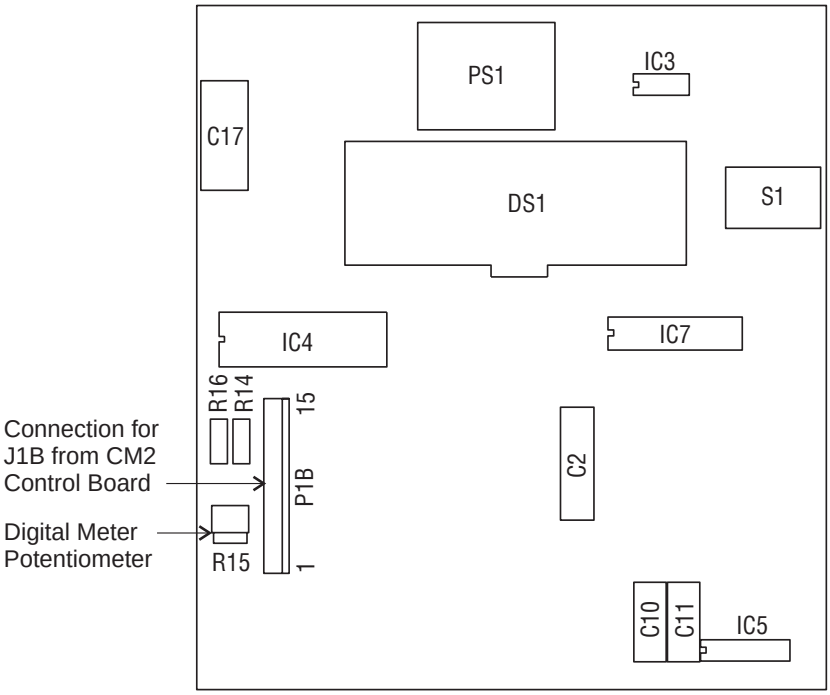
Diagnostics and Troubleshooting

Table 7-A lists possible problems, causes, and solutions that may occur with the rectifier subsystems. Schematic Drawing SD-82604-01, referred to in the table, is shipped with the J85502B-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-82604-01. 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 CM1. If the connection is okay, replace the CM2 board per Section 8. 4. Check wiring associated with coil of K1 or K3, 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+V and/or -V blown. 2. CM2 board is defective.	1. Check fuses per Section 7. 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 3.
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 thyristor.	1. Turn potentiometer counterclockwise. 2. Replace CM2 per Section 8. 3. Replace thyristor per Section 8.
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 Section 8. and then calibrate per Section 7. 3. Replace CM2 per 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. 2. Primary winding of ferro transformer is open.	1. Turn **Off** power at ac service panel and measure contactor coil resistance. If it is open, replace contactor/coil. 2. Check if cables from bottom of TB1 are connected properly. If so, replace T1 per Section 8.
6. Rectifier output voltage is low, not adjustable, and power is **On**.	1. Defective CM2. 2. Shorted thyristor.	1. Replace CM2 per Section 8. Verify that output voltage is adjustable. If not, replace thyristor per Section 8.



Series 3 Digital Meter Board



Series 1 or 2 Digital Meter Board

Figure 7-1: Component Side of CM3 Digital Meter Boards

Figure 7-1 Note: The board is mounted on the rectifier door with the component side toward the door and R15 nearest you.

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 Figure 2-1.

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 **+V** and **-V** fuses located on the control panel.
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 **less than** the plant voltage and/or all rectifiers shut down, then use the following procedure.
   a. If the **CM2** control board has not been replaced, then replace it at this time (see 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 (**Q1**). (See Figure 5-2.)
   – Check for defective thyristor. Replace, if defective, following procedure in Section 8.

Calibrate CM3 Digital Meter

Refer to Figures 5-2 and 7-1.

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.

A Series 3 **CM3** board can be identified by the designation "AM3" which is stamped on the wiring (noncomponent) side of the board. A partial sketch of **CM3** boards is provided in Figure 7-1.

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 7-1). 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.

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 5-2).

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
	±0.02 volt for Series 3 CM3 boards
AMPS	±2.5 percent of rectifier rating*

Notes:

To compare, measure the shunt voltage. 1mV of shunt voltage indicates 1.25A of output current. Example: The shunt voltage should be 40 mV at full load, 50A. at 125 percent of full load, the shunt voltage should be 50 mV. See "Backup High Voltage Shutdown Test (On Line)" in Section 6.

To verify the CM3 digital meter's accuracy, measure the shunt voltage between E1 and E2 of CM1. 1mV of shunt voltage is equivalent to 1.25 amperes of output current; i.e., at a 25 ampere or 50 ampere load, the shunt voltage should read 20mV or 40mV, respectively (20 x 1.25 = 25; 40 x 1.25 = 50). 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 (see 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 Section 6, "Isolated Current Measuring (VI) Test (MCS or Galaxy Controller)," 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 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 Figure 6-1 and Section 6, "Test Load Connection.") The rectifier must be delivering approximately 25A, 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 × (millivolts of shunt voltage*)
   *The tolerance is - 0 lower and + 0.7% higher.

   If so, this procedure is completed. If not, continue with Step 3.

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 2.

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 55A, 10 percent above the rectifier's current rating.

1. Remove the rectifier from service as specified in Steps 1 through 5 of "Removing a Rectifier From Service" in this section. Connect the test load following Steps 3 through 9 of Section 6, "Test Load Connection."

2. Adjust the test load to 55A, 10 percent, or more, above the rectifier's current rating. Read the load current on the **OUTPUT** meter.

3. 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.

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

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

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

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

8. Disconnect the test load from the output terminals of the rectifier.

9. Reconnect the + and – output leads to **TB3** in the rectifier.

10. Remove the tape and reconnect the rectifier's ground output lead to the plant charge ground bus bar.

11. Remove the tape and reconnect the rectifier's “hot” output lead to the plant charge bus bar.

12. Restore the rectifier to service (instructions below).

Adjust Current Limit

The **DC OUTPUT** circuit breaker must be closed (**On**) in order to adjust the current limit either on or off line. If you want to adjust the current limit off line, the rectifier must be disconnected from battery as described in Section 6, “Test Load Connection,” rather than Section 7, “Removing a Rectifier from Service.”

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

In Steps 4 and 5 of the "Current Limit Test (Off Line)" in Section 6, 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 the "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 50-51A, 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 50-51A.

Restoring a Rectifier to Service

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

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.

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

Controls	Status/Position
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

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.

Notes

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 Table 7-A.

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 (see Section 6, “Adjusting Rectifiers to Float Voltage”).

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

8 Spare Parts and Replacement Procedures

Introduction

This section gives information on spare parts for the Lineage® 2000, J85502B-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 Section 2, "Circuit Modules." Kit number H569-358 L17 contains these replaceable boards for the J85502B-1 rectifier. Table 8-A shows the contents of this kit along with the part numbers.

Table 8-A: Spare Circuit Modules			
Order	**Lucent Technologies Comcode**	**Part Number**	**Description**
Kit Number H569-358 L17		CM1 (ED-83158-30 G2, A)	Option Board
	104428735	CM2 (205A1 or 205B)	Control Board
	104032693	CM3 (207A)	Digital Meter Board
		CA1 (ED-83156-30 G1)	Snubber Board
Order Separately	107087850	CM5 (434A)	AC/DC Voltage Monitor Without AC Alarm
	107368060	CM5 (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.

Caution

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.

- 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 heelstrap with a grounded dissipative floormat.

- 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 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.

Table 8-B: Modifications for the CM1 Option Board

List/Option	Keep Straps Or Resistors Marked With	Remove Straps Or Resistors Marked With	Stamping To Be Added on ED-83158-30
1	K, V, Q, ZA	F, N, W, T, M	Mod BA
1 and WA	K, V, Q	F, N, W, T, M, ZA	Mod BB
1 and WB	K, V, M, ZA	F, N, W, T, Q	Mod BC
1, WA and WB	K, V, M	F, N, W, T, Q, ZA	Mod BD
2	K, W, T, ZA	F, N, V, M, Q	Mod BE
2 and WA	K, W, T	N, V, M, Q, ZA	Mod BF
2 and WB	K, W, M, ZA	F, N, V, T	Mod BG
2, WA and WB	K, W, M	F, N, V, T, Q, ZA	Mod BH

Modifying the CM1 Option Board

As described in schematic drawings SD-82604-01, 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 J85502B-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

Spare Fuses

Table 8-C provides spare fuse information for the J85502B-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)	70G	1/2	BUSSMANN* 70G	B3, C1
	FA2 (-V)				

*Bussmann is a trademark of the Bussmann Company.

Replacing Circuit Modules

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

Caution

Follow instructions above in “Handling Circuit Modules” 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 fuses assigned to the rectifier, or turn the circuit breaker **Off**.

4. At the plant controller, remove the **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.

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

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 the four quick-disconnect connectors from the **CM1** option board.

10. Remove header connectors from **CM1**.

11. Remove the two mounting nuts and associated lockwashers securing **CM1**.

12. 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."

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

14. Replace the two mounting nuts and associated lockwashers securing **CM1**.

15. Replace the header connectors on **CM1**.

16. Replace the four quick-disconnect connectors on **CM1.**

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

18. 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" 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 fuses assigned to the rectifier, or turn the circuit breaker **Off**.

4. At the plant controller, remove the **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 the cable from **P2A** on **CM2** by unlatching first, then pulling the cable connector.

8. If **CM5** is not in place, disconnect the ribbon cable from **P1A** on **CM2**.

   If **CM5** is in place, remove it from **CM2**, leaving the ribbon cable connected to **CM5**; also remove the Y, R, and S leads of **CM5** from points E2, E4, and E9, respectively, on **CM2**. (If BK and W leads of **CM5** are connected to E1 and E3 of **CM2**, remove BK and W leads from **CM2**, cut off at **CM5**, 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-blade 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 **CM5** is not used, reconnect the ribbon cable to **P1A** on the new **CM2** board.

    If **CM5** is used, reconnect it to **CM2**; reconnect the Y, R, and S leads of **CM5** onto points E2, E4, and E9, respectively, of **CM2**. (The BK and W leads of **CM5**, if not removed in Step 8, 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" 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 fuses assigned to the rectifier or turn the circuit breaker **Off**.

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

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

6. Locate the digital meter board.

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.

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.

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 as described in "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 these sections before using the rectifier disassembly procedures.

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.

Warning

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

The ac service and dc battery buses can be safely disconnected from the rectifier by following the first eight steps of "Disconnecting a Rectifier," 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 (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 KS21343, L1. Diode thermal pads used in new rectifiers are type DP125, comcode 405229154. Triac **Q1** uses DP123, comcode 405229170.

- 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 “Replacing Components.” Also provided in the same group of instructions is the procedure for taking apart bolted and insulated connections, such as those used on large transformer leads.

- 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-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

Table 8-E: Minimum Torque for all Electrical Connections						
Screw Size	Torques in 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)

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 socket cap screws.
5. Ferrous flat 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 than 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.

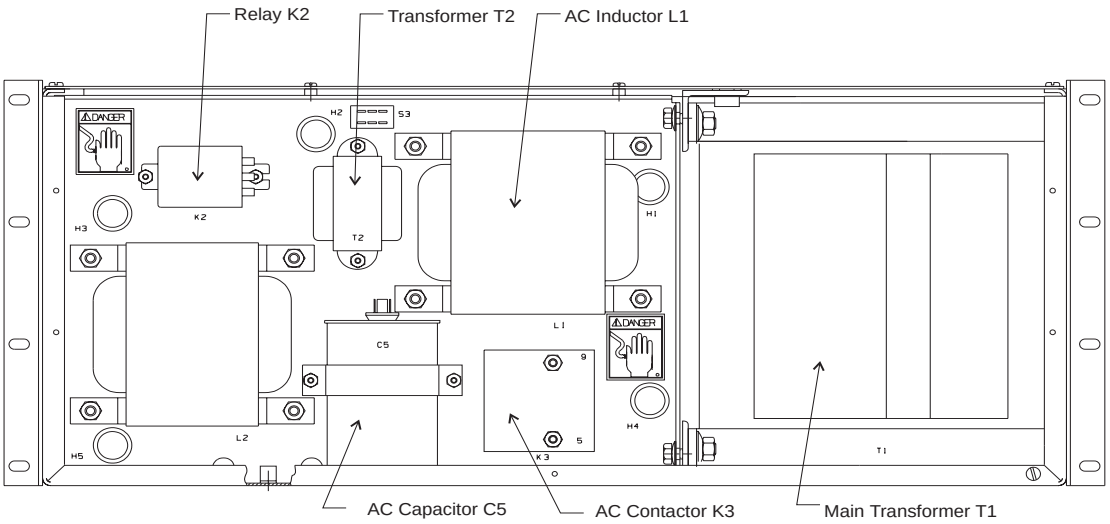


Figure 8-1: Rear Compartment of the J85502B-1 Rectifier With the Cover Removed

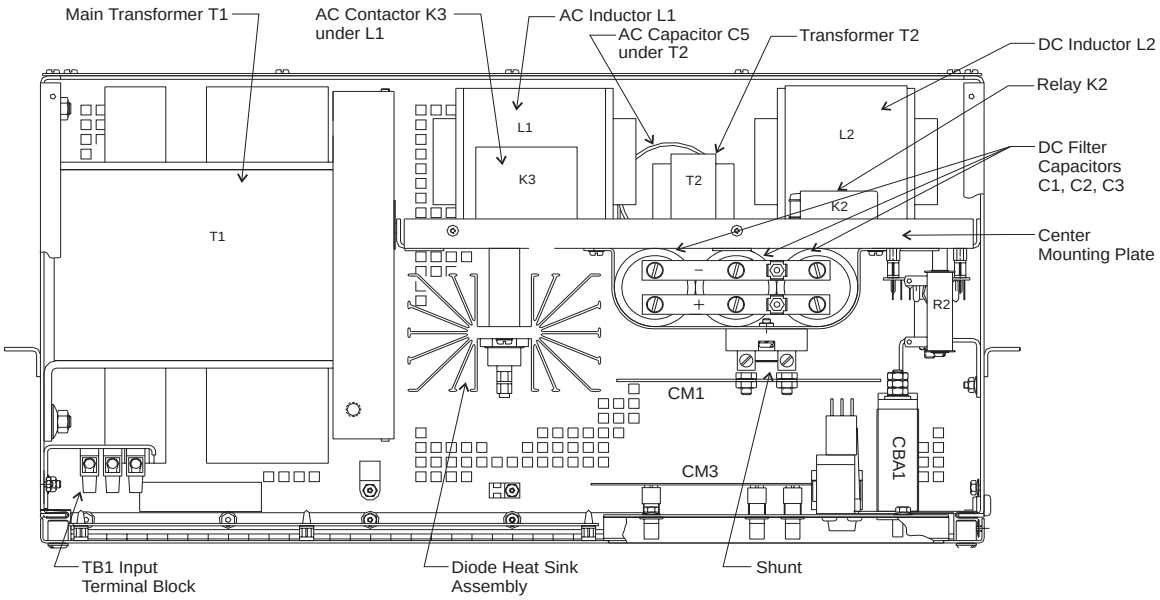


Figure 8-2: Top View of J85502B-1 Rectifier

Replacing Components

Disconnect the rectifier as described in "Disconnecting a Rectifier," below. Refer to Figures 5-2, 6-3, 8-1, and 8-2 for component locations.

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 J85502B-1 rectifier is constructed with the main transformer (**T1**) on the left using the entire depth of the unit. The right portion of the unit has front and rear compartments separated by a center mounting plate.

Output Volts Adjust Potentiometer (R4)

1. Noting their positions for reassembly, unsolder the wires from the potentiometer (**R4**).
2. Remove nut to free the potentiometer from its bracket.

DC Output Circuit Breaker (CBA1) and Bracket

1. Disconnect header connector **P5** from the **CM1** option board.
2. Remove the two screws that hold the **CBA1** bracket to the rectifier cabinet.
3. Carefully clear wires and cables aside while pulling the **CBA1** bracket out to access its back side.
4. Disconnect the quick-disconnect connectors from the back of **CBA1**.
5. Disconnect two dc cables from studs on the back of **CBA1**.
6. Remove the two screws on the front of **CBA1** that secure it to its bracket, and remove **CBA1**.

Snubber Board (CA1)

1. Remove the **CBA1** bracket as described in "DC Circuit Breaker (CBA1) and Bracket."

2. Remove the quick-disconnect connectors from the **CA1** board.

3. Remove the **CA1** board from its support standoffs, one at a time, by pushing in on the spring-loaded tabs while pulling out on each corner of the board.

4. When reversing the procedure for reinstallation, make sure the board is fully seated on the support stand-offs in locked position.

Thyristor (Q1)

1. Move TB3 aside by removing the two mounting nuts, but do not remove leads.

2. Remove the CM1 option board (see "Replacing CM1 Option Board).

3. Remove CBA1 bracket assembly from frame by removing its two mounting screws. Move CBA1 bracket out of the way.

4. Remove thyristor Q1 mounting bracket by removing two mounting nuts from studs on the wall.

5. The wire(s) from Q1 are tied to the center mounting plate. Loosen the wire tie on the plate by removing its nut.

6. Remove Q1 mounting nut.

7. Noting their connection positions, unsolder leads from Q1.

Diode Heat Sink Assembly

1. Remove the upper (common) lead from the heat sink that goes to dc capacitor C1 by removing the terminal nut.

2. Carefully push T1 Lead 7 just enough to access heat sink. Use caution to avoid bending the wires entering T1.

3. Remove the two mounting screws that secure heat sink.

4. Lift sink out and rotate clockwise to gain access to back side.

5. The diodes can now be tested or removed. (See "Rectifier Diode Test and/or Replacement."

DC Filter Capacitors (C1, C2, or C3)

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. Discharge capacitors in a safe manner, if necessary.

Note

To successfully perform this procedure, it is usually necessary to have access to the rear compartment of the rectifier (see note following Step 5.

1. Move the output terminal block TB3 aside by removing the two mounting nuts, but do not remove the leads.

2. Remove the CM1 option board (see “Replacing CM1 Option Board”).

3. Remove the CBA1 bracket assembly per Section 5.7.2.

4. Remove the diode heat sink assembly (See “Diode Heat Sink Assembly”).

5. Unscrew the two capacitor clamp screws from the center mounting plate.

Note

There is a wire from C3 to the dc inductor L2 that is mounted in the rear compartment. This wire is usually held to another wire in the rear compartment by a wire tie. The tied wire restricts tilting the top of the capacitors forward, which is necessary in order to access their mounting screws. If this wire tie is not in place, access to the rear compartment is not necessary in order to remove the dc capacitors.

6. If the wire tie mentioned in the note above restricts the movement of the wire attached to C3, gain access to the rear compartment and cut the wire tie.

7. Rotate the top of capacitor/bus bar assembly forward until capacitor terminal screws (through bus bars) can be accessed.

8. Noting their connection points, remove screws holding desired capacitor(s).

9. During reinstallation, use caution when reinstalling leads to capacitors to avoid stripping the threaded copper capacitor terminals. Insure capacitor is being installed with the proper polarity.

Rear Compartment Components: AC Inductor L1, AC Capacitor C5, DC Inductor L2, AC Contactor K3, Transformer T2, and Relay K2

All components in the rear compartment of the J85502B-l rectifier are accessible by removing the top and rear covers. Follow the procedure for "Disconnecting a Rectifier" in this section in order to remove a rectifier from a frame, if necessary, to remove these covers.

The following points should be noted:

- To facilitate replacement, note the positions of all quick-disconnect and other leads or header connectors before removing.

- In the case of the dc inductor L2, one of the leads goes to the front compartment and terminates on a dc capacitor terminal. The entire dc capacitor removal procedure (see DC Filter Capacitors) must be performed prior to removing the dc inductor in order to disconnect this lead.

- In order to remove T2, the header connector P4 on the CM1 option board (front compartment) must be disconnected and passed through hole 2 (H2) to the rear compartment. (The leads from T2 connect to P4.) It may be necessary to cut a cable tie before P4 can be passed through to the rear compartment.

- Early production models of the J85502B-1 rectifier without 208/240 Vac switch S3 have an ac contactor that is designated K1. Newer production rectifiers, containing S3, have a contactor that is designated K3.

Main Transformer (T1)

Notes

This procedure assumes that the rectifier has been removed from the bay and that all covers of the rectifier have been removed.

Lead numbers refer to T1 unless otherwise noted.

1. Disconnect lead 1, 2, or 3 from contactor K3.
2. Disconnect ac leads from TB1 at L1, L2, and L3.
3. Remove the diode heat sink assembly (see "Diode Heat Sink Assembly") and disconnect the diode pigtail connections of leads 6 and 8. (See "Rectifier Diode Test and/or Replacement.")
4. Disconnect lead 5 from dc capacitor common negative terminal.
5. Disconnect leads 9 and 10 from C5.
6. Disconnect P2 header connector from the CM1 option board, leads 11 and 12.
7. Remove the L1 inductor from the rear compartment.
8. Remove the nut holding the top angle bracket to the center mounting plate.
9. Remove the two nuts and one bolt that hold the top angle bracket to T1.
10. Loosen the remaining five nuts that hold the center mounting plate to the frame.
11. Slide the center mounting plate forward.
12. Remove the top angle bracket by first pivoting it upward above the front threaded stud and then sliding it out to the left.
13. Remove the two nuts that hold T1 to the lower angle bracket.

14. Remove the two nuts that hold the lower angle bracket to the frame.

15. Remove the four nuts that hold T1 to the left side of the frame.

16. Rotate the center mounting plate diagonally, counterclockwise, and forward.

17. Slide T1 to the left and then lift with the proper lifting equipment (300 lb. capacity minimum).

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 secures the diode to the heat sink. The stud can be anode or cathode of diode; see the rectifier SD-82604-01 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. The diode is now electrically isolated for test purposes.

2. If this procedure is being performed to test a diode, skip to Step 7. To replace a diode that is known to be defective, continue with Step 3.

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

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

5. Connect the pigtail lead of the replacement diode by reversing the work done in the previous two steps, Step 4 first and then Step 3. Use the hardware saved in Step 4. When reversing Step 3, 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.

6. Install the stud of the replacement diode through the mounting hole in the heat sink. Use the thermal pad,

DP125, comcode 405229154) that was saved in Step 1. Install the new stud nut and torque to 100-125 in/lbs. This completes the rectifier diode replacement procedure. If maintenance is completed, reinstall the diode heat sink assembly according to the "DC Filter Capacitors" section.

7. **Testing a Rectifier Diode:** To determine if the diode is good, use a meter with a diode test function, or measure the forward and backward resistances of the diode. 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.

8. If the diode checked bad, proceed to Step 3 of this procedure to remove and replace it. If the diode checked good, proceed to Step 6 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 J85502B-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 open (**Off**).

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 rectifier's output filter capacitor must be completely discharged. Verify by connecting a DMM to test points **E2** and **E8** on **CM1**. 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. 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 160 to 180 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.