

***Product Manual***

***167-790-125***

***Comcode 107006215***

***Issue 2***

***September 1996***

***Lucent Technologies  
Lineage<sup>®</sup> 2000  
Flexible Power System  
693AA DC/DC Converter***

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***

## ***Description of Product***

This Lucent Technologies product manual (167-790-125) covers product features and specifications, converter technology, installation and testing, as well as operation and maintenance.

This manual describes the Flexible Power System 693AA DC/DC Converter which transforms 24-volt dc source voltages into highly regulated, low noise, -50-volt, 10-ampere dc power sources for use with telecommunications loads. This converter is used in the Lineage<sup>®</sup> 2000 Flexible Power System (FPS) DC/DC converter plant.

When used in the Lineage<sup>®</sup> 2000 FPS DC/DC converter plant, the power system can serve power needs within the 10 to 120 ampere range. To achieve this current range, the system grows in capacity from a one-shelf plant, which accepts up to six converters, into a two-shelf plant capable of housing 12 converters.

Included in the shelf assemblies is a sophisticated plant monitor and control panel, facilities to terminate the input distribution, and output distribution and protection panels. The monitor and control panel serves both one- and two-shelf plants. Input termination and output distribution/protection facilities are provided with each shelf. Figure 1-1 shows a 693AA DC/DC Converter. Figure 1-2 illustrates one and two shelf DC/DC Converter or Rectifier/Converter plants.

The Lineage<sup>®</sup> 2000 FPS series converters are designed specifically for applications where size, weight, ease of installation and maintenance are of overriding importance.

When plugged into a converter plant shelf assembly as shown in Figure 1-2, all interconnections between the converter, the monitor and control panel and the input and output distributions are completed. This front access, plug-in design plant permits growth and easy maintenance without interrupting service.

Because the DC/DC converter plants are physically interchangeable with Lineage<sup>®</sup> 2000 ECS battery plant rectifier shelves, these converter plants may be used with ECS battery plants to provide fully integrated systems where dual voltage, battery backed power is needed.

These features make the FPS series converters the ideal choice for power applications in the 10 to 120 ampere range. UL recognized and CSA certified, these FPS series converters can be operated with or without the monitor and control panel, providing the user with maximum flexibility.

## ***Technology Highlights***

The Lucent Technologies family of Lineage<sup>®</sup> 2000 FPS series converters represents a significant advancement in space utilization and ease of installation over previously available products. A unique Bell Laboratories design, which incorporates 100 kHz switching frequency, advanced technology, and forced-air cooling, has resulted in converters which occupy minimal space. This 10-pound switchmode converter design provides excellent output regulation over a wide range of load currents, and input voltages. Processing the power at higher frequencies allows for substantial reduction in the size and weight of the energy storage elements.

The SR series converters use forced-air cooling to help achieve high power density and light weight. Each unit is equipped with easily replaceable, self-contained cooling fans (see Section 6). Thermal alarm circuitry offers additional protection by shutting down the converter and providing an alarm when the internal temperature exceeds approximately 70°C. Forced air cooling improves the reliability of the converter by reducing the internal ambient temperatures of the converter to essentially the outside ambient temperature.

FPS series converters feature automatic load-share circuits which force the converters to equally share the plant load, thus reducing the stress on individual converters. FPS series converters are self protected; short circuits and system overloads

are handled automatically, if the short circuit is removed, or the system load reduced, the converters automatically resume normal operation.

Signal interfaces between the FPS series converters and the plant monitor and control panel provide alarm monitoring, converter output voltage adjustment, plant current monitoring, lamp test, and converter on/stand by control.

These features allow Lucent Technologies to offer a switchmode converter product and associated power plants that meet the same standards for system flexibility and reliability found in our ECS power plants equipped with SR series rectifiers.

### ***Additional Information***

The data listed below provide the J-codes and product manual select codes for the FPS products associated with the FPS 10A/-48V FPS Series Converter.

693AA DC/DC Converter  
Apparatus code: 693AA  
Product Manual: 107006215  
Select code: 167-790-125

FPS DC/DC Converter Plant  
J-Code: J85500K-1 List 10  
Product Manual: 107006256  
Select code: 167-790-124

FPS Monitor and Control Unit  
Apparatus code: 115C  
Product Manual: 107008328  
Select code: 167-790-048

### ***Technical Support***

Technical support for Lucent Technologies equipment is available to customers around the world.

***USA, Canada,  
Puerto Rico, and  
the US Virgin  
Islands***

On a post-sale basis, **during the Product Warranty period**, our Technical Support telephone number 1-800-CAL RTAC (1-800-225-7822) provides coverage during normal business hours. Product Specialists are available to answer your technical questions and assist in troubleshooting problems. For

out-of-hours EMERGENCIES, the 800 number will put you in touch with a Regional Technical Assistance Center Engineer via our 24 hour a day, 7 day per week Help Desk.

When Technical Support is required in **the Post-Warranty Period**, the service may be billable unless you hold an extended warranty or contractual agreement.

***Central and South America***

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

***Europe, Middle East, and Africa***

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

***Asia Pacific Region***

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

***Product Repair and Return***

Repair and return service for Lucent Technologies equipment is available to customers around the world.

***USA, Canada, Puerto Rico, and the US Virgin Islands***

For information on returning of products for repair, customers may call 1-800-255-1402 for assistance.

***Central and South America***

If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

***Europe, Middle East, and Africa***

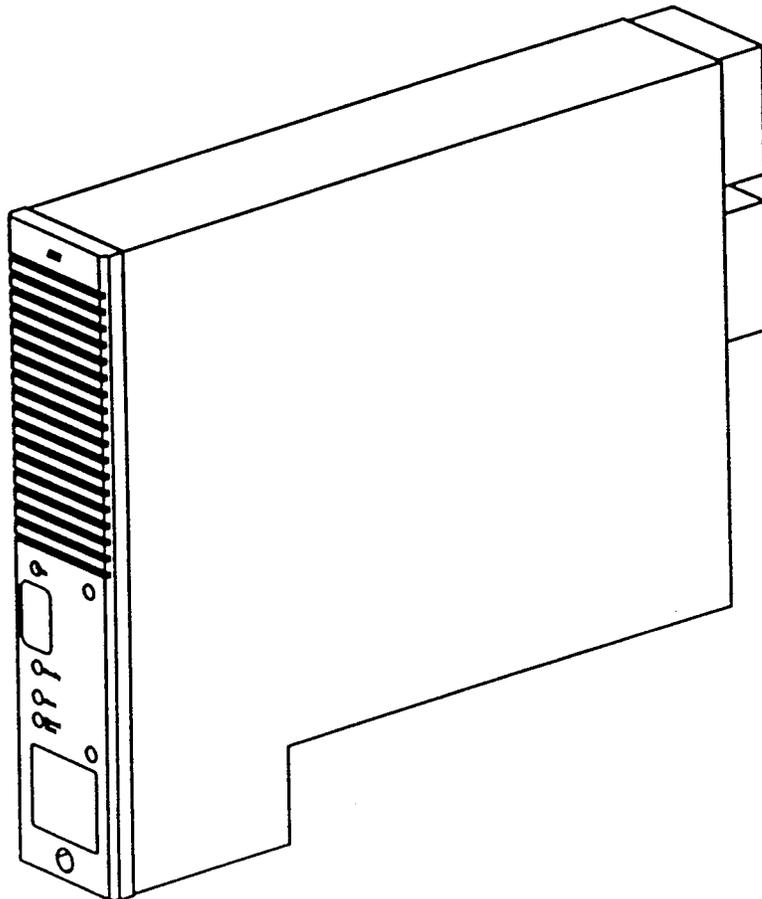
If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

**Asia Pacific  
Region**

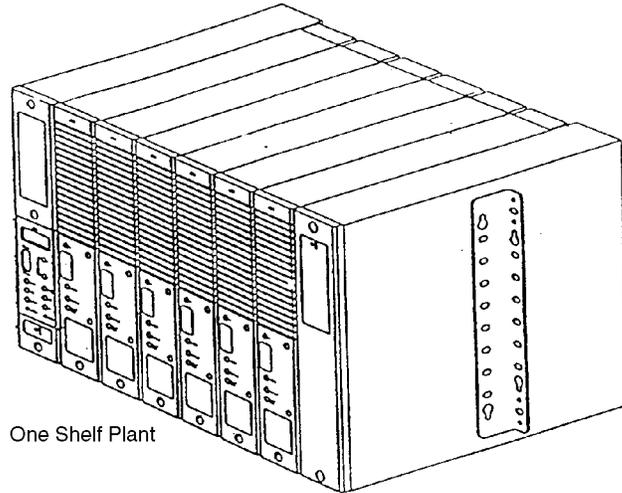
If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

**Customer  
Service**

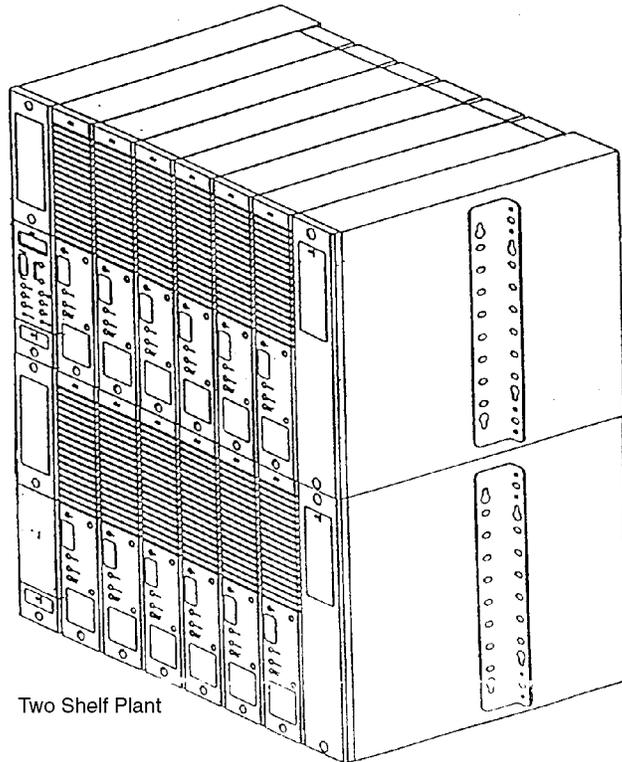
For customer service, any other product or service information, or for additional copies of this manual or other Lucent Technologies documents, call 1-800-THE-1PWR (1-800-843-1797). Specify the select code number for manuals, or drawing number for drawings. Contact your regional customer service organization or sales representative for information regarding spare parts.



**Figure 1-1: Lineage<sup>®</sup> 2000 FPS 693AA DC/DC Converter**



One Shelf Plant



Two Shelf Plant

**Figure 1-2: Lineage<sup>®</sup> 2000 FPS Power Plants**

## 2 *Product Description*

### *Converter Specifications*

**Table 2-A: FPS 693AA DC/DC Converter Specifications**

Nominal Output Voltage	-50 volts dc
Operating Voltage Range	48-52 volts dc
Output Current	0-10 amperes over the operating voltage range
Nominal Input Voltage	24 volts dc
Input Voltage Range	20-30 volts dc
Input Current (see note 2)	List 1 current: 22 amperes List 2 current: 30 amperes Maximum current: 32 amperes
Efficiency	83% typical 82% minimum
Regulation	+/-3.5%
AC Ripple	250 millivolts peak-to-peak maximum, over the range 10 Hz to 20 MHz
Output Noise	28 dBrc
Load Share Accuracy	0.5 ampere
Heat Dissipation	95 watts/325 BTU/hr typical (see note 1)
Temperature	32 to 122°F (0 to 50°C)

**Table 2-A: FPS 693AA DC/DC Converter Specifications**

Altitude	-200 to 13,000 feet -61 meters to 3962 meters For altitudes above 5000 feet, derate the temperature by 3.6°F per 1000 feet. For altitudes above 1524 meters, derate the temperature by 0.656°C per 100 meters.
Humidity	10-95% noncondensing
Audible Noise	57 dBA measured from 2 feet or 0.6 meter from the converter.
Electrostatic Discharge	IEC 801-2 Level 5 (15 KV) at 40% relative humidity.
Radiated and Conducted Emissions	FCC Part 15, Level A
Electromagnetic Immunity	10 V/m over the range of 20 to 2000MHz
Earthquake Rating	Zone 4, upper floors
Safety Agency Approvals	Recognition per UL 1950 CSA approved per 22.2/154
<p>Note 1: Data specified for input voltage of 27 volts and output of 50 volts and 10 amperes.</p> <p>Note 2: List 1 input current specified at input voltage of 27 volts, an output of 50 volts and 10 amperes and efficiency of 83%. List 2 input current specified at input voltage of 20 volts, an output of 50 volts and 10 amperes and efficiency of 83%. Maximum input current specified at input voltage of 20 volts, an output of 52 and 10 amperes and efficiency 82%.</p>	

## ***Physical Description***

The Lineage<sup>®</sup> 2000 693AA DC/DC Converter is a plug-in unit designed for use with FPS power plants as illustrated in Figure 1-2. The frame mounting dimensions and weight of converters and the plants are given below.

Converter	Height: 12 inches Width: 2.6 inches Depth: 15 inches Weight: 10 pounds
Single-shelf plant	Height: 12 inches Width: 21.5 inches Depth: 15 inches Weight: 35 pounds
Single-shelf plant equipped with six converters	Weight: 95 pounds
Frame Mounting Requirements	Standard 23 and 26 inch relay racks Vertical mounting centers: 1.00 inches (25 mm) Horizontal mounting centers: 22.32 inches (567 mm) or 24.32 inches (618 millimeters)

## ***Features***

The following list describes the standard features designed into the Lineage<sup>®</sup> 2000 FPS series converter covered in this manual.

Light weight, easy to install	These connectorized, pluggable units may be installed in an FPS power plant in less than two minutes.
Simplified plant administration	Converters may be installed in a working plant without interrupting service or requiring adjustment. System failures are repaired by replacing the defective converter. Defective fans may be replaced in the field.
Front access only	The converters and the FPS power plants may be installed and serviced without the need for rear access.
User friendly	Front panel LED indicators on the converters and the plant monitor and control panel indicate the system status. A digital meter indicates plant output voltage and load current.
Lamp test	A push-to-test switch on the plant monitor and control panel activates all converter alarm and status LED indicators.

Parallel operation	The converters are capable of operating in parallel with other 693AA DC/DC Converters.
Load share	A load share circuit automatically forces the converters to share the plant load. The load share circuit is made fail-safe by using an isolated load share bus between the converters. Upon failure, the failed converter is disconnected from the load share bus.
Active inrush current limiting	Upon application of the dc source voltage, an active circuit limits the peak inrush current, thus eliminating nuisance tripping of customer provided input breakers.
Output current limit	The converter provides a constant output voltage up to its rated output current, at which point it begins to provide constant current. The maximum output current is limited to less than 125% of the rated output and no user adjustment is necessary.
Internal selective high-voltage shutdown	If the converter plant voltage goes too high, only the defective converter or converters will shut down.
Restart circuit	If a converter has been shut down due to high voltage, it will try to restart a maximum of three times automatically. After three unsuccessful tries, the converter shuts down and locks down.
Converter alarm	The converter alarm provides both a local visual indication of low output voltage and a signal to the plant monitor and control panel. An CFA is generated by the following output undervoltage, thermal alarm, and/or an operated internal fuse.
Thermal alarm	The FPS series converters are fan cooled to increase their reliability. Excess internal temperatures caused by fan failure or other conditions initiate a thermal alarm. See Section 6 - Maintenance for details on fan replacement.

## ***Additional Information***

Dynamic response	Step changes in load over the range of 10 to 90 percent, or 90 to 10 percent, will not cause the voltage measured at the point of regulation to overshoot or undershoot more than 5 percent. After the step change, the voltage will return to and stay within the regulation band within 300 milliseconds.
Lightning protection	The converters are capable of withstanding without damage repeated surges of the following waveforms (per IEEE C62.41-1991 and IEEE 587-1980 requirements): <ul style="list-style-type: none"><li>• Rise time of 8 microseconds to 3000 amperes peak amplitude and decay time to 1500 amperes in 20 microseconds.</li><li>• 0.5 microsecond - 100 kHz ring wave with a peak voltage of 6000 volts.</li></ul>
Shipping	The converter in its shipping container will withstand the vibrations and shocks normally encountered in shipping without damage or degradation of performance.



Although the converters and FPS power plants are keyed to prevent accidental insertion of converters having input or output voltages that differ from the plant voltage, care should be exercised to avoid using excess force to seat a converter in a plant.

**Warning**

Converters and rectifiers in the Flexible Power System product family appear similar and may be identified only by the label.

***Heat Dissipated  
to Environment***

The maximum heat load imposed on the environment by a converter is provided in Table 2-A in Section 2. The 693AA DC/DC Converters are designed for forced air cooling: the building or area must have a maximum ambient temperature no greater than 50°.

**Warning**

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

## **4**                      ***Displays, Controls, and Interface Signals***

### ***General***

The following information provides a functional description of the displays, controls and interface signals associated with normal plant operations and maintenance procedures. The FPS series converter and the Monitor and Control Unit are shown in Figure 4-1. Each item identified by an index number is listed and described below.

### ***Displays and Controls***

The plant operational controls and status indicators are listed below and shown in Figure 4-1.

1. **Digital volt/ampere meter:** A three-digit, backlit, LCD meter which displays plant voltage or plant current for FPS Converter Plants and rectifier plant voltage and current for FPS Rectifier/Converter Plants.
2. **Meter select switch:** A two position switch used to select the plant output, volts or current, to be displayed on the plant meter.
3. **Normal:** This green LED lights while the plant converters are operating normally and are able to furnish power to the load. While in this operational mode, the converters can be switched to the standby mode by a control signal originated by the customer and routed to the converter through the Monitor and Control Unit.

4. **Power Minor alarm (PMN):** A yellow LED which lights to signify one or more of the following conditions: one converter alarm (13) or one converter in Standby (12).
5. **LED Test:** When depressed, this momentary closure switch lights all plant status LEDs and all segments on the plant meter.
6. **Voltage test jacks:** Test jacks are provided to measure the plant output voltage in FPS Converter Plants and the plant rectifier output voltage in FPS Rectifier/Converter Plants.
7. **Major Fuse alarm (MJF):** A red LED which lights to signify that an output distribution fuse or circuit breaker has operated while exposed to excessive current. Manual operation of the circuit breakers typically does not cause an MJF alarm.
8. **Power Major alarm (PMJ):** A red LED which lights to signify one or more of the following conditions: two or more converter alarms (13), two or more converters in Standby (12), or a major fuse alarm (7).
9. **Voltage Adjustment (V Adj):** A screwdriver adjustable, recessed potentiometer which adjusts the plant output voltage for FPS Converter Plants and the plant rectifier output voltage for FPS Rectifier/Converter Plants.
10. **On:** This green LED lights while the converter is operating normally and is able to furnish power to the load. While in this operational mode, the converter can be switched to the standby mode under local control (11) or by a control signal originated by the customer and routed to the converter through the Monitor and Control Unit.
11. **Power On/Standby switch:** This two-position switch determines the operation status of the converter.
12. **Standby:** This yellow LED lights while the converter is in the standby mode. In this mode, the converter control and alarm circuits are powered; however, the power circuits are inhibited to prevent the converter from producing output power. To switch the converter from Standby to On, both the local and remote control signals must be switched to the power On state.
13. **Alarm:** This red LED lights to indicate that the converter has shut down due to an output undervoltage condition, a thermal alarm, or an operated internal fuse.

14. **Thermal alarm:** This red LED lights when the converter shuts down due to inadequate air flow indicating possible intake air blockage, fan failure or inlet air temperature above 122°F (50°C).

## *Interface Signals*

This section describes the interface signals between FPS series converters and the Monitor and Control Unit.

15. **On/Standby control:** A plant Monitor and Control Unit originated signal which controls the operational status of the converter. When the signal is present, the converter is forced into the standby mode.
16. **Output voltage adjust:** A plant Monitor and Control Unit originated control voltage which sets the converter output voltage to the desired value within the converter operating voltage range. For controller-less operation, the converter output is internally adjusted to the nominal voltage.
17. **Output current monitor:** A signal provided to the plant Monitor and Control Unit proportional to the converter output current.
18. **LED Test:** A plant Monitor and Control Unit originated signal which tests the converter status LEDs. When the signal is present all LEDs illuminate.
19. **Alarm Return (AR):** A signal path between the Monitor and Control Unit and both rectifiers and converters in FPS power plants that provides a common return path for signals 15, 18, and 20.
20. **Converter Alarm:** A signal to the Monitor and Control Unit indicating low rectifier output voltage resulting from a converter failure or excess load.

## *Additional Information*

21. **Mounting screw:** Hex head screw used to secure the converter to the plant assembly.

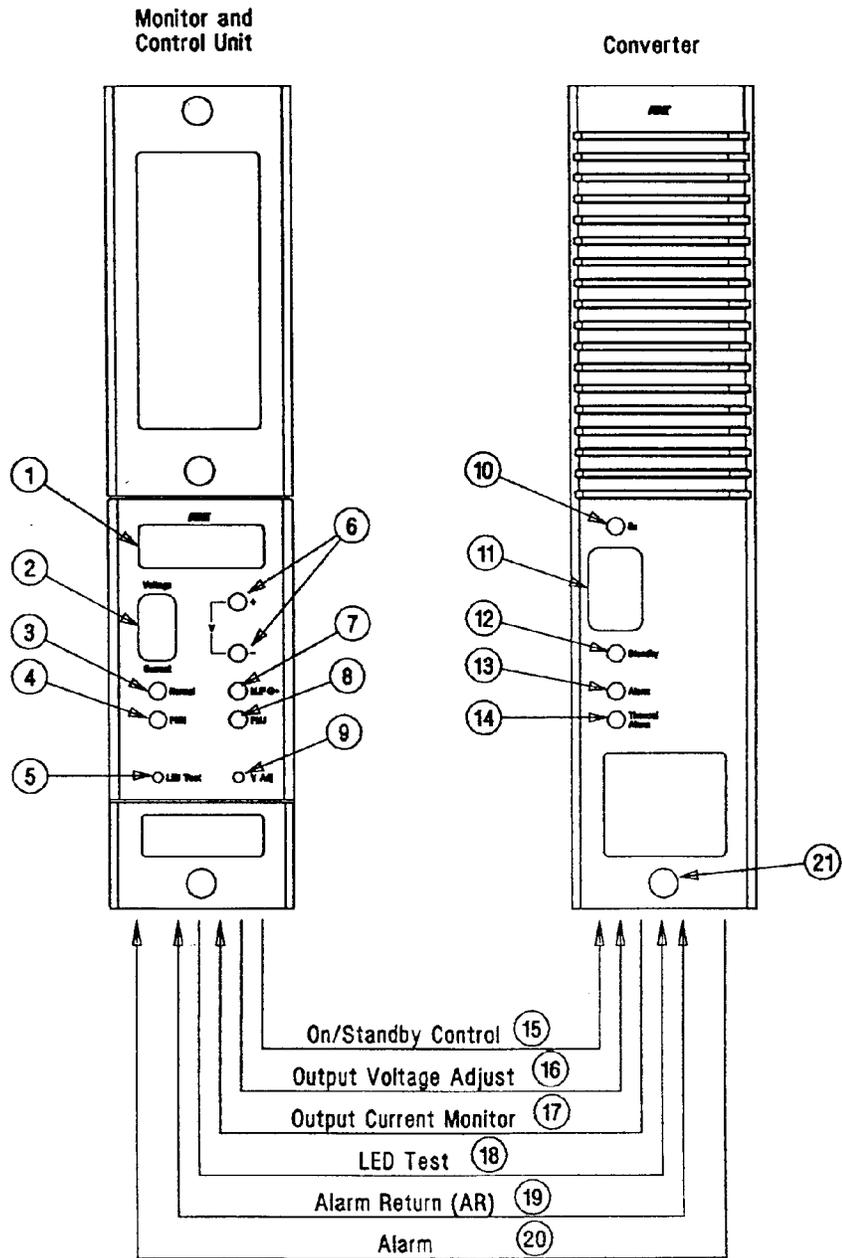


Figure 4-1: Functional Description

## **5**                      ***Installation***

### ***Introduction***

This section covers the unpacking and handling requirements for converter installation and removal, as well as initial start up and checkout procedures.

#### **Warning**

Only persons trained and experienced in the installation of telecommunications power equipment should install the converters and associated FPS power plants.
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### ***Installation Tools and Test Equipment***

The following tools and test equipment are required for installation and test of the converters.

- Insulated 3/16" Allen wrench key (provided with each FPS power plant).
- Fluke 8060A Digital Multimeter (DMM) or equivalent. The accuracy of an equivalent meter should be +/-0.05% on the dc scales.

### ***Unpacking and Handling***

Immediately upon removal from shipping cartons, check contents against the respective shipping lists and inspect for possible shipping damage. Contact carrier if the equipment was damaged in transit and request instructions for filing a damage claim.

## ***Adding a Converter to a New or Operating FPS Power Plant***

The procedures for installation of a converter in an operating plant or a new plant are identical. Refer to Figure 4-1 and proceed as follows:

1. Verify that the On/Standby switch is in the Standby position.
2. Place converter at the selected converter slot. The converter must be horizontal and at the correct height so that it rests on the top of the plant shelf assembly.
3. Grasp the front handle and carefully slide the converter toward the back panel of the plant shelf assembly. Push until seated. The front edge of the converter should overhang the plant shelf assembly by approximately 1/4 inch.
4. Use a 3/16" (5mm) Allen head wrench to turn the recessed converter locking screw located in the lower center of the converter clockwise until the converter is firmly seated.

Proceed to paragraph "Initial Start-up and Checkout."

## ***Disconnecting a Converter from an Operating Plant***

Refer to Figure 4-1 and proceed as follows:

1. Verify that the On/Standby switch is in the Standby position.
2. Use a 3/16" (5mm) Allen head wrench to turn the recessed converter locking screw counterclockwise until the screw turns freely.
3. Grasp the front handle and slide/pull the converter from the plant shelf assembly.

### **Note**

Due to energy storage in the converter, the front LEDs will remain lit for approximately one minute after removal of dc voltage. No hazardous voltages exist on the converter terminals during this time.

## ***Initial Start-up and Checkout***

### ***Introduction***

This section describes the testing procedure for both newly installed or replacement converters. If the plant in which the converter is being connected has never been operational, consult the plant and monitor and control panel product manuals for their installation test procedures. The converter installation test must be performed after plant monitor and control panel tests have been completed.

### ***Electrical Testing for Converters***

The following procedures can be used to verify that the converters are working either after initial installation, subsequent addition, or replacement of a converter. For troubleshooting and diagnostics, refer to Section 6. Refer to the appropriate figures in Section 4 during the performance of these procedures. Those unfamiliar with the function of converter controls and indicators should read Section 4.

### **Warning**

Before turning on any converter, be sure that the associated framework and cable rack are properly grounded per local job instructions and code requirements.
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### ***Background Information***

Voltage required to operate the indicators on the converter, as well as some of the relays is derived from the dc input voltage. The dc voltage is available to these circuits whenever dc service is available and either the On or Standby LED is illuminated.

### ***Initial Power Up and Adjustment***

Set the dc supply and converter controls as follows:

1. Verify that the source voltage dc circuit breaker is On or the appropriate fuses in the service panel are installed.
2. Verify that only the Standby LED is illuminated on the converter.
3. Turn the converter power switch to ON. Verify that only the power On LED lights.

**Note**

If LED's status is not as specified, refer to Section 6 for troubleshooting help.

4. Repeat steps 1-3 for all converters to be placed on line.
5. When converters are added to a working plant, the converter output voltage is automatically adjusted to the plant output voltage.
6. During initial installation of an FPS DC/DC converter plant, the plant voltage is set using the voltage adjustment on the monitor and control panel. When installed in an FPS Converter/Rectifier plant, the converter output voltage is automatically set to the plant voltage. Verify the voltage is set correctly using the plant meter or using a test meter.

**Note**

If the converter status or voltage adjustment is not as specified, refer to Section 6 for troubleshooting help.

## **6**                      ***Maintenance***

### ***Introduction***

This section provides field maintenance information and procedures for the converters. Those unfamiliar with the function of converter controls and indicators should read Section 4.

### ***Fan Maintenance***

The expected life of the converter fans at 25°C (77°F) is seven years. The fans are mounted external to the converter allowing the fans to be replaced in the field without opening the converter. When both fans fail, the converter shuts down and issues a converter alarm and a thermal alarm both locally and to the monitor and control panel.

Two approaches can be taken to fan maintenance. The first approach is to routinely replace all fans every five years ensuring that the fans do not fail in the field under normal operating conditions. This approach is appropriate when there are no remote alarm facilities at the site. The second approach, assuming one has remote alarm capability, is to wait until the fans fail. The converter will safely shutdown and issue both a fail alarm and a thermal alarm. The fans can then be replaced. Since it is likely that all the converters in that installation are of roughly the same age, all converter fans at that site should be replaced at that time. The approach used depends on the convenience of the site as well as the monitoring of alarms used at the site.

See paragraph “Replacement of Fan” for the fan replacement procedure.

## ***Lamp Test***

The following test may be used to determine if all front panel LEDs and the display are functioning properly.

1. Press the lamp test switch on the monitor and control panel.
2. While the lamp test switch is pressed, all front panel LEDs should be illuminated.

## ***Diagnostics***

### ***Introduction***

This section diagnoses possible problems that may occur with the converter installed in an FPS power plant. Use the flow chart in Figure 6-1 to isolate the malfunction to the defective replaceable components or assembly.

Diagnostics consist of determining whether or not the converter needs to be replaced in the event it does not deliver power. Diagnostics also help determine if the problem is in a component other than the converter.

### ***Equipment Required***

- 3/16" Allen wrench for replacing converters.
- Fluke 8060A Digital Multimeter (DMM) or equivalent. The accuracy of an equivalent meter should be +/-0.05% on the dc scales.

### ***Replacement of Fan***

Refer to Figure 6-1 and proceed as follows:

1. Refer to Section 5 to remove the converter.
2. Remove two screws holding fan and fan guard onto back panel of chassis.
3. Separate fan assembly from chassis back panel.
4. Unplug connector on old fan from back of power unit.
5. Plug in connector on new fan to back of power unit.
6. Attach fan assembly to chassis back panel using two screws.
7. Repeat steps 2 through 6 for the second fan.

8. Replace and restore ac service according to the procedures outlined in Section 4.

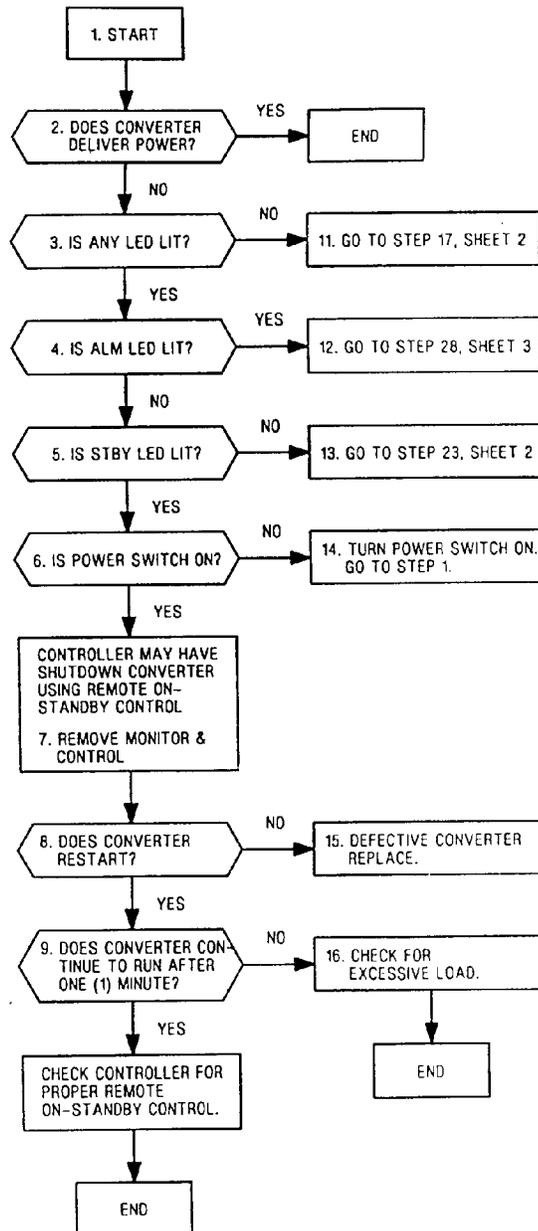


Figure 6-1: Troubleshooting Flowchart (Sheet 1 of 3)

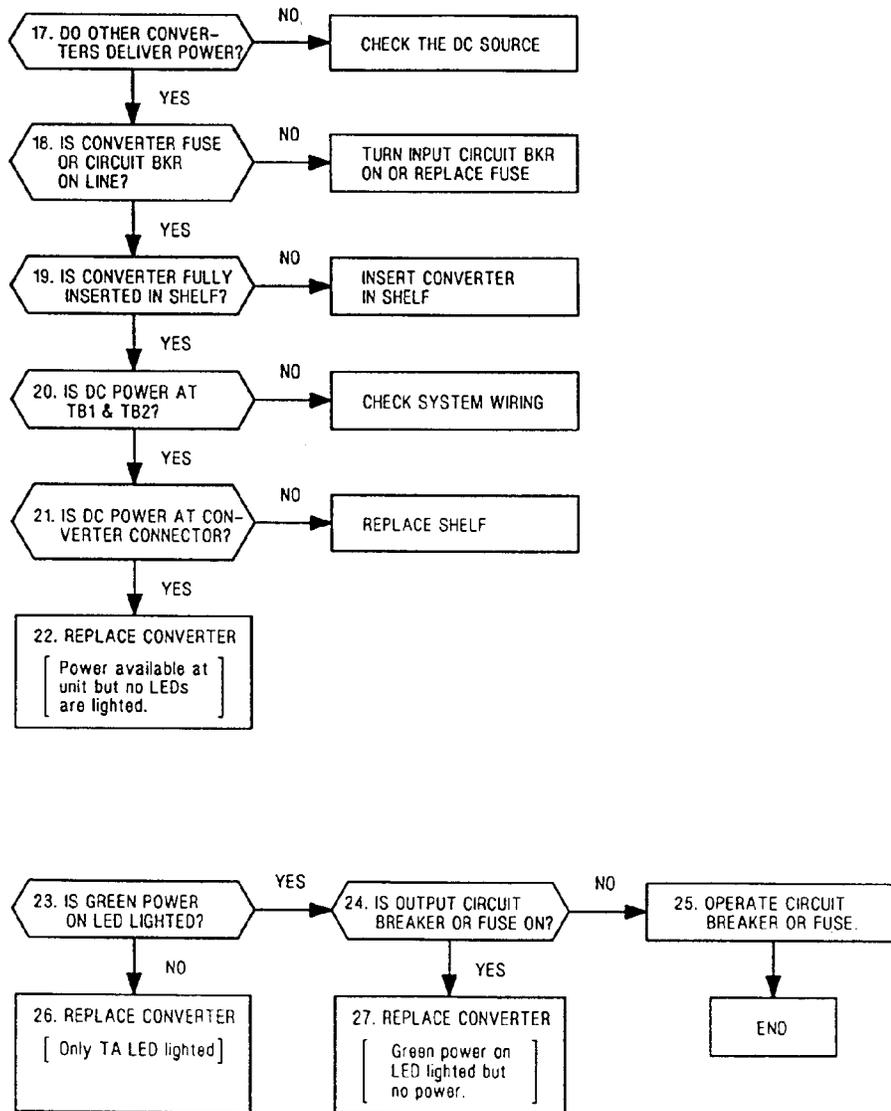


Figure 6-1: Troubleshooting Flowchart (Sheet 2 of 3)

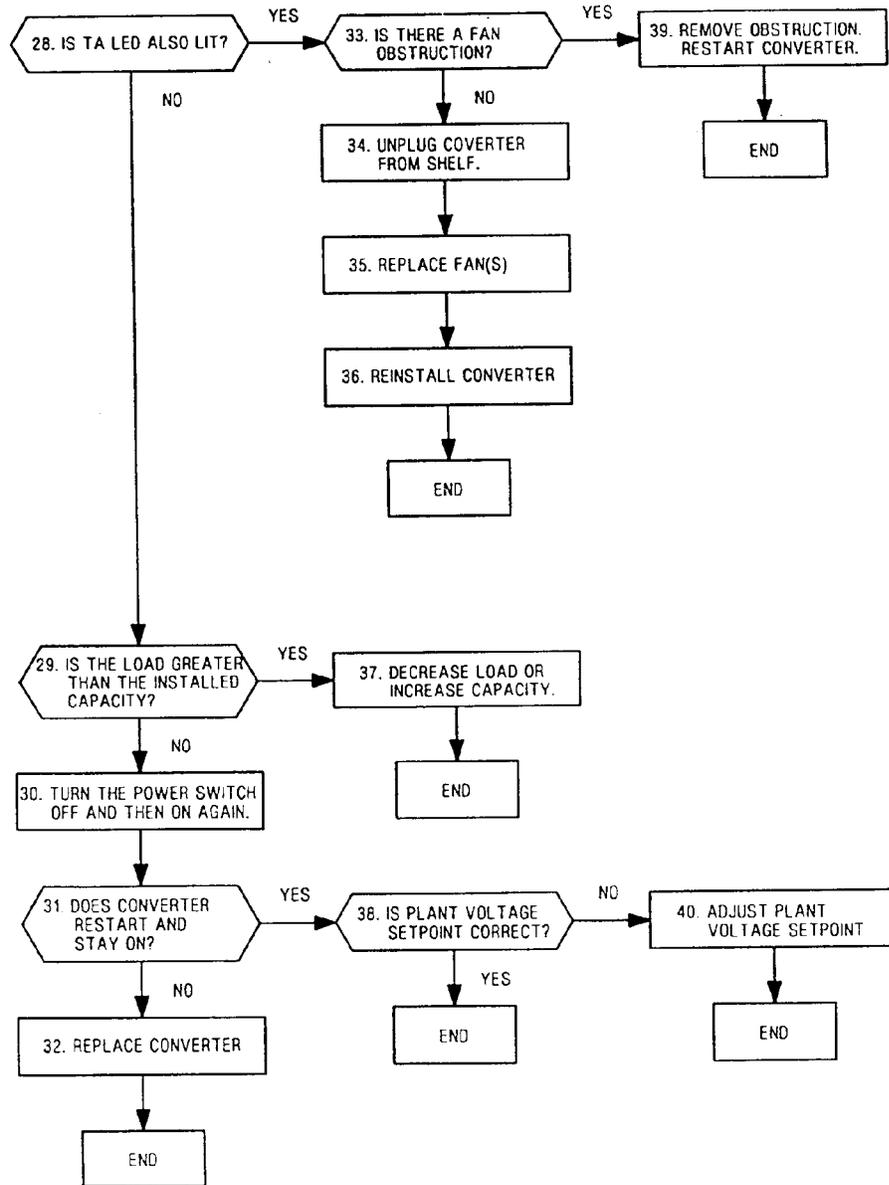


Figure 6-1: Troubleshooting Flowchart (Sheet 3 of 3)

## 7 *Spare Parts*

With exception of the fan, the 693AA DC/DC Converter is repaired by replacement; therefore, consideration should be given to sparing the converter itself. See appropriate Lucent Technologies representative for details on the repair policy for this converter.

The recommended spare parts for the SR series converters are given below.

**Table 7-A: Recommended Spare Parts**

<b>Converter</b>	<b>Part Description</b>	<b>Comcode</b>
693AA	DC Fan Assembly	847017548

## 8 *References*

The following drawings are shipped with all FPS converter plants and FPS rectifier/converter plants. These drawings provide the details, not provided in this manual, that are necessary for proper installation of converters in these plants.

**Table 8-A: Drawing References**

<b>Drawing</b>	<b>Drawing Title</b>
J85500K-1	Lineage <sup>®</sup> 2000 FPS Rectifier/Converter Plant
T-83158-30	Lineage <sup>®</sup> 2000 FPS Rectifier/Converter Plant
SD-83158-01	Lineage <sup>®</sup> 2000 FPS Rectifier/Converter Plant

## 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.
- H. 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.

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