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MX28B1200/2400
MX28B1200/4800
-48 VDC POWER SYSTEMS
User's Manual

(Document # 990-1148A)

Table of Contents

Revision History

Revision	Date	By	Description
1	31 JAN, 2002	JNF	Converted to APC numbering
2	28 SEP, 2003	BET	Updated Format and added 4800

Table of Figures

1 Safety First!

It is very important to follow all safety procedures when unpacking, installing and operating any sort of power equipment.

1.1. Warning Symbols

	**CAUTION**: An indication that special care is required to prevent injury, equipment damage or misuse

	**WARNING**: An indication of an electrical hazard that may cause serious personal injury or death, catastrophic equipment damage or site destruction.

1.2. General Precautions:

	**WARNING**: The DC power plant is supplied from a nominal 220VAC, 50/60 Hz source. Keep the AC input enclosure cover in place when the system is operational or energized

	**WARNING**: Hazardous energy levels are present on bare conductors in the -48VDC distribution connection area of the plant. Accidental shorting of distribution conductors can cause arcing and high currents that can cause serious burns or other physical harm. It is recommended that: a. Any jewelry, rings or watches be removed while working on this equipment. b. Handles of all wrenches, screwdrivers, cutters and pliers are insulated.

	**WARNING**: Ensure that all of the DC and external AC circuit breakers are in the OFF position prior to connecting service to the power plant. Confirm that all voltages have been removed including any battery sources before proceeding**.**

Specific **CAUTION** and **WARNING** will be placed in manual where appropriate.

2 Introduction

2.1. General Information

DC Power Plants from APC have unique features that make them easy to install, maintain, and upgrade. The rectifier units are modular and truly “hot-pluggable” into the shelf assembly without any separate AC wiring. All system settings are made from the system control unit that provides monitoring and control functions for each component of the system as well as alarm listings for system diagnosis and maintenance.

The APC Model MX28B is a modular stand-alone -48V DC power plant. It is configurable in such a manner that it will support most typical applications within the specified current ranges (50-4800 amperes) without special application engineering or assistance. Distribution can be included for a variety of circuit breakers or Telecom style fuses. These circuit breakers can be 1 to 700 amps. Fuses can be 70 to 600 amps. An optional low voltage disconnect (LVD) can be provided on either the battery or the load side. A 1200 amp MX28B Rectifier Bay is shown in **Figure 2.2-1.** A block diagram is shown in **Figure 2.2-2.**

2.2. How to Use This Manual

Each section of this manual can be read in any order and should provide a complete explanation of the subject described by the title. However, the sequence of the sections is designed to provide a typical step-by-step process for successful use of the equipment.

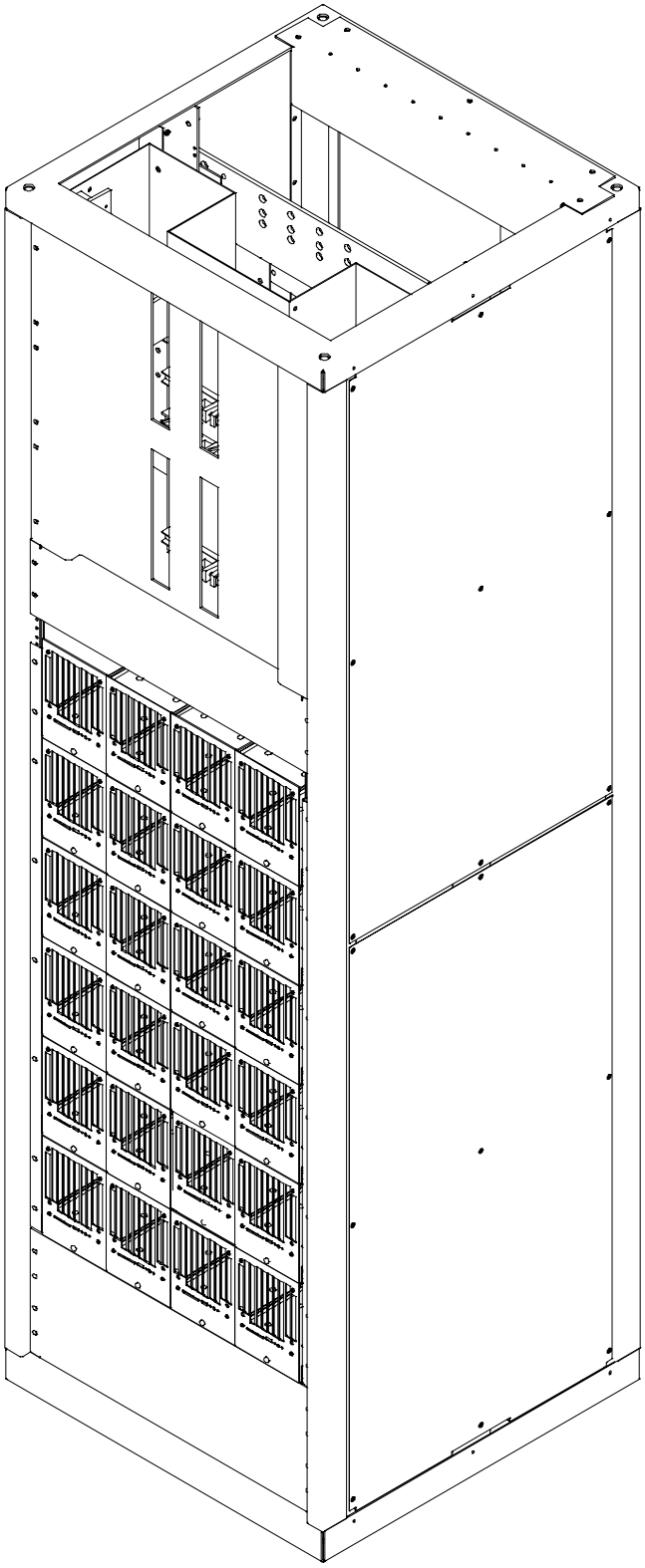


Figure 2.2-1 MX28B-1200 –48 VDC Power Plant Rectifier Bay

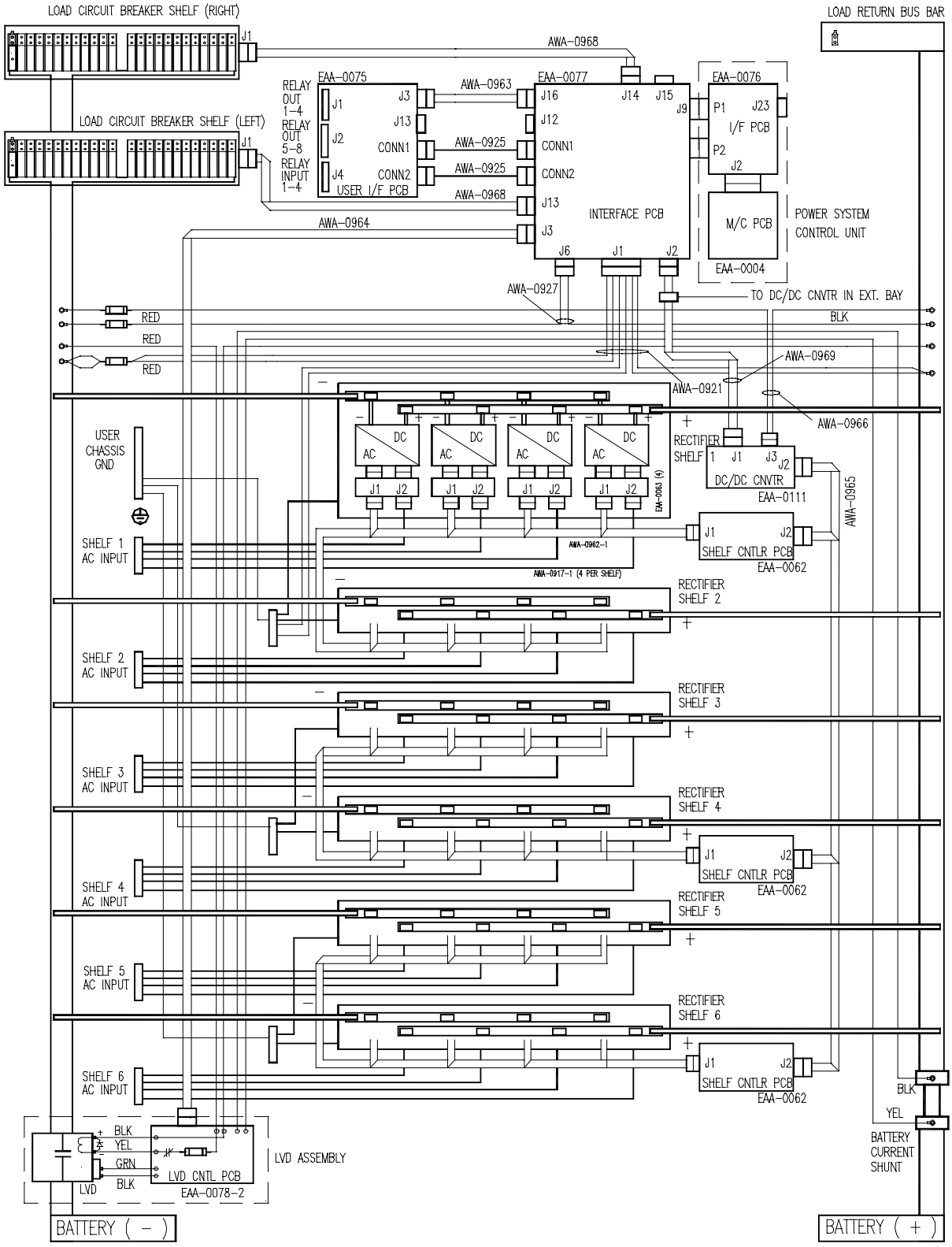


Figure 2.2-2 MX28B Block Diagram

3 Installation

3.1. Unpacking Equipment

Remove equipment from packing material and inspect for shipping damage or missing items. It is important to report damage or material shortages to the shipping carrier while a representative is on site.

If concealed damage or material shortages are found at a later time, contact the shipper to make arrangements for inspection and claim filing. Refer to **Section 7** in the event it is necessary to return equipment to APC.

	**CAUTION**: Appropriate lifting techniques and safety equipment should be used to remove equipment from packing.

	**PLEASE RECYCLE**: The shipping materials can be recycled. Please save them for later use or dispose accordingly.

3.2. Mechanical Installation

Room / Location

NOTE: The APC Model MX28B DC power plant is to be installed in a room, vault, or similar enclosure that is accessible only to qualified persons in accordance with the NEC or the authority having jurisdiction.

Prior to installation, drawings, floor loading requirements, external alarm points, AC service entrance, and grounding schemes should all be checked and confirmed. If batteries are to be mounted in a room separate from the power plant, careful attention should be paid to battery cable voltage drop effects. Environmental operating temperatures and ventilation/cooling considerations should also be noted, not just for the power system but also for all other equipment that may reside in the power room area.

Mounting

The box frame housing the MX28B components is self-supporting, but designed to be bolted to the floor of the housing structure. **Figure 3.2-1** shows the footprint of the box frame and the mounting points with dimensions (shown in inches). Consult the system design specifications to see if it is necessary to electrically isolate the frame from the floor structure. This is required in many installations.

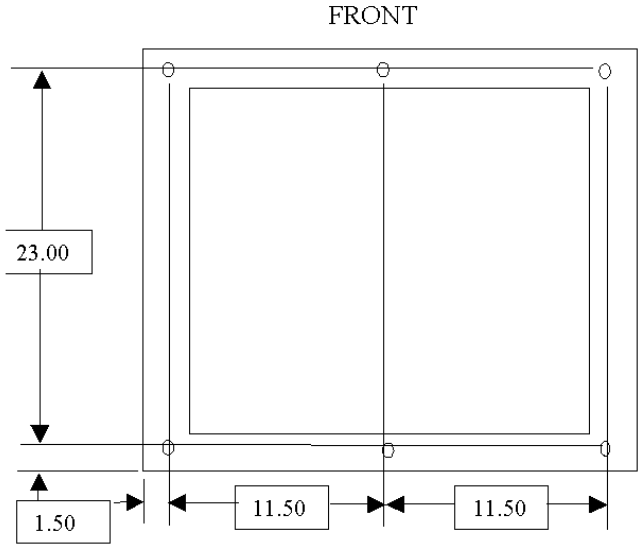


Figure 3.2-1 Floor Mounting Dimensions

Systems with multiple box frames are mounted with each frame touching, side by side. The side cover panels where two frames touch are removed so that bus work and control cables can pass between the frames. Three holes are provided in center vertical rail of each side to allow the frames to be mechanically secured to each other if desired.

Power Bus Connections

At the top of each bay there are 3 power buses that transfer the power from 1 bay to another. The system is rated such that the entire load can be run from a fuse or circuit breaker bay mounted next to the rectifier bays. The MX28B-1200/2400 has a maximum of two rectifier bays. The MX28B-1200/4800 can be expanded to four rectifier bays. The power buses are connected together in each bay by splicing the buses together. The MX28B1200/2400 is a 1200 Amp system expandable to 2400 Amps. The MX28B-1200/4800 is a 1200 Amp system expandable to 4800 Amps. Each MX28B-1200/2400 power bus is comprised of 2 laminations of 5” X 1/4” bus. See **Figure 3.2-2** for details. Each MX28B-1200/4800 power bus is comprised of 3 laminations of 6” X 1/4” bus. See **Figure 3.2-3** for details. The power bays are spliced together with splice plates provided with each expansion bay. The size and thickness of the splice plates must match the power bus. See **Figure 3.2-4** for details.

Figure 3.2-2 MX28B-1200-2400 has a maximum capacity of 2400 Amps.

Figure 3.2-3 The MX28B1200-4800 can be expanded to 4800 Amps.

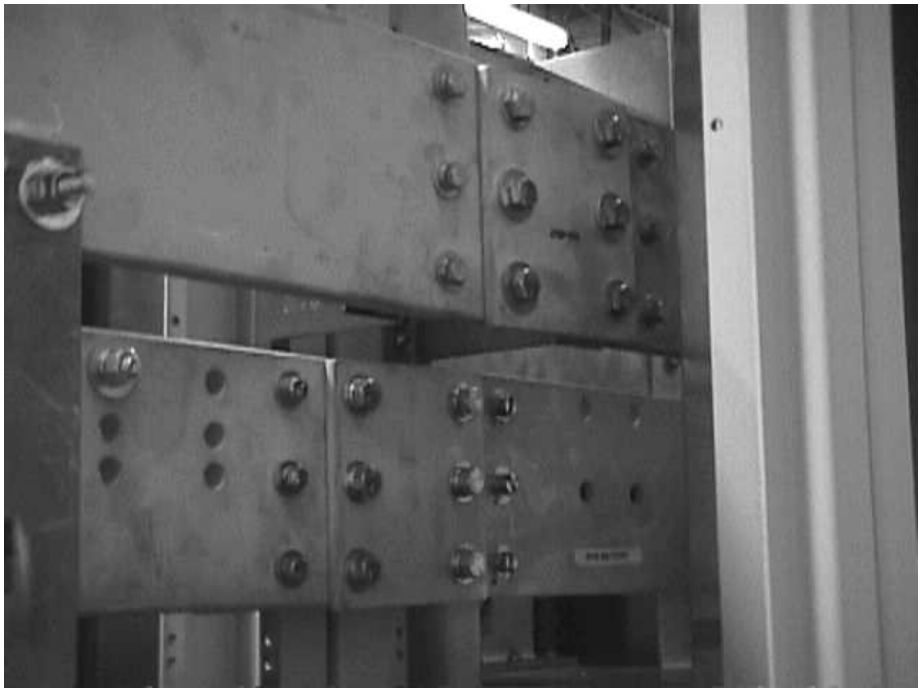


Figure 3.2-4 Splice Plate Installation

Circuit Breaker/LVD Ribbon Cable Connections

Additional cables must be connected between cabinets to ensure that the circuit breaker alarms in the expansion bays are reported correctly. The circuit breakers and LVDs are connected together through the use of a Circuit Breaker / LVD Expansion Board. The ribbon cables on the left hand side of the board go to the bay to the left. The ribbon cables on the right hand side of the board go to the bay to the right. If there is an open Alarm Contact Bus connector (no bay to the side of the unit) the cable connector is left open and no further action is required. However if the LVD Bus ribbon cable connector is open, the pins nearest the connector will have to be jumpered. Install the jumpers using **Figure 3.2-5** as a guide to jumper orientation. If a cable is installed remove the jumpers on the pins nearest the installed ribbon cable.

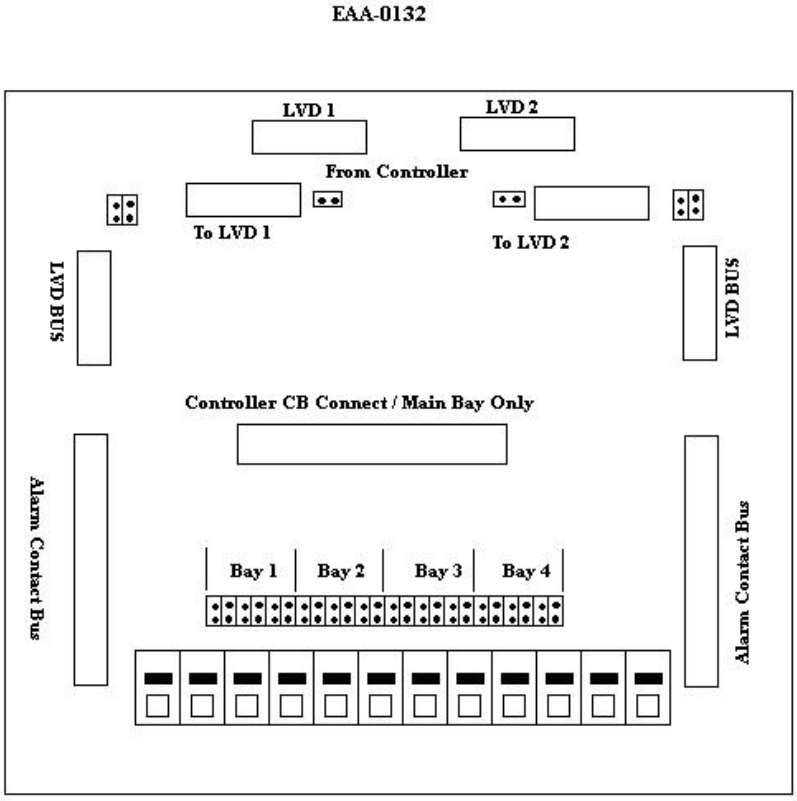


Figure 3.2-5 Circuit Breaker / LVD Expansion Board

Fuse Alarm Ribbon Cable Connections

There is a 16-conductor ribbon cable, if any bay has fuses installed. This cable ties together the Wago breakout board in each bay with fuses. The ribbon cable must connect all the Wago breakout boards together with one ribbon cable. The idea is that each fuse will have one wire in the ribbon cable for the alarm. Two fuse alarm wires should not be connected to the same fuse. See **Figure 3.2-6** for details. Ribbon cable pin 1 is for Fuse 1. Ribbon cable pin 2 is for Fuse 2 etc.

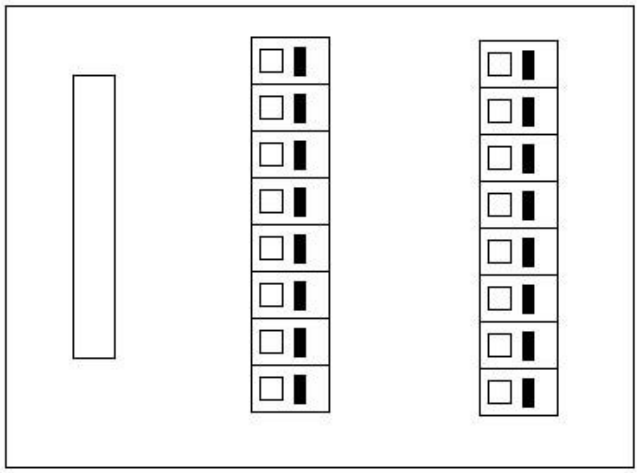


Figure 3.2-6 Wago Fuse Alarm Breakout Board

Ventilation

The rectifier modules for this system have fans that provide front-to-rear airflow for internal cooling. The MX28B housing should mounted such that there is free airflow to the front and top of the unit. [Refer to **Section 8.5** for environmental characteristics.] Free airflow should be ensured so that the power system can provide full power without de-rating.

3.3. AC Power Connections

	**WARNING**: Ensure that all of the external DC and AC circuit breakers are in the OFF position prior to connecting service to the power plant. Confirm that all voltages have been removed including any battery sources before proceeding**.**

The MX28B DC power plant requires the supply of 208/220/240/277 VAC single-phase, 50/60 Hz power through individual external 20-amp circuit breakers to the AC input terminal block connections for each rectifier module in the system. Two rectifier modules are required to accommodate the full AC input voltage range. The 1MRF28H54BV rectifier is designed for the standard 208/220/240 VAC input service, while the 1MRF28H54BV50 is used for the 277 VAC

input. The AC wiring, from the AC input terminal block connections to the hot-pluggable AC input connector for each rectifier, is factory installed.

The AC input enclosure, located at the top rear of the MX28B rectifier bay, is provided with nine ¼ -inch pilot holes in the top plate. Remove the ac input enclosure from the box frame in order to punch or drill the appropriate number of conduit openings for the conduit size(s) desired. *Do not leave the ac input enclosure in place when punching or drilling holes in order to prevent metal pieces from falling into the power system.*

AC wiring passing through the conduit will be routed through the access opening in the ac input enclosure into the vertical wiring channel where safety ground bar and rectifier input terminal blocks are located. The terminal block(s) is labeled as Rectifier 1 through Rectifier 4 with each position having inputs designated “L1” and “L2/N” for connection of the two ac wires **Figure 3.3-1.** Each terminal block represents connections for one shelf, with positions 1 through 4 corresponding to the rectifier shelf positions numbered from left to right as viewed from the front.

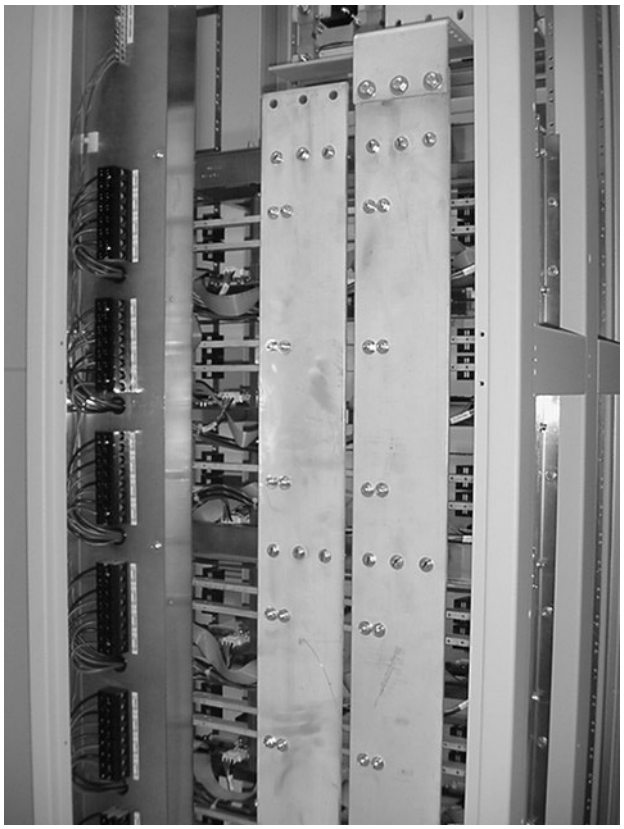


Figure 3.3-1 AC Input Wiring

The suggested wire size is #10 AWG rated at 90°C or higher; however, the ambient temperature and number of wires in a conduit must also be considered in accordance with NEC requirements. It is suggested that feeds for four rectifiers (8 wires) and one safety ground wire be run in a one-inch conduit; however, be sure to follow any local electrical wiring codes.

If the AC input power is provided from a three-phase distribution panel, the circuit breaker positions should be selected such that the load is balanced as much as possible.

	**WARNING**: The MX28B DC power plant is supplied from a high voltage source. Keep the AC input enclosure in place when the system is operational or energized.

3.4. Battery Connections

	**WARNING**: Hazardous energy levels are present on bare conductors in the -48VDC distribution connection area of the plant. Accidental shorting of distribution conductors can cause arcing and high currents that can cause serious burns or other physical harm. It is recommended that: c. Any jewelry, rings or watches be removed while working on this equipment. d. Handles of all wrenches, screwdrivers, cutters and pliers are insulated.

Planning the Battery Installation

The battery cable(s) should be sized sufficiently large to limit the voltage drop from the MX28B DC power plant to the battery during charging per system design requirements. The cable(s) must also carry the full load current during battery operation. If assistance is required to determine the necessary cables for the application, contact your sales representative or APC.

An external fuse or circuit breaker (various options are available from APC) is recommended in the negative line (located at the battery end) to protect the cables from the battery to the MX28B DC power plant. The power plant can monitor auxiliary contacts from this breaker.

Connecting the Battery Cables

⚠	**WARNING**: Make certain that the battery polarity is correct when making connections to the Model MX28B DC power plant. Incorrect connection could cause severe equipment damage.

The battery cable connections are located at the top rear of the unit as shown in Figure 3.4-1. The battery positive (return bus) and battery negative (-48V bus) buses each provide four sets of 3/8" holes on one-inch or 1-3/4" centers for connecting two-hole battery cable lugs. Connect the battery cables as applicable using 3/8-16 bolts (not provided) and tighten them with a torque wrench to 200 in-lbs (23 N-m).

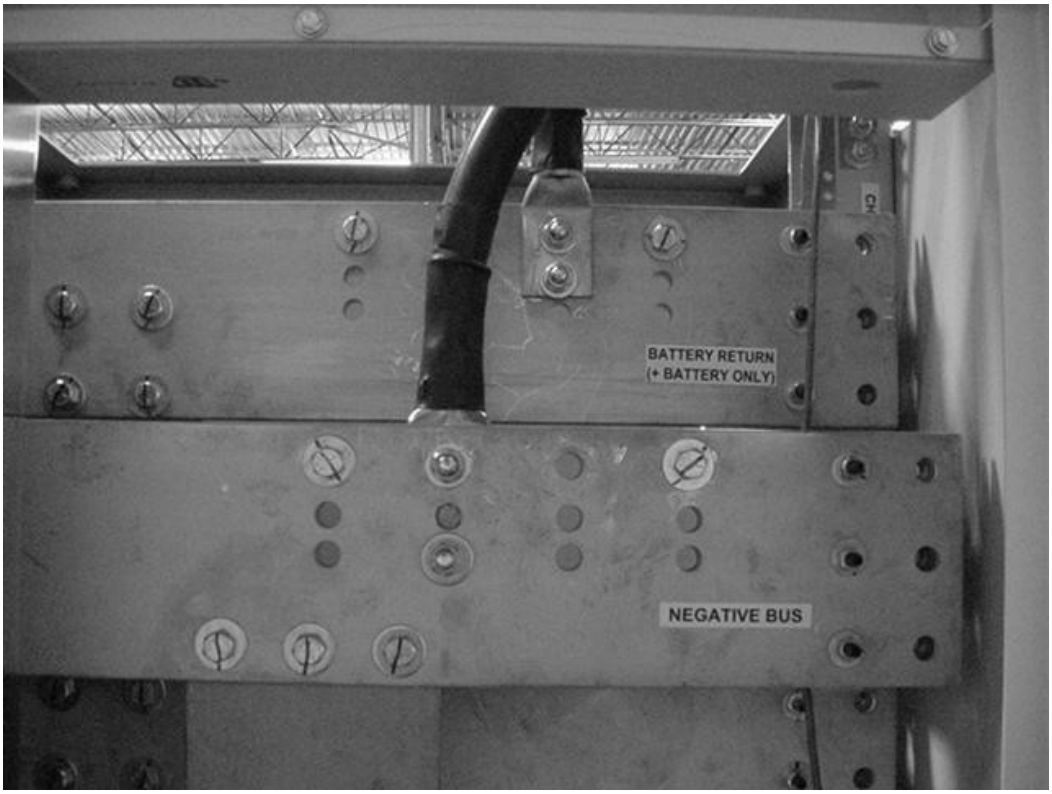


Figure 3.4-1 Battery Cable Connection Locations

Battery Temperature Probe Installation

The optional temperature probe is used to monitor the battery string temperature. To get the most representative temperature measurement, the probe should be placed in contact with a battery cell that is centrally located. The probe should be placed directly in contact with the cell (not the frame surrounding the cell). Generally, the cell cover can be used; be careful not to allow the probe body to touch the terminals. Remove the adhesive protection strip from the probe body and press the adhesive side of the probe on the battery cell cover. See Figure 3.4-3 for details. Plug the connector end of the temperature probe into J5 of the control unit backplane card. Route the cable as required positioning the probe on the selected battery cell. See Figure 3.4-2 for Details.

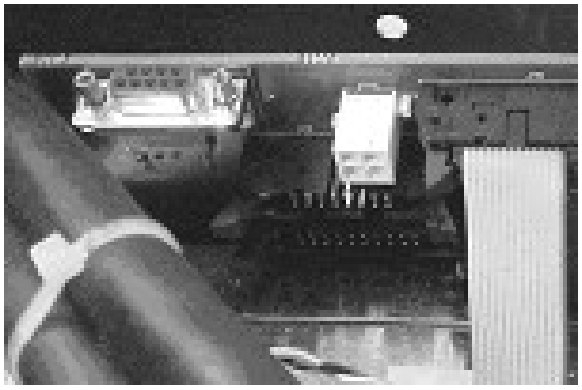


Figure 3.4-2 Battery Probe Connection

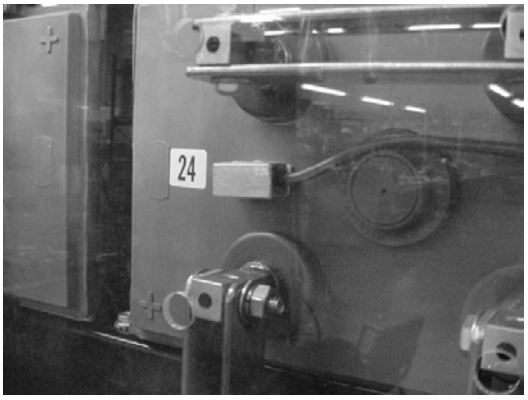


Figure 3.4-3 Battery Probe Installation

3.5. DC System Grounding

The Positive Battery connection (return bus) for the power plant must be connected to the Master Station Ground. The return bus provides 3/8" holes on 1 inch or 1-3/4 inch centers for connection of a two-hole lugged cable to the Central Office Ground. Details for this connection should be provided in the site electrical grounding plans.

A connection to tie the frames together is also available. At the top of both sides of the box frame is a pair of studs for connecting a grounding cable. This #6 AWG cable is provided with each expansion frame.

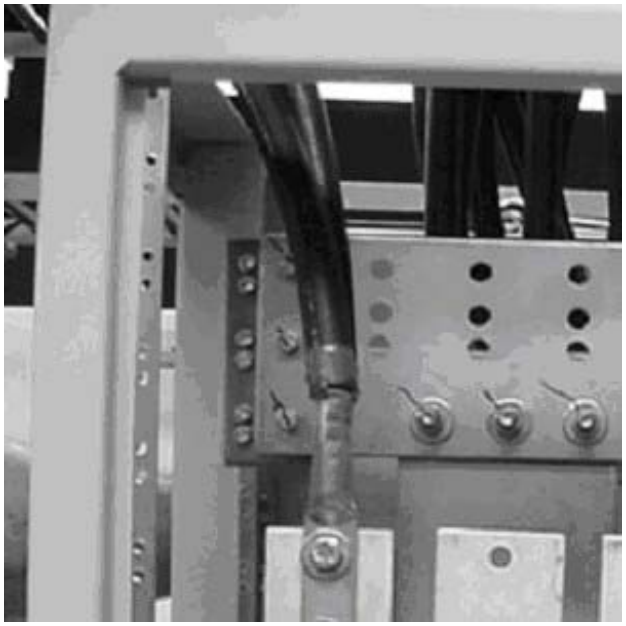


Figure 3.5-1 DC System Grounding

Figure 3.5-2 Box Frame Ground

3.6. DC Power Output Over-Current Protection

There are several different options for DC output power distribution. Distribution provides a convenient method of connecting the load cables as well as over-current protection.

DC Plug-in Circuit Breakers

A standard 48-position plug-in circuit breaker tier provides -48V distribution. Various circuit breaker sizes from 1 to 100 amps are available, with 60-100 amp breakers requiring two positions and a circuit breaker adapter kit. Each rectifier bay has two 24-position breaker tiers. Each breaker tier is connected at its center to the -48V DC bus, and each side of the tier has a total current capacity of 300A. Each breaker tier has a total current capacity of 600A. Each rectifier bay has a total current capacity of 1200A. It is therefore necessary to balance the load on the rectifier bay to avoid overloading any section of the output bus. Also when planning the output installation, take into consideration the configuration of the plant and the number of rectifiers installed.

Any combination of up to 48 single (1-50 Amp) or up to 24 double (60-100 Amp) breakers may be installed. If all rectifier bays are installed with snap-in breakers, up to 192 single or 96 double breakers may be installed. In the main bay a pair of ribbon cables routed directly to the controller backplane handles alarming. In the expansion bays, each 24-breaker tier is alarmed as a group of breakers. A two-pin connector on each tier connects to the Circuit Breaker expansion board in each bay. Circuit breaker alarms can be monitored by attaching the other end of the alarm wire to the gray Wago connector on the Circuit Breaker / LVD Expansion board. Since the normally open contacts are monitored, any tripped breaker will give an alarm. Install the alarm wire in the Wago connector on the expansion board. Jumper the pins behind

the Wago connectors based on what bay the circuit breaker tiers are in. Typical circuit breaker numbering is bay 1: Cir Bkr 1-48, Bay 2: Cir Bkr 49-50, Bay 3: Cir Bkr 51-52 and Bay 4: Cir Bkr 53-54. **Figure 3.6-1** shows the power plant's main bay (with ribbon cables) DC distribution section with the front cover opened.

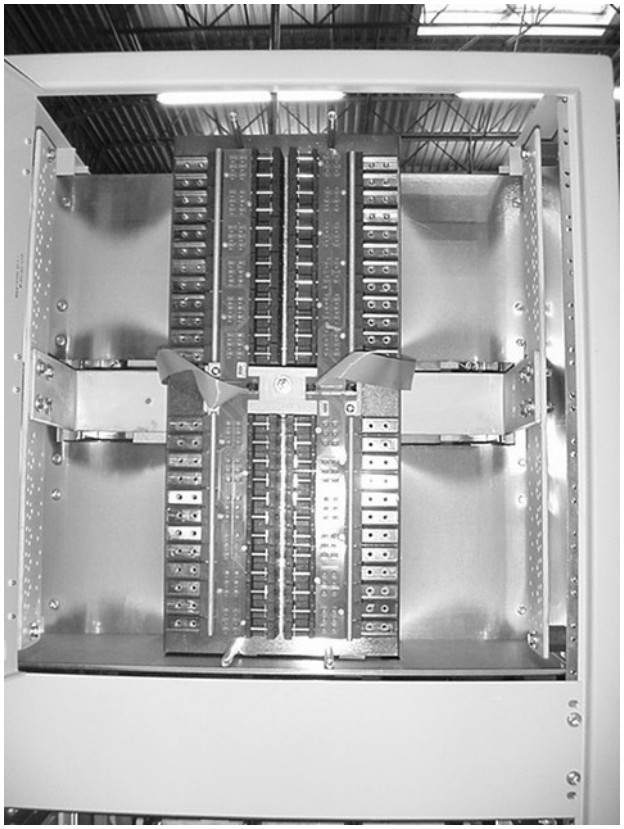


Figure 3.6-1 DC Distribution (Front Cover Opened)

Available plug-in circuit breakers are shown in Figure 3.6-2**.** These are only breakers and do not include any hardware.

Plug-in circuit breakers rated at 60A or more require two mounting positions and require a circuit breaker adapter, which is included in the circuit breaker kit. Adaptors are available with studs for #10-32 nuts on 5/8" centers, #10-32 nuts on ¾" centers, or ¼-20 nuts on 1" centers. The circuit breaker kit includes all necessary mounting hardware. Available plug-in circuit breakers are shown in Figure 3.6-2**.**

BREAKER RATING	PART NUMBER		BREAKER RATING	PART NUMBER
1 A	FFA-0014		40 A	FFA-0020
3 A	FFA-0015		50 A	FFA-0025
5 A	FFA-0016		60 A	530-9088

10 A	FFA-0017		70 A	530-9089
15 A	530-9093		80 A	530-9090
20 A	FFA-0018		100 A	530-9091
30 A	FFA-0019			

Figure 3.6-2 Plug-in Circuit Breakers

BreakerRating	Part Number	Adaptor Size
60 A	FFA-0021-1	#10 studs on 5/8” centers
60 A	FFA-0021-2	#10 studs on ¾” centers
60 A	FFA-0021-3	¼” studs on 1” centers
70 A	FFA-0022-1	#10 studs on 5/8” centers
70 A	FFA-0022-2	#10 studs on ¾” centers
70 A	FFA-0022-3	¼” studs on 1” centers
80 A	FFA-0023-1	#10 studs on 5/8” centers
80 A	FFA-0023-2	#10 studs on ¾” centers
80 A	FFA-0023-3	¼” studs on 1” centers
100 A	FFA-0024-1	#10 studs on 5/8” centers
100 A	FFA-0024-2	#10 studs on ¾” centers
100 A	FFA-0024-3	¼” studs on 1” centers

Figure 3.6-3 Plug-in Circuit Breaker Kits

DC Bolt-in Circuit Breakers

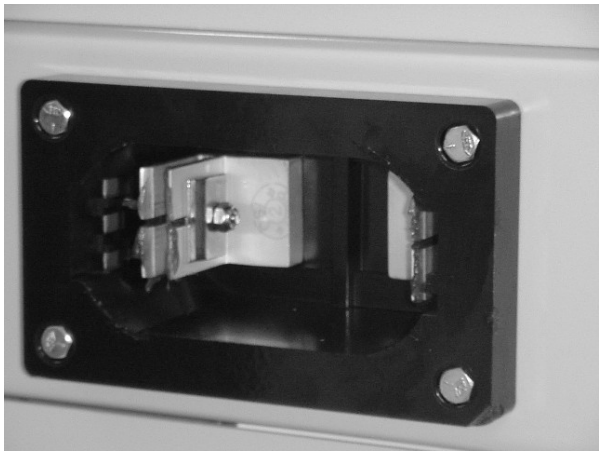
Bolt in Breakers in a variety of sizes up to 700 Amps are available. Triple pole breakers are available in sizes ranging from 400-700 Amps. Double pole breakers are available in sizes ranging from 250-400 Amps. Single pole breakers are available in sizes ranging from 100-225 Amps. Small breakers (half the size of a single pole breaker) are available in sizes ranging from 1-100 Amps.

Two different panels are available for breaker mounting. AAB-0647 has cutout holes for 4 triple pole breakers. Each hole will accept one triple pole breaker, 1 double and one single pole breaker or 3 single pole breakers. AAB-0648 has cutout holes for 6 double pole breakers. Each hole will accept one double pole breaker or 2 single pole breakers. Each double breaker hole will accommodate 4 small breakers ranging in size from 1 to 100 Amps. See Figure 3.6-4 for details.

Figure 3.6-4 Bolt-in Circuit Breakers

Telecom Fuses

Telecom fuses in sizes ranging from 70 – 600 Amps are available. A panel in each rectifier bay will accommodate 4 fuse holders. Typical fuse numbering is Bay 1: Fuse 1-4, Bay 2: Fuse 5-8, Bay 3: Fuse 9-12 and Bay 4: Fuse 13-16. Only one fuse can be hooked up to any alarm wire. Refer to the following pictures for more information.



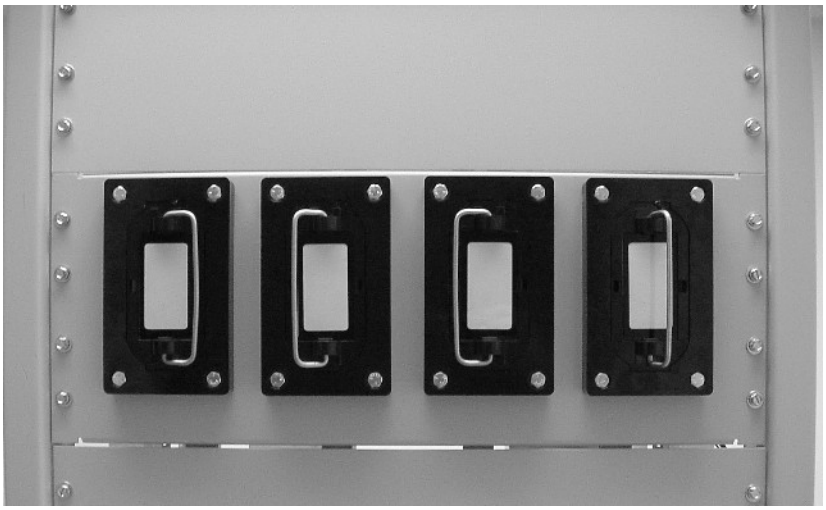


Figure 3.6-5 Telecom Fuses

3.7. Installation of Circuit Breakers and Fuses

Plug-in Circuit Breaker Installation

⚠	**CAUTION** During circuit breaker installation, carefully align the breaker alarm terminals with the alarm terminal board to avoid breaker terminal damage.

1) Remove the circuit breaker cover panel and the plastic cover(s) from the desired location(s).
2) Install the circuit breaker(s) by snapping the top terminal onto the upper bus bar and rotating the unit down until the second terminal snaps onto the breaker termination post as shown in **Figure 3.7-1** The breaker alarm terminals are designed to make contact with the alarm terminal board as the breaker is snapped into place.
3) Reattach the circuit breaker cover panel.

NOTE: Circuit breaker alarm contacts close when the circuit breaker is tripped but not when it is turned OFF.

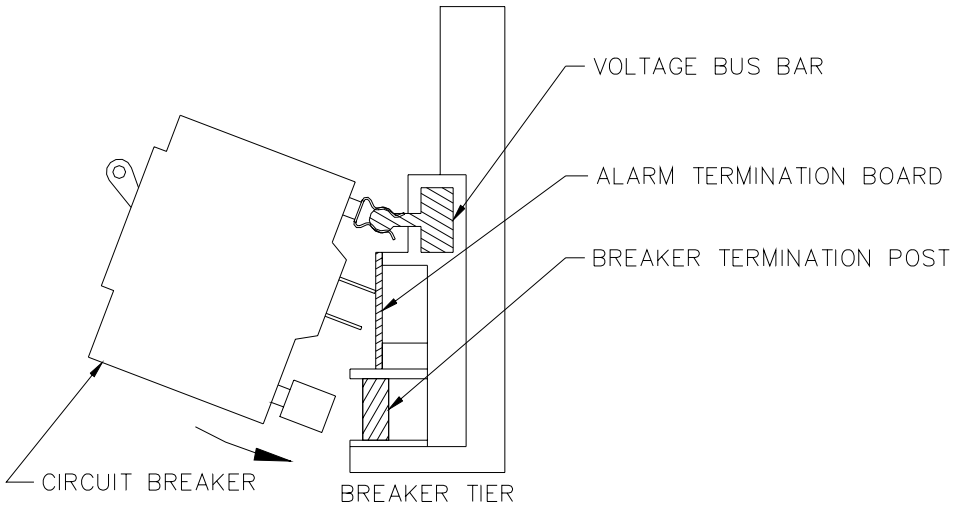


Figure 3.7-1. Installation of Circuit Breakers

Bolt-in Circuit Breaker Installation

1) Remove the circuit breaker cover panel and the plastic cover(s) from the desired location(s).
2) Install the circuit breaker(s) by bolting the circuit breaker onto the bus at the bottom of the assembly. Bolt the lug landing bus to the top of the breaker.
3) Attach alarm wires to circuit breaker alarm outputs. The wires should be attached to the contacts that are open when the breaker is on and closed when the breaker is off or tripped. See **Figure 3.7-2** for details. Circuit breaker alarms can be monitored by attaching the other end of the alarm wire to the gray Wago connector on the Circuit Breaker / LVD Expansion board. Six different circuit breaker or groups of circuit breakers can be monitored in each bay. Since the normally open contacts are monitored, any tripped breaker will give an alarm.
4) Install the alarm wire in the Wago connector on the expansion board. Jumper the pins behind the Wago connectors based on what bay the circuit breaker are in. Typical circuit breaker numbering is bay 1: Cir Bkr 49-54, Bay 2: Cir Bkr 55-60, Bay 3: Cir Bkr 61-66 and Bay 4: Cir Bkr 67-72. See **Figure 3.2-6** for details.
5) Reattach the circuit breaker cover panel.

NOTE: Circuit breaker alarm contacts change state when the circuit breaker is tripped or turned OFF.

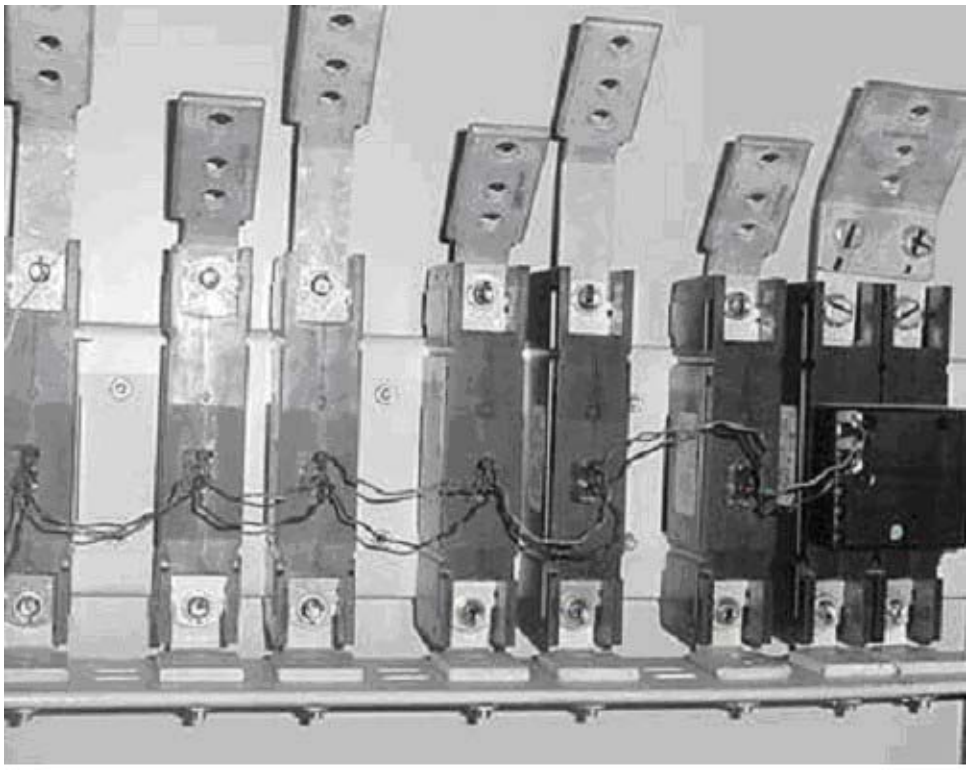


Figure 3.7-2 Circuit Breaker Alarm Wiring

Telecom Fuse Installation

1) Remove the fuse(s) from the desired location(s) by pulling the fuse holder straight out of the fuse holder base.
2) Install the fuse(s) by bolting the fuses(s) into the fuse holder.
3) Re-install the fuse holder by pushing the holder straight in.
4) Connect the alarm wiring to the alarm terminal at the output of the fuse holder base.
5) Connect the alarm wiring to the Fuse alarm Wago breakout board.

NOTE: Fuse alarm contacts sense the voltage on the output of the fuse. When the fuse is blown the output voltage is zero. Only connect one fuse to each Wago connector in any bay.

GMT Fuse Installation

Fuse holders that accommodate GMT fuses are located on the interface card mounted in the top left side of the unit. Insert the fuse in the holder; observing the tripped indicator is correctly oriented. These fuse holders are only connected to -48VDC if the system has been purchased with the GMT fuse option. This option supplies -48VDC to lugs on the interface card through a 50 Amp circuit breaker located in circuit breaker Position 1. The interface card provides fuse holders for eight fuses, labeled “F1” through “F8”, which can be used for small -48V DC loads. Use the chart shown in Figure 3.7-3 to help determine what size fuses will carry the desired current. Refer to Figure 3.9-1 for Interface board GMT fuse locations.

NOTE: The controller will not report GMT Fuse failures in the MX28B1200 system. Only telecom style fuses can be monitored. Use GMT fuses only in non-essential applications.

		AMBIENT TEMPERATURE		
		20° C	50° C	60° C
FUSE SIZE	10 Amp	7 Amp	6 Amp	5 Amp
	12 Amp	8 Amp	7 Amp	6 Amp
	15 Amp	10 Amp	9 Amp	8 Amp

Figure 3.7-3 GMT Fuse Temperature De-rating Chart

3.8. Load Connections

Cable Size Considerations

The DC load cable(s) should be sized sufficiently large to limit the voltage drop from the MX28B DC power plant to the loads per system design requirements. The cable(s) must also carry the full load current during battery operation. During battery operation the voltage will be lower, therefore the current will typically be higher. If assistance is required to determine the necessary cables for the application, contact your sales representative or APC.

Circuit Breaker Connections (1 to 50 Amps)

Connections for 1 to 50 amp DC loads require standard two-hole lugs with holes for #10 screws (810-0032) on 5/8" centers and are located directly beside the corresponding circuit breaker. See for details.

Circuit Breaker Connections (60-100 Amps)

Circuit breakers rated for 60 to 100 amp DC are twice as wide as the smaller breakers and therefore require two positions and a circuit breaker adapter kit. The adaptor connects the two output lug positions to one lug. Adaptors are available with studs for #10-32 nuts on 5/8" centers, ¼-20 nuts on ¾" centers, or ¼-20 nuts on 1" centers. The adaptor is installed directly beside the two positions the circuit breaker is mounted on, using #10 screws provided in the kit. The lugs (not included with the kit) fasten on to the adaptor's studs using nuts and washers provided in the kit. See for details.

Return Connections (1-100 Amps)

The load returns connect to the return buses located to the outside of the breaker connection points as seen in Error! Reference source not found.. Each return bus provides 28 sets of threaded #10-32 holes on 5/8" centers, fourteen sets of threaded ¼-20 holes on 5/8" centers and fourteen sets of threaded ¼-20 holes on 1" centers for connection of two-hole lugs on load return wires.

Figure 3.8-1 Load connections for snap-in breakers

Figure 3.8-2 Return Connections

GMT Fuse Connections

GMT fuses are only connected to -48VDC if the system has been purchased with the GMT fuse option. This option supplies -48VDC to lugs on the interface card through #6 AWG power cables controlled by a 50 Amp circuit breaker located in circuit breaker Position 1. The 2-hole lugs on both ends of the power cables have #10 holes on 5/8" centers. Connections to the GMT fuses are made at terminal block connectors labeled "F1" through "F8" that are located on the interface card mounted in the top left side of the unit. The connector is sized to accept #12 – #28 AWG wire. Each connector has two positions, labeled "-48V" and "RTN", for connection of the -48V DC load and load return wires. Refer to Figure 3.9-1 for Interface board connections.

NOTE: The controller will not report GMT Fuse failures in the MX28B1200 system. Only telecom style fuses can be monitored. Use GMT fuses only in non-essential applications.

3.9. Monitoring and Relay Output Connections

Front Panel DB9 Connection

The front panel DB-9 connector is for use by the factory only. Do not hook up the special RS-232 cable (APC part number 940-0024C). This cable is only to be used with the DB-9 near the Web/Simple Network Mail Protocol (Web/SNMP) card.

"Smart" Cable DB9 Connection

The DB9 connector on the top right hand side of the unit, behind a blank panel directly above the controller, uses the special RS-232 cable (APC part number 940-0024C) to allow local access through a Terminal Emulation program like HyperTerminal™ or Procomm™ .

RJ45 Ethernet Connector

The optional management card, which is behind a blank panel directly above the controller, has an RJ-45 connector to support a TCP/IP protocol over a 10BaseT Ethernet Local Area Network (LAN).

Relay Output Connections

There are eight alarms available that provide outputs via Form “C” relay contacts. The last two of these are pre-assigned as the Minor and Major relay outputs. The Major relay is energized (NO-C contacts closed) during normal (non-alarm) operating conditions; all the other relays energize when an alarm condition occurs. The other six outputs are initially designated as “Relay 1” through “Relay 6” (the user may assign more meaningful names if desired). The various system alarm conditions can be assigned to any of the eight alarm outputs. There are three sets of Wago connectors on the interface card. Two are for Output Relays and one is for Input Relays. To attach the Output Relay wires, push down on the white spring-loaded lever; Insert the wire and release the lever. Refer to the board layout in Figure 3.9-1 for Output Relay connections. The relay contacts should only be used to switch resistive loads of 0.5 amperes or less at 60 volts or less. The following shows the alarm output connection designations.

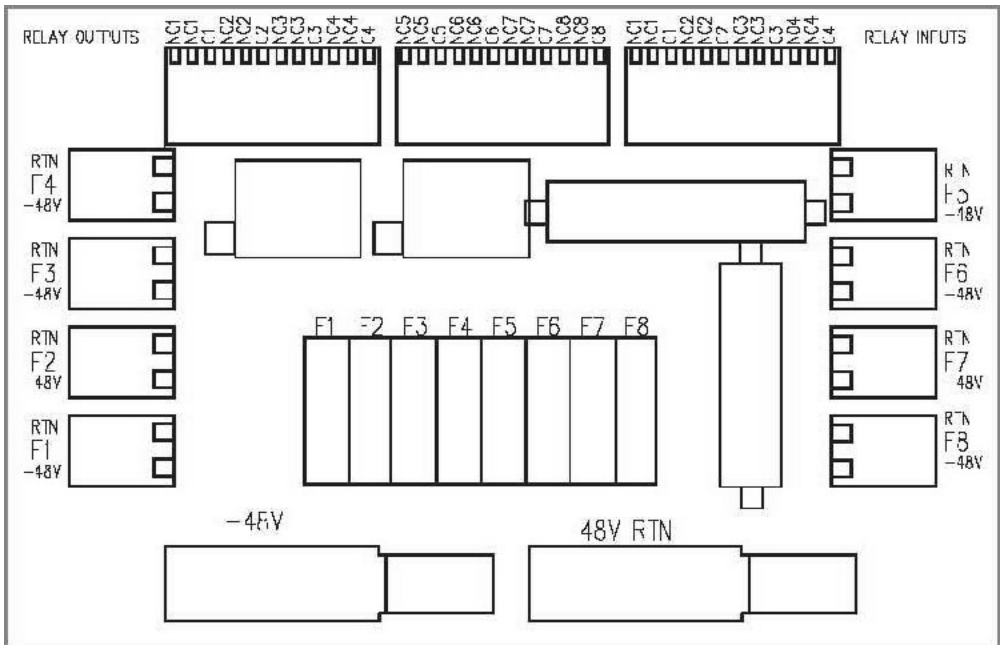


Figure 3.9-1 Interface Board

RELAY OUTPUT	TERMINAL DESIGNATION NO-NC-C	USER ALARM NOTES
RELAY #1	NO1-NC1-C1	_____
RELAY #2	NO2-NC2-C2	_____
RELAY #3	NO3-NC3-C3	_____
RELAY #4	NO4-NC4-C4	_____
RELAY #5	NO5-NC5-C5	_____
RELAY #6	NO6-NC6-C6	_____
MINOR	NO7-NC7-C7	_____
MAJOR	NO8-NC8-C8	_____

Figure 3.9-2 Output Relay Connections

3.10. External Alarm Input Connections

Four external alarm inputs with assignable priority levels are available. These alarm inputs respond to external dry contact closures between normally open (NO) and common (C) or contact openings between normally closed (NC) and C.

External Alarm Source (non-alarm state)	Connect To Input Alarm Terminals
OPEN	NO-C
CLOSED	NC-C

Figure 3.10-1 External Alarm Input Definition

Connector J4 is located on the interface card mounted in the top left side of the unit. Refer to Figure 3.9-1 for Interface board connections. Systems are shipped with jumper wires connecting each NC and corresponding C contact. A jumper wire should be removed only if the corresponding NC-C contacts are going to be used. To attach the Input Relay wires, push down on the white spring-loaded lever; insert the wire and release the lever.

EXTERNAL ALARM INPUT	J4 TERMINAL DESIGNATION (NO-NC-C)	USER ALARM NOTES
#1	NO1-NC1-C1	_____
#2	NO2-NC2-C2	_____
#3	NO3-NC3-C3	_____
#4	NO4-NC4-C4	_____

Figure 3.10-2 External Alarm Input Connections

3.11. Rectifier Module Installation

	**WARNING**: Rectifier DC output circuits would be damaged if battery were installed incorrectly. Before rectifier installation, ensure proper battery polarity and that the battery is isolated from the rest of the system

The rectifier modules are shipped in separate containers. Follow the procedure below to install a rectifier module.

1) Remove the rectifier from its shipping container.

2) Remove any rectifier retaining screws from the shelf position where the rectifier is to be installed.

3) Slide the rectifier module into the shelf between the guides until it is fully seated.

4) Fasten the rectifier in place with the rectifier retaining screw (included in literature kit with product manual).

Since all adjustments are made from the system control unit, no rectifier adjustments are necessary.

NOTE: All "FLOAT" – "BOOST/EQUALISE" switches (one is located on the front of each rectifier in the system) must be set to "FLOAT" to allow the MX28B to control the output voltage properly.

	**CAUTION**: Rectifier fan inlet filters are available for dusty or hostile environments. Failure to periodically check and clean filters can lead to rectifier shutdown due to over temperature and produce power plant failure.

4 Commissioning and Preventive Maintenance

4.1. Pre-Commissioning Inspection

Environment

1. Ensure the DC system environment is suitable for operation.
2. Ensure that there is sufficient clearance around the system for service.
3. Ensure that there is no sign of damage to the DC system.
4. Consult with customer to disable installed customer alarms before servicing the unit. This will allow the unit to be serviced without creating false alarms.

Electrical Installation

1. Ensure that the DC wiring is properly installed, sized, terminated and identified.
2. Ensure that the AC wiring is properly installed, sized, terminated and identified.
3. Ensure that the battery is properly connected to the System.
4. Ensure that the DC output over-current protection devices are adequate for the size of wiring installed.
5. Ensure that the DC Positive is bonded to central office ground (- 48 volt system).
6. Note the resistance of the ground bond.
7. Note any currents flowing in the ground.
8. Record ambient temperature.
9. Verify that the battery polarity is correct.
10. If a battery disconnect device(s) is/are present, note the following for each device:
    a. DC Voltage Rating.
    b. DC Current Rating
    c. Interrupting Current Rating

Battery Visual and Safety Inspection

1. Check the mechanical integrity of the battery framing, racking, or cabinet.
2. Check that the battery framing, racking or cabinet is adequately secured to the floor.
3. Check compliance with seismic zone requirements.
4. Check the general appearance and cleanliness of the battery.
5. Record the manufacturer, model number, and capacity of the battery string(s) on Site Form.
6. Record the batch number, date code, and serial number of each cell or mono-block, and any other pertinent information that is available on the battery cells on the Site Form.
7. Check that the cell or mono-block numbering starts at the positive battery string terminal and is correct.
8. Check that anti-oxidation compound is properly applied.
9. Visually inspect each cell for:
    a. Cracks.

b. Case leaks.
c. Post- seal leaks.
d. Pressure relief valve leaks (VRLA only).
e. Case swelling (VRLA only).
f. Case swelling (VRLA only).

10. Check the torque of all battery inter- cell connector in accordance with the battery manufacturer's specifications.

4.2. Commissioning

Initial Set-up

1. Remove all rectifiers. Ensure that the float/equalise switch is on float.
2. Disconnect battery by removing a link in each string or opening the battery disconnects.
3. Check that battery voltage does not appear on the system bus.
4. Disconnect all loads.

AC Power Up

	**WARNING**: The DC power plant is supplied from a nominal high voltage AC voltage source. Keep the AC input enclosure cover in place when the system is operational or energized

1. Verify that AC voltage is present for each rectifier at the back- plane position (Blue J2 of 0P-9131) inside the rectifier compartment. The AC input breaker for each rectifier should be switched on and off to ensure that you have power at every rectifier and that the breaker disconnects the rectifier.
2. Verify that all of the circuit breaker positions are labeled to the corresponding rectifier correctly.
3. Insert all rectifiers.
4. Turn all rectifier circuit breakers on.
5. The main screen should appear on the control unit display (see Figure 5.6-1). The display on the control unit is a 2-lines by 16-characters display. The cursor cycles below the characters of the active selection on the display. Information shown in the second line of Figure 5.6-1 that extends beyond 16 characters (to the right of the "S" in "ALARMS") can viewed on the control unit display by using the scrolling controls (refer to **Section 5.6** for operation of the control unit).

NOTE: When AC power is initially applied, there is a 60-second period during which no alarms are reported.

DC Power Up:

1. Verify with a voltmeter that the dc voltage is within 0.1 Vdc of the System Voltage. If the voltage is off adjust the R offset setting under the OEM menu. If the R Offset setting is more than +/- 1.00 Volt dc, contact APC for a replacement controller module.
2. Adjust battery float voltage to negative (-)49 Volts.
3. Verify System Low Voltage Alarm.
4. Adjust battery float voltage to negative (-)57 Volts.
5. Verify System High Voltage Alarm.
6. Restore the battery float voltage to negative (-) 54.00 Volts or desired voltage.

Rectifier Test:

1. To verify that all rectifiers are reporting correctly to the controller, navigate through the menu and verify that the status for every rectifier in the system is Rect (N) FF OFF.
2. Remove any rectifier and verify that you get a Minor alarm for rectifier 1 of n failure.
3. Remove a second rectifier and verify that you get a Major alarm for rectifier 2 of n failure.

LVD Test

1. Enable the LVD's that are installed.
2. Set the LVD trip for each LVD to negative (-)56 Volts.
3. The LVD should have dropped out (opened). Verify visually or by monitoring the voltage at the battery connection. Also, the minor alarm should be on.
4. Set LVD Trip back to negative (-)42 Volts.
5. The LVD should have closed. Verify visually or by monitoring the voltage at the battery connection. The minor alarm should be off.
6. Ensure that the LVD parameters are set to desired value.

Battery Power Up

1. Monitor battery current and verify that it is +/- 0.1 Amps.
2. If the voltage is off adjust the S offset setting under the OEM menu.
3. Set battery maximum recharge setting by determining the entire battery string capacity and dividing by 10 hours. This setting will recharge the battery in 10 hours.
4. Enter this value in the Max Batt Rech screen.
5. Monitor the battery current while closing the battery disconnects or installing open battery links. Arcing can occur during this connection.
6. The voltage may drop if the maximum battery recharge current is exceeded.
7. The current should gradually decrease when the battery is nearing full charge.

Circuit Breaker/ Fuse Test:

1. For plug- in circuit breakers. Monitor alarm screen for circuit breaker alarm while shorting out each pair of alarm contacts (using a pair of tweezers) on the circuit breaker interface circuit board. Verify proper voltage at the circuit breaker common bus.
2. For fuses: Monitor alarm screen for fuse alarm while removing fuses from each position. Verify proper voltage at fuse common bus.
3. Turn on fuses and circuit breakers as desired.

User Inputs

1. Change the user input to desired alarm via the controller for any input that will be used.
2. Exercise the alarm by causing the input to change state.
3. Verify the desired relay output on the controller module.

Output Relays:

1. Change the alarm parameter to desired relay output via the controller for any relay output that will be used. All alarm parameters are shipped as either major or minor, but may be changed to any of 6 output relays.
2. Program out put relay to desired major or minor alarm to complete programming.
3. Exercise the output relay by causing the alarm to change state.
4. Verify the desired relay output on the controller module.

Battery Temperature Compensation

1. Enable battery temperature compensation if desired.
2. Ensure that battery temperature probe is connected to the system and attached to the battery.
3. Verify that the system voltage is above the float voltage if the battery temperature is below 25 degrees C and below the float voltage if the battery temperature is above 25 degrees C.

4.3. Final Inspection:

1. Verify that the interior and exterior of the system is clean and free from debris.
2. Ensure all wires connected and bolts are properly tightened.
3. Ensure the following the User, Service, and Calibration parameters are set properly on the controller (default settings are in parenthesis):
   LVD (Param)
   - LVD1 Trip (-42.00 V)
   - LVD1 Reset (-48.00 V)
   - LVD2 Trip (-42.00 V)
   - LVD2 Reset (-48.00 V)

   Batt (Set-alm)
   - Batt Disc Thr (10 A)

   Batt (Param)
   - Batt Float (-54.00 V)
   - Batt Max Rech (50 A)

   Batt (Comp)
   - Comp Method (OFF)
4. Verify on the status menu that the system is functioning correctly with no alarms.
5. Be sure to leave the site as orderly and neat as possible.

5 Operation

5.1. Technical Description

The MX28B-1200/2400 Power System is designed to supply safe –54 VDC primary power through the use of up to 24 rectifier modules. One rectifier bay may be added to increase the capacity to 48 rectifiers. The MX28B-1200/4800 Power System is designed to supply safe –54 VDC primary power through the use of up to 24 rectifier modules. Three rectifier bays may be added to increase the capacity to 96 rectifiers. In conjunction with an external battery string, it will supply backup power as well. The Power System Control Unit (PSCU) will monitor all MX28B functions and provides battery management including controlled battery recharge with temperature compensation and low voltage disconnect. Integrated DC output distribution supports loads ranging from ¼ Amp all the way to 700 Amps. Battery recharging, temperature compensation and low voltage disconnect are included. The controller can monitor up to 4 discrete external events with dry contact inputs.

5.2. Rectifier Management

AC Input Power

The basic component of the power system is the rectifier module, which rectifies utility AC into nominal 48 Volts DC. Each rectifier module requires 208/220/240V AC (MRF28H54BV), or 277V ac (MRF28H54BV50) single-phase, 50/60 Hz. A breaker installed in a remote panel should individually protect each rectifier circuit.

DC Output Power

The DC outputs of all the rectifiers in the system are connected to a common bus that is rated to carry the current of the entire system. The rectifier modules will equally share the entire load, independent of the PSCU. The rectifiers will continue to provide DC power if the PSCU is removed or fails.

Rectifier alarms reporting

The rectifier has numerous sensors inside the unit that monitor fan fail, high temperature, high/low voltage, etc. These rectifier sensors trigger outputs that are monitored by the PSCU. In addition rectifier current is measured inside each rectifier. The PSCU can trigger output relays in the event of a rectifier alarm. Refer to Section 5.6 for PSCU control functions.

5.3. System Management

System Output Capacity

The power plant has two basic configurations:
The MX28B-1200/2400 supplies a maximum of 2400 amps or 2350 amps with N+1 redundancy. The housing for this configuration provides two rectifier bays with integrated DC output distribution, a control unit, and expansion bays for added DC output distribution.

The MX28B-1200/4800 supplies a maximum of 4800 amps or 4750 amps with N+1 redundancy. The housing for this configuration provides four rectifier bays with integrated DC output distribution, a control unit, and expansion bays for added DC output distribution. The difference between the MX28B-1200/2400 Main Bay and the MX28B-1200/4800 Main Bay is the size and configuration of the power bus and battery shunt. All other parts are the same for both configurations.

System Voltage Control

The PSCU monitors and adjusts the system voltage. It uses a voltage trim input to the rectifier to precisely control the DC output voltage. In the event of PSCU removal or failure, the shelf rectifier controller card will control the voltage at a programmed default level. In the event of shelf rectifier controller card failure, the individual rectifiers will default to the analog voltage level preset with the front panel “float’ adjustment pots.

System Current

The PSCU monitors individual rectifier currents and displays total system current as a sum of rectifier currents. Load current can be found by adding battery current to system current. Battery Current is positive when the battery is discharging.

Sys Current + Batt current = Load Current

For example, if the battery is charging the Batt Current reading could be (–) 40 A, Sys Current reading could be 120 A. Load Current would be:

Sys Current + Batt current = Load Current
120A + (-) 40 A = 80 Amps.

If the battery is discharging the Batt Current reading would be 40 A, Sys Current would reading would be 40 A. Load voltage would be:

Sys Current + Batt current = Load Current
40A + 40 A = 80 Amps.

System Status and Alarm Reporting

The PSCU monitors system voltage using a high accuracy digital voltmeter attached to the system bus. The PSCU monitors system temperature using a temperature IC mounted in the PSCU. The PSCU monitors system current by summing the current reported by individual rectifiers. The PSCU reports a number of system alarms including system high/low voltage and high/low temperature. Refer to Section **5.6** for PSCU control functions.

5.4. DC Distribution

Distribution is included in each bay for up to 48 plug-in circuit breakers, a variety of bolt in breaker sizes or four telecom fuses. Circuit breaker bays with three rows of bolt in circuit breakers or fuse bays are also available. The plug-in circuit breakers can be 1 to 100 amps, with 60-100 amp breakers requiring two positions and a circuit breaker adapter kit. When a plug-in circuit breaker trips, a normally open switch closes and a CB alarm is reported by the PSCU. To disconnect a load attached to a circuit breaker, move the lever to the down "OFF" position. To disconnect a load attached to a telecom fuse pull the fuse holder straight out of the fuse holder base.

NOTE: Plug-in Circuit breaker alarm contacts close when the circuit breaker is tripped but not when it is turned OFF. Bolt-in Circuit breaker alarm contacts close when the circuit breaker is tripped or turned OFF.

5.5. Battery Management

Battery Charging and Protection

Battery charging and protection are integrated into the MX28B DC power system to support the primary function of providing power to the load. Accurate measurement of battery parameters like voltage, current and temperature are used to maintain and protect the batteries attached to the power plant.

Charging the battery at the correct rate reduces battery heating, increases the charge returned to the battery and prevents excess hydrogen generation or, in the case of VRLA batteries, possible thermal runaway. Battery Maximum Recharge Current is set to the appropriate rate, which is usually based on the size of the battery plant in Ampere-hours.

A typical recharge current setting is battery capacity (abbreviated as "C") divided by number of charging hours. As an example, a "C/10" rate will basically return the battery to full charge in 10 hours. A C/8 rate is probably the highest current, which should be considered for charging under normal circumstances.

Battery Temperature Compensation

The Battery Float Voltage is set to the value recommended by the battery manufacturer in order to maintain correct battery charge at 25ºC. As temperature rises, electrochemical activity in a battery increases. Similarly, as temperature falls, electrochemical activity in a battery decreases. As temperature rises charging voltage should be reduced to prevent overcharge and increased as temperature falls to prevent undercharge. The DC power system uses Battery Temperature compensation to change output voltage to compensate for temperature changes. This temperature compensation function is programmed into the PSCU using the compensation parameters settings. Default settings can be changed to values recommended by the particular battery manufacturer.

Battery/Load Low Voltage Disconnect

In order to prevent damage to the battery due to deep discharge, the DC power system has hardware and software support for a battery or load Low Voltage Disconnect (LVD). A battery LVD has the loads permanently attached to the rectifiers and the battery is disconnected from the system. A load LVD has the battery permanently attached to the rectifiers and the loads are disconnected from the system.

When the battery voltage reaches the threshold set by the *LVD 1 Trip Voltage* setting during discharge, the DC power system will activate the LVD contactor to disconnect the battery or load from the system. The LVD will remain open until AC power is restored to the system and the bus voltage reaches the level defined by the *LVD 1 Reset Voltage* variable.

NOTE: The LVD is normally energized and must be commanded to open. This assures that the LVD will remain closed even if the controller fails or is removed.

5.6. Controls and Indicators

CAUTION: The controller and the Web/SNMP card have lithium batteries. These batteries are not field serviceable.

- Danger of explosion if battery is replaced by an incorrect type.
- Dispose of used batteries according to the manufacturer's instructions.

Front Panel User Interface

The MX28B control unit provides a user interface designed with a hierarchical menu that can be viewed on the 32-character (2 X 16) display by "navigating" with the "⇦" (left), "⇨" (right), "⇧" (up), and "⇩" (down) arrow keys located on the front panel. The selected item on the display is identified by the cursor cycling beneath its characters.

The "M" (modify) key and the arrow keys are used to set parameters and text to customize the system operation for a specific application. Items that can be modified have "m+" in the upper

right corner of the display. If a security level higher than the one presently set is required to modify the parameter, "s+" is displayed instead of “m+”. Status, alarms, and information screens have "+" in the upper right corner of the display (or “#” in the case of rectifier information screens) and cannot be modified. When AC power is initially applied, there is a 60-second period during which no alarms are reported.

Pressing the "M" key on the front panel will change the "m+" to "M+", indicating that the parameter can now be changed using the arrow keys. Some parameters can be changed to other predefined selections by pressing the up or down arrow keys to display an alternative selection. These parameters can be recognized after the “M” key is pressed by the cursor cycling beneath the characters of the selection. For other parameters, such as text and most numeric values, after the “M” key is pressed the cursor will be displayed under an individual character. The right or left arrow key is used to position the cursor below the character to be changed and the up or down arrow key is used to "spin" the digit or letter to the desired value. When the desired changes have been made to an individual parameter screen, the “M” key is pressed again; the “M+” changes back to “m+” and the new entry is stored in memory.

If the user plans to make any changes to system parameters, the first item that should be verified or entered is the appropriate password for the security level required for the parameters to be modified. Security level 2 (enter 2222 on the “PIN” screen) enables modification of all variable system parameters. Security level 1 (enter 1111 on the “PIN” screen) permits modification of some parameters. No security is required for viewing status items and parameter settings. The security level password is entered through the “PIN” screen. If no front panel keys are pressed for 60 minutes, the active security level password reverts to level 0 and “ APC ” begins to move about the display. Pressing any key returns the display to normal and the password must be re-entered if system parameters require changes.

Eleven LEDs are provided on the front panel of the control unit to indicate system status. Three LEDs grouped together vertically provide overall system status; they are “MAJOR”, “MINOR”, and “NORMAL”, indicating the presence of a major alarm, a minor alarm, or normal operation. The other eight LEDs correspond to the active state of each of the alarm output relays and are labeled “ALM1”•••“ALM6”, “MIN”, and “MAJ”.

```
MX28B-1200      +
   STATUS ALARMS SYSTEM MODULES BATT PIN OEM
```

Figure 5.6-1 Menu Top Line

.

Parameter Locations, Descriptions, and Default Values

The location, description, and factory programmed default value for each of the MX28B system parameters is found in the table below. The table also shows all of the status and information screens with typical displays. The location of a parameter screen is shown in brackets, for example: **[SYSTEM/IN-RLY/RLY-MAP]**. To find the parameters that can be accessed in this category, starting from the main menu screen, do the following:

1. Use the right or left arrow keys to position the cycling cursor below “SYSTEM”.
2. Press the down arrow key once.
3. Use the right arrow key to position the cycling cursor below “IN-RLY”.
4. Press the down arrow key once; the cursor will be cycling below “RLY-MAP”.
5. Press the down arrow key (repeatedly if necessary) until the desired parameter screen is displayed (there are eight parameter screens in this category).

After making any desired changes, return to the main menu press the up arrow key repeatedly. If a parameter requires a level 1 or level 2 security access to permit changes to it, the security level will be found in braces, i.e. Security Level {2}, in the “PARAMETER” column of the table.

Parameter Locations, Descriptions, and Default Values

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Address 1 Security Level {1} **[SYSTEM/SETUP]**	Power plant address or identification - first line.	`Address 1 m+` `APC DCNS, Inc.`
Address 2 Security Level {1} **[SYSTEM/SETUP]**	Power plant address or identification - second line.	`Address 2 m+` `11035 Switzer Av`
Address 3 Security Level {1} **[SYSTEM/SETUP]**	Power plant address or identification - third line.	`Address 3 m+` `Dallas, TX.`

Alarms Item 1
{Status Only}
[ALARMS]
•
•
•
Alarms Item 16
[ALARMS]
	Display of up to 16 active alarms (a typical alarm screen is shown).
	•
	•
	•
	Display of up to 16 active alarms (a typical alarm screen is shown).
		`Alarm Item 1 +`
		`Batt LV Alm Onm`
		•
		•
		•
		`Alarm Item 16 +`
		`No Alarms`

Battery Current {Status Only} **[STATUS]**	Battery current measured by the system controller at the battery current shunt.	`Batt Current +` `-15.0 A`
Battery Discharge Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the battery discharge current exceeds the programmed battery discharge threshold.	`Batt Disc Alm m+` `Minor`
Battery Discharge Threshold Security Level {1} **[BATT/SET-ALM]**	An alarm is generated if the battery discharge current exceeds this value.	`Batt Disc Thr m+` `10 A`
Battery Float Voltage Security Level {1} **[BATT/PARAM]**	One of three parameters that control the DC output voltage. Set the Float Voltage at 25°C battery temperature per the battery manufacturers recommendations.	`Batt Float m+` `-54.00 V`

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Battery High Temperature Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the battery temperature exceeds the Battery High Temperature threshold.	Batt HT Alm m+ Minor
Battery High Temperature Threshold Security Level {1} **[BATT/SET-ALM]**	Battery Temperature is temperature measured at the battery probe. An alarm is generated if the battery temperature exceeds this value.	Batt HT Thr m+ 70.0 C
Battery High Voltage Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the DC output voltage rises above the battery high voltage threshold.	Batt HV Alm m+ Minor
Battery High Voltage Threshold Security Level {1} **[BATT/SET-ALM]**	An alarm will be reported if temperature is lower than the temperature entered. An alarm is generated if the DC output voltage rises above this value.	Batt HV Thr m+ -58.00 V
Battery Low Temperature Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the Battery Temperature drops below the battery Low Temperature threshold.	Batt LT Alm m+ Minor
Battery Low Temperature Threshold Security Level {1} **[BATT/SET-ALM]**	Battery Temperature is temperature measured at the battery probe. An alarm is generated if the battery temperature drops below this value.	Batt LT Thr m+ 0.0 C
Battery Low Voltage Alarm Security Level {1} **[BATT/SET-ALM]**	The output relay energized if the DC output voltage drops below the battery low voltage threshold.	Batt LV Alm m+ Minor
Battery Low Voltage Threshold Security Level {1} **[BATT/SET-ALM]**	An alarm is generated if the DC output voltage drops below this value.	Batt LV Thr m+ -44.00 V
Battery Maximum Recharge Current Security Level {1} **[BATT/PARAM]**	One of three parameters that control the DC output voltage. If Battery Current surpasses the Maximum Battery Recharge Current, the DC output voltage will be reduced (the system limits the charging current to this programmable value).	Batt Max Rechm+ 50 A
Battery Temperature {Status Only} **[STATUS]**	Battery temperature measured by the system controller at the optional battery temperature sensor probe.	Batt Temp + 25.2 C
Circuit Breaker 1 Alias Security Level {1} **[MODULES/CIRBKR/ALIAS]** • • • Circuit Breaker 24 Alias Security Level {1} **[MODULES/CIRBKR/ALIAS]**	An alternate name (alias) that can be assigned to a circuit breaker if desired. • • • An alternate name (alias) that can be assigned to a circuit breaker if desired.	Cir Bkr 1 m+ -48V • • • Cir Bkr 72 m+ -48V

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Circuit Breaker 1 Tripped Security Level {1} **[MODULES/CIRBKR/SET-ALM]** • • • Circuit Breaker 24 Tripped Security Level {1} **[MODULES/CIRBKR/SET-ALM]**	An alarm that indicates Circuit Breaker 1 is tripped. • • • An alarm that indicates Circuit Breaker 24 is tripped.	Cir Bkr 1 Alm m+ Major • • • Cir Bkr 72 Almm+ Major
Compensation High Knee Security Level {1} **[BATT/COMP]**	The temperature compensation high knee is the point above which there is no additional battery voltage compensation for further increases in temperature.	Comp Hknee m+ 40.0 C
Compensation Low Knee Security Level {1} **[BATT/COMP]**	The temperature compensation low knee is the point below which there is no additional battery voltage compensation for further decreases in temperature.	Comp Lknee m+ 0.0 C
Compensation Method Security Level {1} **[BATT/COMP]**	One of three parameters that control the DC output voltage. Activate “ON” or de-activate “OFF” battery temperature compensation.	Comp Method m+ OFF
Compensation Temperature Coefficient Security Level {1} **[BATT/COMP]**	Temperature compensation coefficient between low knee and high knee in mV/cell/°C. (Compensation equals zero at 25°C.)	Comp TC m+ - 3.00mV
Control Unit Revision {Status Only} **[SYSTEM/SETUP]**	Hardware revision level of the control unit. This parameter cannot be changed.	Cntrl Rev + 000002
Date Security Level {1} **[SYSTEM/DATE]**	Internal system calendar date. Used as a date stamp in the event log.	Date m+ DEC 16 1999
Display Type {Status Only} **[SYSTEM/SETUP]**	Type number for the control unit display. This parameter cannot be changed.	Display Type + 000255
Fahrenheit Scale Security Level {1} [**SYSTEM/SETUP]**	Enables selection of Fahrenheit or Celsius temperature scale (Fahrenheit “OFF” displays readings in °C).	Fahrenheit m+ OFF
Firmware Version {Status Only} **[SYSTEM/SETUP]**	Version number of the control unit firmware. **NOTE: Actual firmware version number displayed is the current version as of the date of manufacture.** This parameter cannot be changed.	FW Version + 000189
FUSE 1 Alias Security Level {1} **[MODULES/FUSE/ALIAS]** • • • FUSE 8 Alias Security Level {1} **[MODULES/FUSE/ALIAS]**	An alternate name (alias) that can be assigned to a FUSE Fuse 1 if desired. • • • An alternate name (alias) that can be assigned to a FUSE Fuse 8 if desired.	Fuse 1 m+ -48V • • • FUSE 16 m+ -48V

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
FUSE 1 Blown Security Level {1} **[MODULES/FUSE/SET-ALM]** • • • FUSE 8 Blown Security Level {1} **[MODULES/FUSE/SET-ALM]**	The Output Relay that is energized when FUSE Fuse 1 is blown. • • • The Output Relay that is energized when FUSE Fuse 8 is blown.	FUSE 1 Alm m+ Major • • • FUSE 16 Alm m+ Major
Hardware Battery Current Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the battery current monitoring function.	Hw Batt C Almm+ Minor
Hardware Battery Temperature Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the battery temperature monitoring function.	Hw Batt T Almm+ Minor
Hardware LVD Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a conflict between the commanded and sensed positions of the LVD contactor. Generally the contactor is open when it should be closed.	Hw LVD Alm m+ Minor
Hardware System Temperature Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the system temperature monitoring function.	Hw Sys T Alm m+ Minor
Hardware System Voltage Alarm Security Level {2} **[SYSTEM/SET-ALM]**	The output relay energized if there is a hardware failure in the system voltage monitoring function.	Hw Sys V Alm m+ Minor
Input Relay 1 Security Level {1} **[SYSTEM/IN-RLY/RLY-MAP]** • • • Input Relay 4 Security Level {1} **[SYSTEM/IN-RLY/RLY-MAP]**	The Output Relay that is energized when an external contact closure or opening at the Input Relay 1 connection changes state. • • • The Output Relay that is energized when an external contact closure or opening at the Input Relay 4 connection changes state.	In-Rly 1 Alm m+ Ignore • • • In-Rly 4 Alm m+ Ignore
Input Relay 1 Alias Security Level {1} **[SYSTEM/IN-RLY/ALIAS]** • • • Input Relay 4 Alias Security Level {1} **[SYSTEM/IN-RLY/ALIAS]**	An alternate name (alias) can be assigned to Input Relay 1 if desired. • • • An alternate name (alias) can be assigned to Input Relay 1 if desired	In-Rly 1 m+ Input Relay 1 • • • In-Rly 4 m+ Input Relay 4
Lamp Test Security Level {1} **[SYSTEM/DIAG]**	Setting Lamp Test to “ON” will turn on the “MAJOR”, “MINOR”, “NORMAL”, “MAJ”, and “MIN” LEDs on the control unit front panel.	Lamp Test m+ OFF

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
LVD 1 or 2 Option Security Level {1} **[MODULES/LVD/SET-ALM]**	Must be set to "Enable" if the unit has an LVD. If the unit has an LVD, but it is disabled, the controller will not disconnect the LVD.	LVD Option m+ Enable
LVD 1 or 2 Reset Security Level {1} **[MODULES/LVD/PARAM]**	LVD Reset (reconnect) threshold voltage.	LVD Reset m+ -48.00 V
LVD 1 or 2 Trip Security Level {1} **[MODULES/LVD/PARAM]**	LVD Trip (disconnect) threshold voltage.	LVD Trip m+ -42.00 V
LVD Alarm Security Level {1} **[MODULES/LVD/SET-ALM]**	The output relay that is energized when the controller opens the LVD. If unit has a battery LVD, no power will be available to turn on any Output Relays.	LVD Open Alm m+ Minor
Model Programming Security Level {2} **[SYSTEM/SETUP]**	Model type number for the MX28B DC power plant. Choose the MX28B-1200 if you have the 2500 Amp battery shunt. Choose the MX28B-4800 if you have the 5000 Amp battery shunt. **NOTE: Changing the model number causes the system to reinitialize.**	Model m+ MX28B-1200
OEM R Gain Security Level {2} **[OEM]**	Voltage gain adjustment for factory calibration of system voltage readings/settings.	OEM R Gain m+ 1.000 V
OEM R Offset Security Level {2} **[OEM]**	Voltage offset adjustment for factory calibration of system voltage readings/settings.	OEM R Offset m+ 0.000 V
OEM S Gain Security Level {2} **[OEM]**	Current gain adjustment for factory calibration of battery current readings/settings.	OEM S Gain m+ 1.000 A
OEM S Offset Security Level {2} **[OEM]**	Current offset adjustment for factory calibration of battery current readings/settings.	OEM S Offset m+ 0.0 A
Output Relay 1 Alarm Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]** • • • Output Relay 6 Alarm Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]**	Output Relay 1 Alarm can be "mapped" to activate other output relays ("Ignore" activates no additional relays). • • • Output Relay 6 Alarm can be "mapped" to activate other output relays ("Ignore" activates no additional relays).	Out-Rly 1 Alm m+ Ignore • • • Out-Rly 6 Alm m+ Ignore
Output Relay 1 Alias Security Level {1} **[SYSTEM/OUT-RLY/ALIAS]** • • • Output Relay 6 Alias {1} **[SYSTEM/OUT-RLY/ALIAS]**	An alternate name (alias) can be assigned to Output Relay 1 if desired. • • • An alternate name (alias) can be assigned to Output Relay 6 if desired.	Out-Rly 1 m+ Relay 1 • • • Out-Rly 6 m+ Relay 6

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Output Relay 1 Delay Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]** • • • Output Relay 6 Delay Security Level {1} **[SYSTEM/OUT-RLY/RLY-MAP]**	Delay between sensing of the alarm condition and activation of Output Relay 1. An alarm condition must exist for longer than the delay to be activated. • • • Delay between sensing of the alarm condition and activation of Output Relay 6. An alarm condition must exist for longer than the delay to be activated.	Out-Rly 1 Dly m+ 0 sec • • • Out-Rly 6 Dly m+ 0 sec
Output Relay Major Alias Security Level {1} **[SYSTEM/OUT-RLY/ALIAS]**	An alternate name (alias) can be assigned to the major Relay if desired.	Relay Major m+ Major
Output Relay Minor Alias Security Level {1} **[SYSTEM/OUT-RLY/ALIAS]**	An alternate name (alias) can be assigned to the Minor Relay if desired.	Relay Minor m+ Minor
PIN 1 change Security Level {2} **[SYSTEM/SETUP]**	Permanently change password (PIN) that permits security Level 1 parameter changes - limited access.	PIN m+ 1111
PIN 2 Change Security Level {2} **[SYSTEM/SETUP]**	Permanently change password (PIN) that permits security Level 2 parameter changes - unlimited access.	PIN 2 m+ 2222
PIN Entry Security Level {0} **[PIN]**	Screen for entry of the active password (PIN). Before any changes can be made, the correct pin for the desires security level must be entered. Level 0 – full read access. Level 1 –full read and limited write access. Level 2 – full read and write access.	PIN m+ 0000
Rectifier Communications Fail Timeout Security Level {1} **[MODULES/RECT/PARAM]**	The maximum rectifier communications response time allowed before a communications failure is declared.	RectFailComm m+ 1 min
Rectifier Configuration Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the rectifier configuration differs from its stored configuration. This occurs if a rectifier is added after configuration.	Rect Cfg Alm m+ Minor
Rectifier Current Limit Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when a rectifier has been forced into the current limited mode.	Rect CL Alm m+ n of N
Rectifier Current Limit Alarm Status {Status Only} **[MODULES/RECT/INFO]**	The status will be “ON” if the rectifier has been forced into its current limited mode. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 CL # OFF
Rectifier Current Output Status {Status Only} **[MODULES/RECT/INFO]**	A display of the DC output current for the individual rectifier. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 Curr # 24.9 A

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Rectifier Description {Status Only} **[MODULES/RECT/INFO]**	Displays the model number of the installed rectifier. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 Desc # MRF28H54
Rectifier Fail 1-of-N Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if Rectifier Fail 1-of-N alarm occurs. This is a special rectifier alarm group that signifies that one rectifier has at least one alarm condition.	Rect 1ofN Almm+ Minor
Rectifier Fail 2-of-N Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if Rectifier Fail 2-of-N alarm occurs This is a special rectifier alarm group that signifies that more than one rectifier has at least one alarm condition.	Rect 2ofN Almm+ Major
Rectifier Fail Safe Voltage Security Level {1} **[MODULES/RECT/PARAM]**	Rectifier default output voltage if communication with the control unit fails.	Rect Fail Safem+ -54.00 V
Rectifier Fan Fail Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when a rectifier fan has failed.	Rect FF Alm m+ n of N
Rectifier Fan Fail Alarm Status {Status Only} **[MODULES/RECT/INFO]**	The status will be "ON" if the rectifier fan has failed. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 FF # OFF
Rectifier Fault Alarm (RFA) Status {Status Only} **[MODULES/RECT/INFO]**	The status will be on if the rectifier output has failed. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 RFA # OFF
Rectifier RFA Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when a rectifier output has failed.	Rect RFA Alm m+ n of N
Rectifier Standby Alarm Security Level {1} **[MODULES/RECT/SET-ALM]**	The output relay that is energized or special rectifier alarm group n of N that occurs when the control unit is holding a rectifier in the standby mode.	Rect Stdby Almm+ n of N
Rectifier Standby Alarm Status {Status Only} **[MODULES/RECT/INFO]**	The status will be "ON" if the control unit is holding the rectifier in the standby mode. **NOTE: This information can be viewed for each rectifier installed by using the horizontal arrow keys.**	Rect 1 Stdby # OFF
Store Configuration Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to "Enable" will cause the current rectifier configuration to be stored (the display toggles back to "Disable" after entry).	Store Cfg m+ Disable
System Current {Status Only} **[STATUS]**	The total system output current (calculated as the sum of the individual rectifier output currents).	Sys Current + 145.8 A
System High Temperature Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Temperature exceeds the system high temperature threshold.	Sys HT Alm m+ Minor
System High Temperature Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Temperature is ambient temperature measured inside the controller. An alarm will be reported if temperature is higher than the temperature entered.	Sys HT Thr m+ 70.0 C

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
System High Voltage alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Voltage is above the System High Voltage threshold.	Sys HV Alm m+ Minor
System High Voltage Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Voltage is bus voltage measured by the controller. An alarm will be reported if voltage is higher than the voltage entered.	Sys HV Thr m+ -58.00 V
System Low Temperature Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Temperature is below the System Low Temperature threshold.	Sys LT Alm m+ Minor
System Low Temperature Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Temperature is ambient temperature measured inside the controller. An alarm will be reported if temperature is lower than the temperature entered.	Sys LT Thr m+ 0.0 C
System Low Voltage Alarm Security Level {1} **[SYSTEM/SET-ALM]**	The output relay energized if the System Voltage is below the System Low Voltage threshold.	Sys LV Alm m+ Minor
System Low Voltage Threshold Security Level {1} **[SYSTEM/SET-ALM]**	System Voltage is bus voltage measured by the controller. An alarm will be reported if voltage is lower than the voltage entered.	Sys LV Thr m+ -50.00 V
System Temperature {Status Only} **[STATUS]**	System temperature measured within the control unit.	Sys Temp + 26.7 C
System Voltage {Status Only} **[STATUS]**	System output voltage measured between the MX28B DC power plant -48V and return buses.	Sys Voltage + -54.00 V
Test Major Relay Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to “ON” de-energizes the Major Relay and turns on the “MAJ” LED on the control unit front panel. In normal operation Major Relay is energized so that when a loss of –48 VDC power occurs, the relay will change state.	Test Maj Rly m+ OFF
Test Minor Relay Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to “ON” energizes the Minor Relay and turns on the “MIN” LED on the control unit front panel.	Test Min Rly m+ OFF
Test Relay 1 Security Level {1} **[SYSTEM/DIAG]** • • • Test Relay 6 Security Level {1} **[SYSTEM/DIAG]**	Setting this parameter to “ON” energizes Relay 1 and turns on the “ALM1” LED on the control unit front panel. • • • Setting this parameter to “ON” energizes Relay 6 and turns on the “ALM6” LED on the control unit front panel.	Test Relay 1 m+ OFF • • • Test Relay 6 m+ OFF
Test Relay Enable Security Level {1} **[SYSTEM/DIAG]**	This parameter must be set to “Enable” to permit the eight output relays to be manually tested; otherwise, the state of the relays will be per system conditions.	Test Relay En m+ Disable

PARAMETER NAME/ [MENU LOCATION]	DESCRIPTION	DISPLAY SCREENS / DEFAULT SETTINGS
Time Security Level {1} **[SYSTEM/DATE]**	Internal system clock time (24-hour format). Used as a date stamp in the event log.	Time m+ 9:00:25

Control Unit Menu Structure

The complete menu structure shown in the order in which it is accessed from the control unit display is presented in outline form below. Each indentation to the right represents a menu level below the indicated title.

Top Level	Second Level	Third Level	Fourth Level
MX28B 1200 + STATUS ALARMS	Sys Voltage		
•	Sys Current		
•	Sys Temp		
•	Batt Current		
•	Batt Temp		
MX28B 1200 + US ALARMS SYSTEM	Alarm Item 1		
•	Alarm Item 2		
•	Alarm Item 3		
•	•		
•	•		
•	•		
•	Alarm Item 14		
•	Alarm Item 15		
•	Alarm Item 16		
MX28B 1200 + MS SYSTEM MODULE	SYS + SET-ALM SETUP DA	Sys HV Thr	
•	•	Sys HV Alm	
•	•	Sys LV Thr	
•	•	Sys LV Alm	
•	•	Rect Cfg Alm	
•	•	Rect 1ofN Alm	
•	•	Rect 2ofN Alm	
•	•	Sys HT Thr	
•	•	Sys HT Alm	
•	•	Sys LT Thr	
•	•	Sys LT Alm	
•	•	Hw Sys V Alm	

Top Level	Second Level	Third Level	Fourth Level
•	•	Hw Batt C Alm	
•	•	Hw Batt T Alm	
•	•	Hw Sys T Alm	
•	•	Hw LVD Alm	
•	SYS: + LM SETUP DATE	PIN 1	
•	•	PIN 2	
•	•	Address 1	
•	•	Address 2	
•	•	Address 3	
•	•	Model	
•	•	Fahrenheit	
•	•	Cntrl Rev	
•	•	FW Version	
•	•	Display Type	
•	SYS: + LY DATE OUT-RLY	Date	
•	•	Time	
•	SYS: + TE OUT-RLY IN-R	SYS:OUT: + RLY-MAP ALIAS	Out-Rly 1 Alm
•	•	•	Out-Rly 2 Alm
•	•	•	Out-Rly 3 Alm
•	•	•	Out-Rly 4 Alm
•	•	•	Out-Rly 5 Alm
•	•	•	Out-Rly 6 Alm
•	•	•	Out-Rly 1 Dly
•	•	•	Out-Rly 2 Dly
•	•	•	Out-Rly 3 Dly
•	•	•	Out-Rly 4 Dly
•	•	•	Out-Rly 5 Dly
•	•	•	Out-Rly 6 Dly
•	•	SYS:OUT: + AP ALIAS	Out-Rly 1
•	•	•	Out-Rly 2

Top Level	Second Level	Third Level	Fourth Level
•	•	•	Out-Rly 3
•	•	•	Out-Rly 4
•	•	•	Out-Rly 5
•	•	•	Out-Rly 6
•	•	•	Relay Minor
•	•	•	Relay Major
•	SYS: + LY IN-RLY DIAG	SYS:IN-: + RLY-MAP ALIAS	In-Rly 1 Alm
•	•	•	In-Rly 2 Alm
•	•	•	In-Rly 3 Alm
•	•	•	In-Rly 4 Alm
•	•	SYS:IN-: + AP ALIAS	In-Rly 1
•	•	•	In-Rly 2
•	•	•	In-Rly 3
•	•	•	In-Rly 4
•	SYS: + LY DIAG	Store Cfg	
•	•	Lamp Test	
•	•	Test Relay En	
•	•	Test Relay 1	
•	•	Test Relay 2	
•	•	Test Relay 3	
•	•	Test Relay 4	
•	•	Test Relay 5	
•	•	Test Relay 6	
•	•	Test Min Rly	
•	•	Test Maj Rly	
MX28B 1200 + EM MODULES BATT	MOD: + RECT CIR-BKR	MOD:REC: + SET-ALM PARAM I	Rect CL Alm
•	•	•	Rect Stdby Alm
•	•	•	Rect FF Alm
•	•	•	Rect RFA Alm
•	•	MOD:REC: + LM PARAM INFO	Rect Fail Safe

Top Level	Second Level	Third Level	Fourth Level
•	•	•	Rect Fail Comm
•	•	MOD:REC: + AM INFO	Rect # Desc
•	•	•	Rect # Curr
•	•	•	Rect # CL
•	•	•	Rect # Stdby
•	•	•	Rect # FF
•	•	•	Rect # RFA
•	MOD: + CT CIR-BKR FUSE	MOD:CIR: + SET-ALM ALIAS	Cir Bkr 1 Alm
•	•	•	Cir Bkr 2 Alm
•	•	•	Cir Bkr 3 Alm
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	Cir Bkr 70 Alm
•	•	•	Cir Bkr 71 Alm
•	•	•	Cir Bkr 72 Alm
•	•	MOD:CIR: + LM ALIAS	Cir Bkr 1
•	•	•	Cir Bkr 2
•	•	•	Cir Bkr 3
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	Cir Bkr 70
•	•	•	Cir Bkr 71
•	•	•	Cir Bkr 72
•	MOD: + KR FUSE LVD	MOD:FUS: + SET-ALM ALIAS	FUSE 1 Alm
•	•	•	FUSE 2 Alm
•	•	•	FUSE 3 Alm
•	•	•	FUSE 4 Alm
•	•	•	FUSE 5 Alm

Top Level	Second Level	Third Level	Fourth Level
•	•	•	FUSE 6 Alm
•	•	•	FUSE 7 Alm
•	•	•	FUSE 8 Alm
•	•	•	FUSE 9 Alm
•	•	•	FUSE 10Alm
•	•	•	FUSE 11Alm
•	•	•	FUSE 12Alm
•	•	•	FUSE 13Alm
•	•	•	FUSE 14Alm
•	•	•	FUSE 15Alm
•	•	•	FUSE 16Alm
•	•	MOD:FUSE: + LM ALIAS	FUSE 1
•	•	•	FUSE 2
•	•	•	FUSE 3
•	•	•	FUSE 4
•	•	•	FUSE 5
•	•	•	FUSE 6
•	•	•	FUSE 7
•	•	•	FUSE 8
•	•	•	FUSE 9
•	•	•	FUSE 10
•	•	•	FUSE 11
•	•	•	FUSE 12
•	•	•	FUSE 13
•	•	•	FUSE 14
•	•	•	FUSE 15
•	•	•	FUSE 16
•	MOD: + MT LVD	MOD:LVD: + SET-ALM PARAM	LVD 1 Option
•	•	•	LVD 1 Open Alm
•	•	•	LVD 2 Option
•	•	•	LVD 2 Open Alm

Top Level	Second Level	Third Level	Fourth Level
•	•	MOD:LVD: + LM PARAM	LVD 1 Trip
•	•	•	LVD 1 Reset
•	•	•	LVD 2 Trip
•	•	•	LVD 2 Reset
MX28B 1200 + ES BATT PIN OEM	BAT: + SET-ALM PARAM C	Batt Disc Thr	
•	•	Batt Disc Alm	
•	•	Batt HV Thr	
•	•	Batt HV Alm	
•	•	Batt LV Thr	
•	•	Batt LV Alm	
•	•	Batt HT Thr	
•	•	Batt HT Alm	
•	•	Batt LT Thr	
•	•	Batt LT Alm	
•	BAT: + LM PARAM COMP	Batt Float	
•	•	Batt Max Rech	
•	BAT: + AM COMP	Comp Method	
•	•	Comp TC	
•	•	Comp HKnee	
•	•	Comp LKnee	
MX28B 1200 + ES BATT PIN OEM	PIN		
MX28B 1200 + TT PIN OEM	OEM R Offset		
•	OEM R Gain		
•	OEM S Offset		
•	OEM S Gain		

Front Panel LED Indicators

Major (Red)	On when Major Relay is de-energized*
Minor (Yellow)	On when Minor Relay is energized
Normal (Green)	On when no alarms are active
ALM 1 (Red)	On when Output Relay 1 is energized
ALM 2 (Red)	On when Output Relay 2 is energized
ALM 3 (Red)	On when Output Relay 3 is energized
ALM 4 (Red)	On when Output Relay 4 is energized
ALM 5 (Red)	On when Output Relay 5 is energized
ALM 6 (Red)	On when Output Relay 6 is energized
MIN (Red)	On when Minor Relay is energized
MAJ (Red)	On when Major Relay is de-energized*

* This will produce a major relay output even when all power is lost.

5.7. Alarm Outputs (Output Relays)

There are eight alarm output relays designated Relay 1 through Relay 6, Minor, and Major, respectively. Various system parameters may be programmed to activate any of these alarm relays when set thresholds are exceeded or specific conditions occur. The first six relays can also be assigned a priority and routed or "mapped" to other output alarm relays. Available assignments are "Ignore", "Major", "Minor", and "Relay 1" ··· "Relay 6". Screens for making these assignments are located at **[SYSTEM/OUT-RLY/RLY-MAP]**. This feature makes it possible for a single alarm condition to activate multiple alarm output relays including the Minor or Major alarm relay. A user defined name or "alias" may also be assigned to each of the eight output relay alarms. Screens for making these assignments are located at **[SYSTEM/OUT-RLY/ALIAS]**. For information on making wiring connections to the alarm output relays refer to **Section 3.9**

5.8. External Alarm Inputs (Input Relays)

The controller can monitor any external device that uses a switch or relay to output status information. Connecting the external device to the input relay connections is the first step. The four external alarm inputs (also referred to as “Input Relay Alarms”) can be assigned a priority and routed or “mapped” to alarm output relays. Available assignments are “Ignore”, “Major”, “Minor”, and “Relay 1” ··· “Relay 6” (do not map relay to itself or the alarm will never clear). Screens for making the assignments are located at **[SYSTEM/IN-RLY/RLY-MAP]**. A user defined name or “alias” may also be assigned to each of these input alarms. Screens for making these assignments are located at **[SYSTEM/IN-RLY/ALIAS]**. For information on wiring connections to these inputs refer to **Section 3.10.**

6 Remote Monitoring

6.1. Description

Remote monitoring and control of the DC power system is accomplished through the use of the optional APC Network Management card. This card is a separate module mounted into the top panel of the system controller module.

Complete documentation for the use of the management card accompanies the DC power system in the form of a small Quick Start Guide and a CD. The CD contains electronic copies of User's Manuals along with the necessary software utilities to support the management function.

6.2. Physical Connections

The management card has a RJ-45 connector to support a TCP/IP protocol over a 10BaseT Ethernet Local Area Network (LAN). The 9-pin D-shell connector uses the special RS-232 cable (APC part number 940-0024C) to allow local access through a Terminal Emulation program like HyperTerminal™ or Procomm™.

6.3. Command and Monitoring Protocol

Refer to the User's Guides and associated documentation provided on the management card CD for the details on installation and use of the various communication protocols and command settings.

7 Preventive Maintenance

Preventive Maintenance is typically performed on a quarterly basis.

7.1. Equipment

1. 4 Digit Voltmeter.
2. Clamp-on Ampere meter.
3. Standard Insulated tools.

7.2. Inspection

Environmental Inspection

1. Ensure the DC system environment is suitable for operation.
2. Ensure that there is sufficient clearance around the system for service.
3. Ensure that there is no sign of damage to the DC system.
4. Contact monitoring personnel or disable system alarms before servicing the unit. This will allow the unit to be serviced without creating false alarms.

System Visual and Safety Inspection

	**WARNING**: Hazardous energy levels are present on bare conductors in the -48VDC distribution connection area of the plant. Accidental shorting of distribution conductors can cause arcing and high currents that can cause serious burns or other physical harm. It is recommended that: • Any jewelry, rings or watches be removed while working on this equipment. • Handles of all wrenches, screwdrivers, cutters and pliers are insulated.

1. Ensure that the DC wiring is properly installed, sized, terminated and identified.
2. Ensure that the AC wiring is properly installed, sized, terminated and identified.
3. Ensure that the battery is properly connected to the System.
4. Ensure that the DC output over-current protection devices are adequate for the size of wiring installed.
5. Ensure that the DC Positive is bonded to central office ground (- 48 volt system).
6. Note the resistance of the ground bond.
7. Note any currents flowing in the ground.
8. Record ambient temperature.
9. Verify that the battery polarity is correct.
10. If battery disconnect devices are present, note the following for each device:

a) DC Voltage Rating.
b) DC Current Rating
c) Interrupting Current Rating

Battery Visual and Safety Inspection

1. Check that the battery temperature probe is firmly attached to the battery.
2. Check the mechanical integrity of the battery framing, racking, or cabinet. Tighten where necessary.
3. If there is a battery disconnect device fitted, ensure that it is properly connected and protected.
4. Check the general appearance and cleanliness of the battery. Clean if necessary. Use only approved cleaning materials.
5. Visually inspect each cell for the following, and clean and neutralize if necessary. Document discrepancies on Site form accordingly.
    a. Cracks.
    b. Case leaks.
    c. Post-seal leaks.
    d. Pressure relief valve leaks (VRLA only).
    e. Case swelling (VRLA only).
    f. Terminal corrosion and connector corrosion.
6. Check the torque of all battery inter-cell connector in accordance with specifications. Re-torque if necessary (annual only).
7. Measure and record ambient temperature.

7.3. Test

System Voltage Test

Verify with a voltmeter directly attached to the DC bus that the system voltage is correct. If the voltage is off by more than 0.1V recalibrate the controller with the OEM/R Offset setting.

System voltage should also agree with the battery float voltage set up in the battery parameters section. The system may be off because of battery temperature compensation or battery recharging.

Rectifier Current Test

1. Insert voltmeter probe between I+ and common jack on front of each rectifier.
2. Record current for each rectifier using the formula – Voltage X 10amps/volt.
3. Rectifier current displayed under Rectifier/Info should agree with the recorded current.

Rectifier Current Share Test

Verify that the highest rectifier current and the lowest current are within 5 amps.

System Current Test

Verify the System current equal to the total of the rectifier currents. System current should equal the total current of the loads as well as any battery current.

Rectifier Alarm Test

1. Verify that all of the rectifiers report RFA Alarm is off.
2. Verify that the battery voltage reading on the voltmeter is negative (-)54.00 ± 0.02Volts.
3. Remove 1 rectifier and verify that you get a Minor alarm for Rect 1 of n failure on the controller and the customer remote alarm panel.
4. Remove the second rectifier and verify that you get a Major alarm for Rect 2 of n failure on the controller and the customer remote alarm panel.
5. After the fan has completely stopped spinning, insert a plastic pen or plastic screwdriver into the fan blade of one of the rectifiers and reinsert both rectifiers
6. Verify that you get the fan fail alarm on controller and the customer remote alarm panel.
7. Remove the fan fail device.

System Temperature Test

Verify that the system temperature is correct.

Battery Current Test

1. Measure the battery current with a clamp-on meter.
2. Verify that the battery current is below 5 amps.
3. Verify that the displayed battery current is within ± 5 amps. Adjust OEM/S Offset if required.
4. Determine the total battery capacity at the site:
   Cells connected in series make up a string, and the capacity is determined by the capacity of a single cell. Add amp/hour capacity for all strings connected in parallel. Enter the total battery capacity in the appropriate box on the Site Form.
5. Determine the Max. Batt. Recharge rate:
   Divide Total battery capacity by 20 hours and enter it in the appropriate box on the Site Form.
6. Verify that the Max. Batt. Recharge rate is set to the calculated value.
7. Remove AC power to the rectifiers purposely causing the battery discharge alarm to come on.
8. Verify that the System Current is 0 ± 5 amps.
9. Verify that the battery current is within 5 % of the system current recorded previously.
10. Verify that the Battery Discharge Alarm is on.
11. Restore AC power to the rectifiers.

Battery Temperature Test

If the battery teperature probe is used in this system, verify that the battery temperature is correct.

LVD Test

1. Verify that the Battery Float voltage is set to negative (-) 54.00 Volts via the control panel and verify the temperature compensation setting is at its default setting (disabled).
2. Enable the LVD's that are installed.
   Note: In single-bay systems, only LVD1 is used. In multi-bay systems LVD1 and LVD2 are used in parallel.
3. Ensure that the LVD parameters are set to proper value.
4. Install rectifiers and restore AC power.
5. Set the LVD Trip to –56.00 Volts.
6. The LVD should have dropped out (opened). Verify it by monitoring the voltage at the battery connection.
7. Verify that the LVD Open Alarm is registered on the controller and at the customer remote alarm panel.
8. Reset the LVD Trip to negative (-) 42Volts.
9. Verify that the LVD Open Alarm has been removed.

Battery Preventive Maintenance Procedure

The purpose of the preventive maintenance is to ensure that the battery is in good, working condition. The observations, measurements, and tests performed are designed to determine the "state of health" of the battery. It will also allow for the prediction of future performance and preempt possible failure.

1. Measure the float charge voltage.
   a. At the power bay bus.
   b. At the battery.
   c. Reset voltage if necessary.
2. Measure the float current on each battery cable. If it is fluctuating, measure maximum and minimum.
3. Measure the AC ripple voltage at the battery.
4. Using an Alber Cellcorder, measure the float voltage of each cell or monoblock. Record the battery memory location allocated on the Cellcorder.
5. Using an Alber Cellcorder, perform a load test on each cell or monoblock and measure the internal cell resistance and inter-cell resistance of each cell or monoblock.
6. Measure and record the specific gravity of each cell using an individual hydrometer or Cellcorder attachment hydrometer (VLA only).
7. Ensure that the electrolyte level is adequate. Add approved water where necessary (VLA only).
8. Measure and record the temperature of the electrolyte of each cell (VLA only).

9. Ensure that all protective covers are replaced and that the battery is electrically non-hazardous to personnel that could be working in the vicinity. Detail any discrepancies.
10. Download the Cellcorder to a PC and create a data file for each battery string. Keep a copy of the results on disk.

7.4. Final Inspection:

6. Verify that the interior and exterior of the system is clean and free from debris.
7. Ensure all wires connected and bolts are properly tightened.
8. Ensure the following the User, Service, and Calibration parameters are set properly on the controller (default settings are in parenthesis):
   LVD (Param)
   - LVD1 Trip (-42.00 V)
   - LVD1 Reset (-48.00 V)
   - LVD2 Trip (-42.00 V)
   - LVD2 Reset (-48.00 V)

   Batt (Set-alm)
   - Batt Disc Thr (10 A)

   Batt (Param)
   - Batt Float (-54.00 V)
   - Batt Max Rech (50 A)

   Batt (Comp)
   - Comp Method (OFF)
9. Verify on the status menu that the system is functioning correctly with no alarms.
10. Be sure to leave the site as orderly and neat as possible.

8 Specifications

The overall system specifications can vary, depending upon the number of rectifier modules. Note that some specification items are provided on a “per rectifier” basis and must be combined or totaled for a give system configuration.

8.1. AC Input

1MRF28H54BV Rectifiers

Nominal Input Voltage	208, 230 VAC
Input Voltage Range	176 – 264 VAC
AC Frequency Range	45 – 65 Hz
Apparent Power Factor	99% Typical, 98% Minimum
Maximum Input Current (per Rectifier)	13.9 Amps @ 230V AC

1MRF28H54BV50 Rectifiers

Nominal Input Voltage	277 VAC
Input Voltage Range	176 – 293 VAC
AC Frequency Range	45 – 65 Hz
Apparent Power Factor	99% Typical, 98% Minimum
Maximum Input Current (per Rectifier)	11.0 Amps @ 277V AC

8.2. DC Output (with either 1MRF28H54BV Rectifiers and 1MRF28H54BV50 Rectifiers)

Nominal Output Voltage (factory set)	54.5 VDC
Operating Voltage Range	44 – 58 VDC
Rated Output Current (per Rectifier)	50 A
Rated Output Power (per Rectifier)	2800 W (45ºC)
Efficiency	91% Typical

8.3. Controls and Indicators

Rectifiers

Input Healthy LED	AC power present.
Output Healthy LED	DC output voltage within operating range (-39.5 to –59.5 VDC).
Output Current LED	On when rectifier is supplying current.
Thermal Control LED	On when one of three internal sensors is above 90ºC
Current Limit LED	On when rectifier is in current limit.
Overvolts LED	On when rectifier is above 57 Volts. (Must be powered down to reset)
Overtemp LED	On when one of three internal sensors is above 130ºC. Power Conversion is inhibited.
Fan fail LED	On when Fan is running too slow.
Standby LED	On when the unit is in the standby mode. No output power is produced. Rectifier is still active
+V Test Point	Rectifier Voltage can be measured with a voltmeter between COM and +V.
COM Test Point	Negative reference for both +V and +I
+I Test Point	Rectifier Current can be measured with a voltmeter between COM and +I.

Float / Boost/Equalize Switch	Used to Control voltage on systems without a PSCU
Float Trim Pot	The float pot is used to adjust the default float voltage (54.5 VDC).
Boost/Equalize Trim Pot	The boost/equalize pot is used to adjust the default boost equalize voltage (57.5 VDC).

Power Shelf Control Unit

Major (Red)	On when Major Relay is de-energized*
Minor (Yellow)	On when Minor Relay is energized
Normal (Green)	On when no alarms are active
ALM 1 (Red)	On when Output Relay 1 is energized
ALM 2 (Red)	On when Output Relay 2 is energized
ALM 3 (Red)	On when Output Relay 3 is energized
ALM 4 (Red)	On when Output Relay 4 is energized
ALM 5 (Red)	On when Output Relay 5 is energized
ALM 6 (Red)	On when Output Relay 6 is energized
MIN (Red)	On when Minor Relay is energized
MAJ (Red)	On when Major Relay is de-energized*

8.4. Mechanical

Dimensions	84” high x 26” wide x 26” deep	
Weight	Housing	400-600 lbs. (181-272 Kg)
	Rectifier (each)	11 lbs (5Kg)
Color	Dawn Gray	
Mounting	Floor Mounting	

8.5. Environmental

Ambient Temperature	(Operating)	-45ºC to +55ºC (+65ºC with reduced power output)
	(Storage)	-45ºC to +85ºC
Humidity	(Operating)	0 – 85% RH (non-condensing)
	(Storage)	0 – 95% RH (non-condensing)
Altitude	(Operating)	3000 m (9840 ft.)
	(Storage)	10000 m (39370 ft.)

8.6. Compliance

NEBS	Level 3
Safety	UL 1950
EMC	FCC Part 15 Class A

9 APC Worldwide Customer Support

Customer Support for this or any other APC product is available at no charge. You can contact APC Customer Support in any of the following ways:

- Use an APC web page to find answers to frequently asked questions (FAQs), to access documents in the APC Knowledge Base, and to submit customer support requests.
  - http://www.apc.com (Corporate Headquarters)
    Connect by links to APC web pages for specific countries and regions, each of which provides customer support information.
  - http://www.apc.com/support/
    Submit customer support requests.

- Contact Local or regional APC Customer Support by telephone or e-mail.
  - For e-mail addresses and local, country-specific, customer support telephone numbers worldwide, refer to: http://www.apc.com/support/contact.
  - For e-mail addresses and technical support telephone number of major APC regional customer support centers, use the following list:

US and Canada (Toll Free)	+1 (800) 800-4272 (1-800-800-4APC)
Worldwide (Toll Call)	+1 (401) 789-5735 (US)

- Contact the APC representative or other distributor from whom you purchased your APC hardware device or APC software application for information on how to obtain local customer support.

10 Limited Product Warranty

The limited warranty provided by American Power Conversion Corporation ("APC") in this Statement of Limited Factory Warranty applies only to Products Buyer purchases for your commercial or industrial use in the ordinary course of Buyer's business.

APC PRODUCTS COVERED ("Product or Products"):

MX281200/2400
MX281200/4800

Terms of Warranty:

APC warrants that the Product shall be free from defects in materials and workmanship, for a period of two (2) years from the date of shipment.

Warranty Procedure

If initial physical inspection results in identification of a material or workmanship flaw(s) that could impair Product performance as defined by APC's electrical and physical specification in effect at the time of shipment, and if this flaw(s) is not due to transportation damage or installation abuse, contact APC or call the 24-hour emergency number, (800) 800 4APC, to request assistance.

You will be provided either a) an RMA number with instructions for return of the equipment or component(s) to the APC factory service center, FOB destination, freight pre-paid, for examination, or b) for non-returnable systems and equipment, notice to wait until an APC authorized service representative arrives at the site to inspect the equipment. Repaired or advance replacement modules or circuit components will normally be available within 24 to 48 hours of receipt of equipment or RMA.

Warranty Obligations - Repair or Replacement

If, during the warranty period, the Product is found to be physically or electrically faulty due to defective materials or workmanship, the defective Product(s) or component(s) will be repaired or replaced at the sole option of APC. If the procedure outlined above for contacting APC immediately after identifying a material or workmanship flaw(s) that could impair Product performance has been properly followed, such repair or replacement of Product(s) or component(s) shall include all charges for replacement materials or repair labor. Costs incurred for replacement installation including, but not limited to, installation equipment, travel expenses of an APC representative(s), and costs of installation material transportation expenses are not included as a part of this warranty. Any replacement components or materials furnished under this warranty may be new or factory remanufactured. THIS WARRANTY DOES NOT COVER CONSUMABLES OR PREVENTATIVE MAINTENANCE ITEMS. REPAIR OR REPLACEMENT OF A DEFECTIVE PRODUCT OR COMPONENT THEREOF DOES NOT EXTEND THE ORIGINAL WARRANTY PERIOD.

Exclusions and Limitations

This Warranty is extended to the first person, firm, association or corporation for whom the APC Product specified herein has been bought. This Warranty is not transferable or assignable without the prior written permission of APC.

This limited warranty does not cover damage due to external causes, including accident, abuse, misuse, servicing not authorized by APC, usage not in accordance with Product instructions, failure to perform preventative maintenance, and problems cause by use of parts and components not supplied by APC. This limited warranty does not apply to Products from which the serial numbers have been removed, or to conditions resulting from improper use, accidents, external causes, including installation, relocation of hardware, service or modifications not performed by APC or its authorized service providers, or operation outside the environmental parameters specified for the Product. APC does not warrant that the operation of any Product will be uninterrupted or error free. Warranty service may not be performed if APC or other suppliers reasonably believe conditions at the Buyer's site represent a safety or health risk.

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