"LINEAGE* " 2000
MICROPROCESSOR CONTROLLED SYSTEM BATTERY PLANT
CONTROLLER DESCRIPTION

CONTENTS PAGE

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1. GENERAL

1.01 This practice describes the physical and functional characteristics of the plant controller used in the LINEAGE 2000 Microprocessor Controlled System (MCS) battery plant.

1.02 Whenever this practice is reissued, the reason(s) for reissue will appear in this paragraph.

1.03 The controller described in this practice will manage a 24- or 48-volt, positive or negative plant to provide power for the loads as well as float and recharge capability for the battery string(s). The controller can manage a power plant equipped with up to 16 rectifiers.

1.04 The controller is available as either an automatic microprocessor based smart plant controller or as a conventional plant controller. If a conventional plant controller is selected, it may be upgraded to a smart plant controller at a later date.

1.05 This issue of the practice is based on circuit schematic diagram SD-82588-01, Issue 1. If this practice is used with equipment or apparatus that is associated with earlier or later issues of the drawings, refer to the SD to determine the extent of the changes and the manner in which the practice may be affected.

2. PHYSICAL DESCRIPTION

A. Introduction

2.01 Both the smart microprocessor controller and the conventional plant controller require the same amount of panel space. If a conventional plant controller is upgraded to a smart plant controller, the chassis assembly, standard card cage, and ED-83006 auxiliary circuit pack are retained and reused in the smart plant controller.

B. Plant Controller (Smart Plant)

2.02 The smart plant controller (Fig. 1) measures 9 inches high, 26 inches wide, and 12 inches deep. The front panel contains a 40-character, single-line alphanumeric vacuum fluorescent display (VFD). Red membrane switch pads access major alarm information. Yellow membrane switch pads access minor alarm information. A blue membrane switch keypad (numeric keypad) is provided to enter rectifier, feeder number(s), perform alarm cutoff (ACO), and to set the 24-hour system clock. Gray membrane switch pads access various standard and optional plant features. Behind the panel faceplate (hinged to open downward) (Fig. 2), is the card cage(s) for the system circuit packs. Circuit packs for standard and optional features are plugged into the controller as needs dictate. When new options are added to the plant, keypad inserts are replaced in the faceplate, if necessary. Sixteen fuse positions are located to the extreme left side of the controller for rectifier REG fuses. Below the REG fuses are six fuse positions to provide controller power, alarm power, and battery voltage to all connected rectifiers.

C. Plant Controller (Conventional Plant)

2.03 The conventional plant controller (Fig. 3) measures 9 inches high, 26 inches wide, and 12 inches deep. The front panel contains the PLANT VOLTAGE and PLANT LOAD CURRENT analog meters. Test jacks [VM CAL (+) and (−)] are located on the front panel for PLANT VOLTAGE meter calibration. Alarm indicators give a visual indication of the cause of alarms. Behind the panel faceplate (hinged to open downward) (Fig. 4), is the standard card cage for the conventional plant controller circuit packs as well as the smart plant circuit packs if the plant is ever upgraded. Sixteen fuse positions are located to the extreme left side of the controller for rectifier REG fuses. Below the REG fuses are six fuse positions to provide controller power, alarm power, and battery voltage to all connected rectifiers.

3. FUNCTIONAL DESCRIPTION

A. General

3.01 The plant controller provides management for either 24- or 48-volt positive or negative, battery plants.

3.02 Either controller (smart or conventional) manages up to 16 rectifiers. The rectifiers may be of one type and capacity or a combination of types and capacities.

3.03 The current capacity of the plant is determined by the sum of the current capacities of the individual rectifiers (including spare rectifier, charge, and recharge capacity.)

B. Smart Plant Controller

3.04 ***General:*** The smart plant controller uses a microprocessor based technology controller to manage the plant. Refer to Fig. 5 for the smart plant controller block diagram. The plant load current and float voltage are monitored to determine float voltage and load/recharge requirements. Individual rectifiers are monitored and checked continuously for rectifier data, status, output current, alarms, and malfunctions. Periodically, the microprocessor runs a self-diagnostic test and a system test to detect malfunctions.

3.05 The front panel of the smart plant controller (Fig. 6) has a black polymer face and contains the following:

- A 40-character, single-line alphanumeric vacuum fluorescent message display
- Major alarm indicators/controls
- Minor alarm indicators/controls

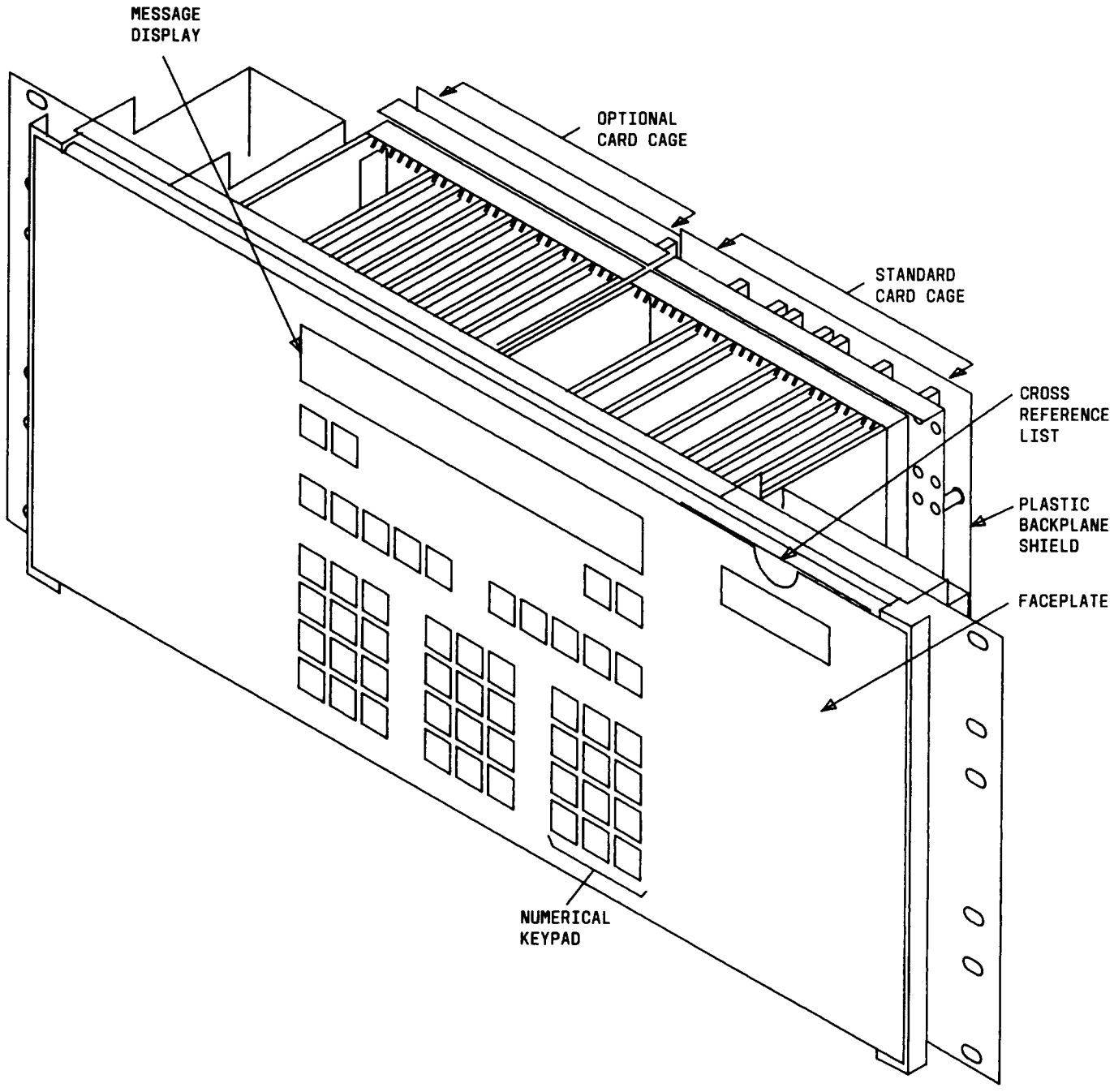

Fig. 1—Smart Plant Controller

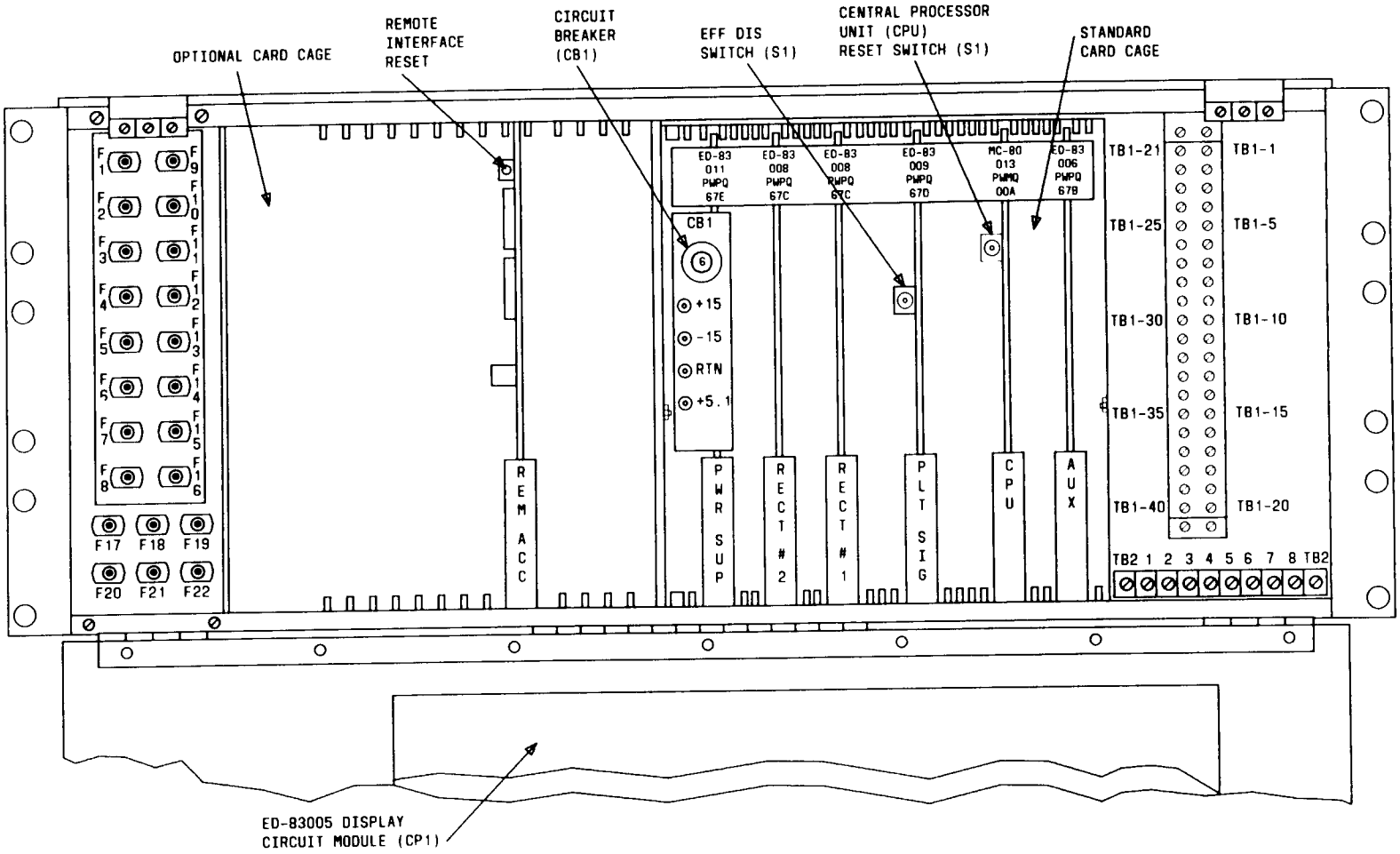

Fig. 2—Smart Plant Controller (Faceplate in Open Position)

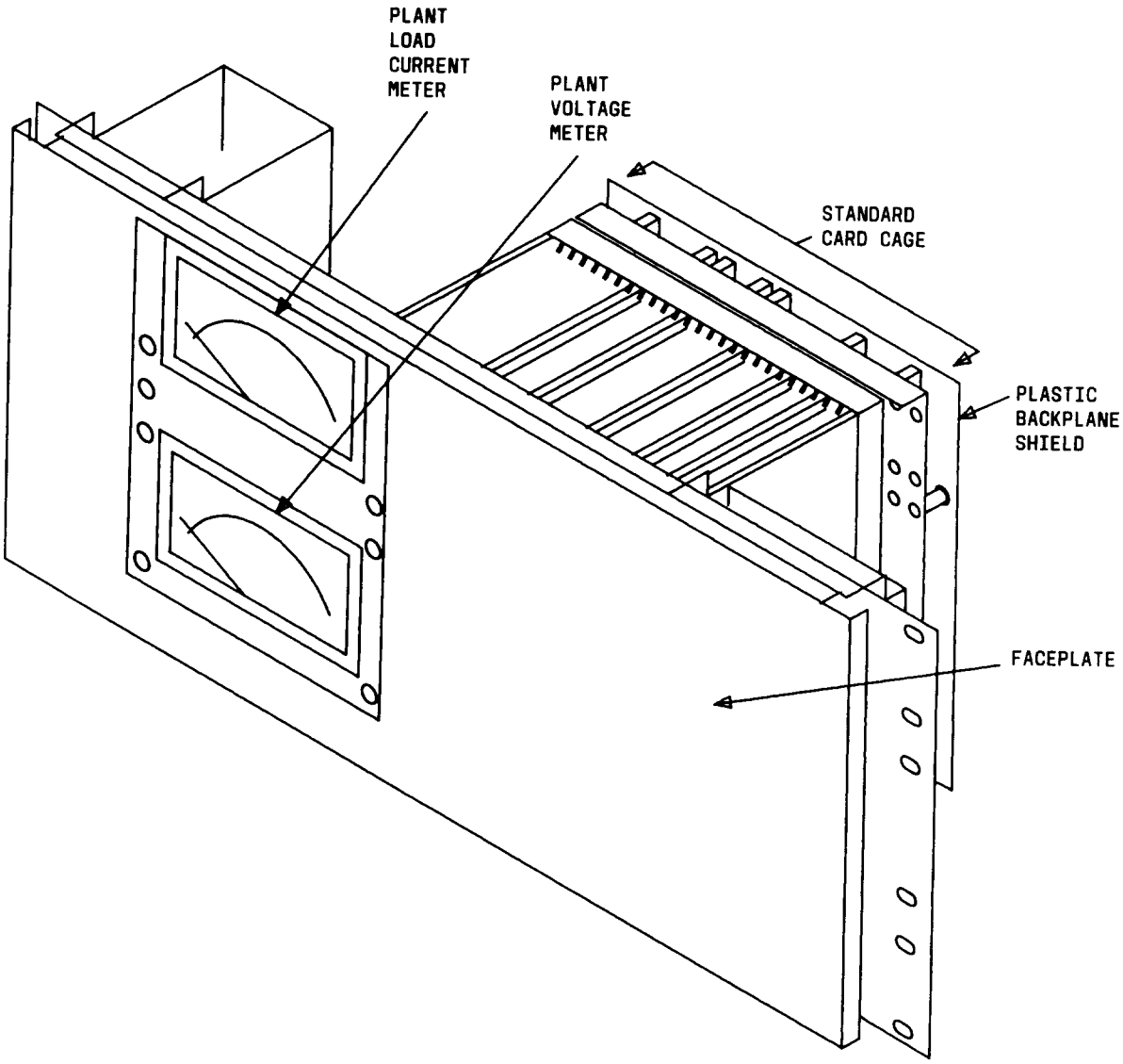

Fig. 3—Conventional Plant Controller

- Specific system function controls
- Numeric keypad
- Rect and Feeder Assignment Cross Reference List.

The message display informs the operator, in plain English, of plant data such as test, current and voltage measurements, and trouble diagnostics. The major alarm controls access the reason(s) for major alarms [reason(s) for major alarms appear on the message display]. The minor alarm controls access the reason(s) for minor alarms [reason(s) for minor alarms appear on the message display]. The specific system function controls allow the operator to run tests on the plant and access plant operating data. The numeric keypad is used to set the system clock and to select the rectifier to be checked. Behind the panel faceplate (hinged to open downward) (Fig. 2) are 16 fuse positions (F1 through F16) for rectifier regulation (REG) fuses. Below the REG fuses are six fuse positions to provide the following:

- CTF (F17)—The CTF fuse provides battery sense voltage for major circuit functions.

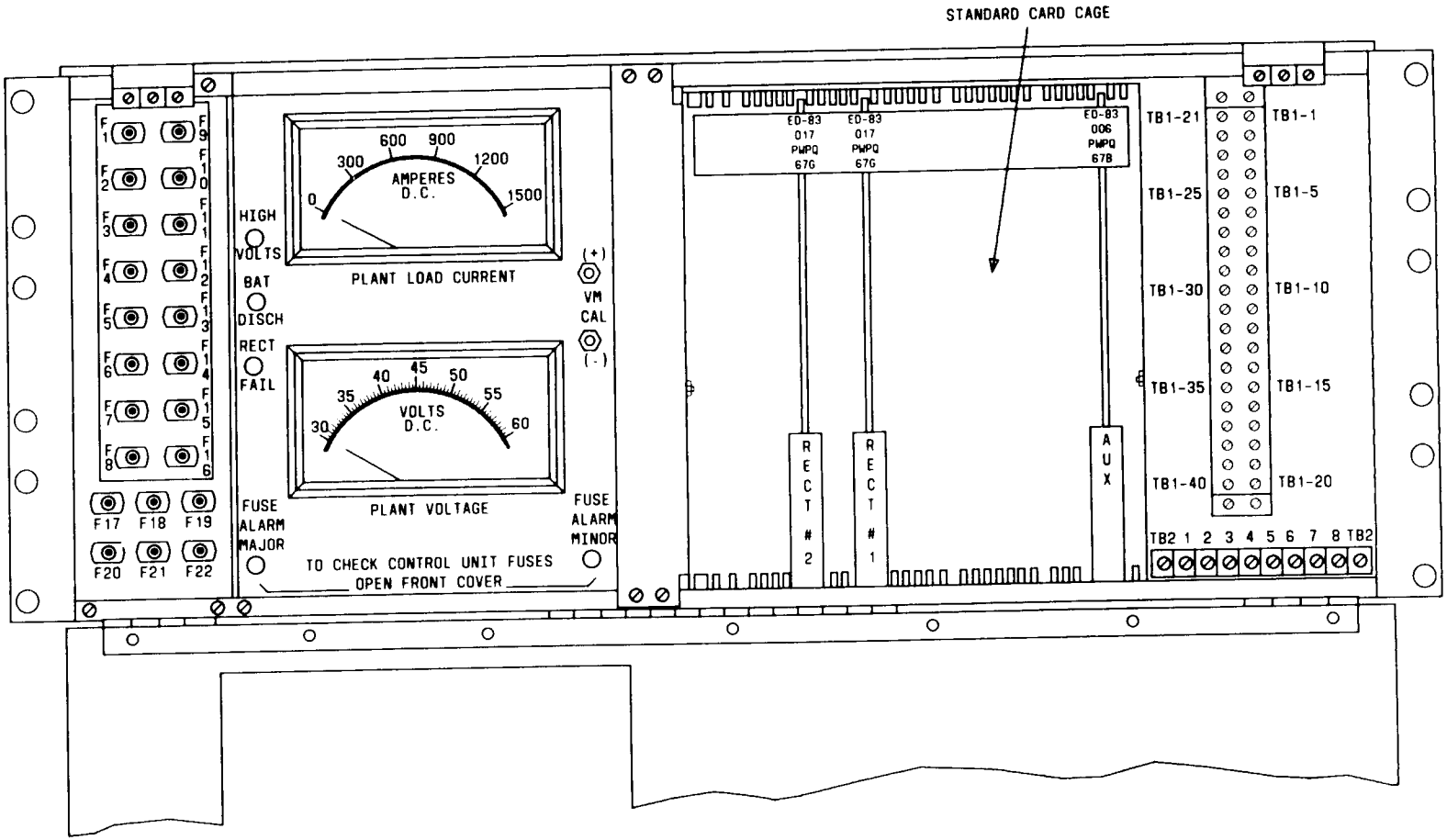

Fig. 4—Conventional Plant Controller (Faceplate in Open Position)

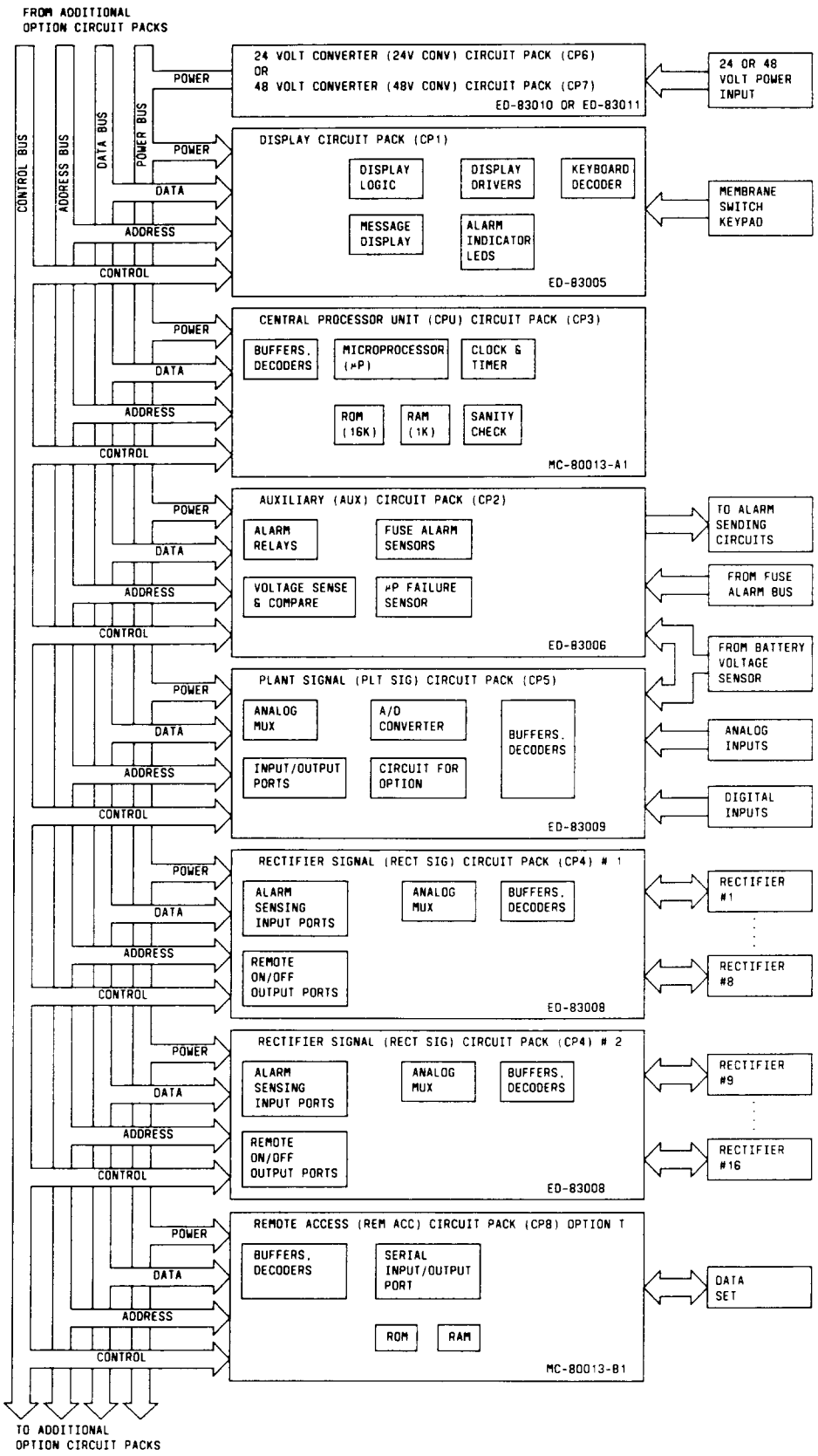

Fig. 5—Smart Plant Controller Block Diagram

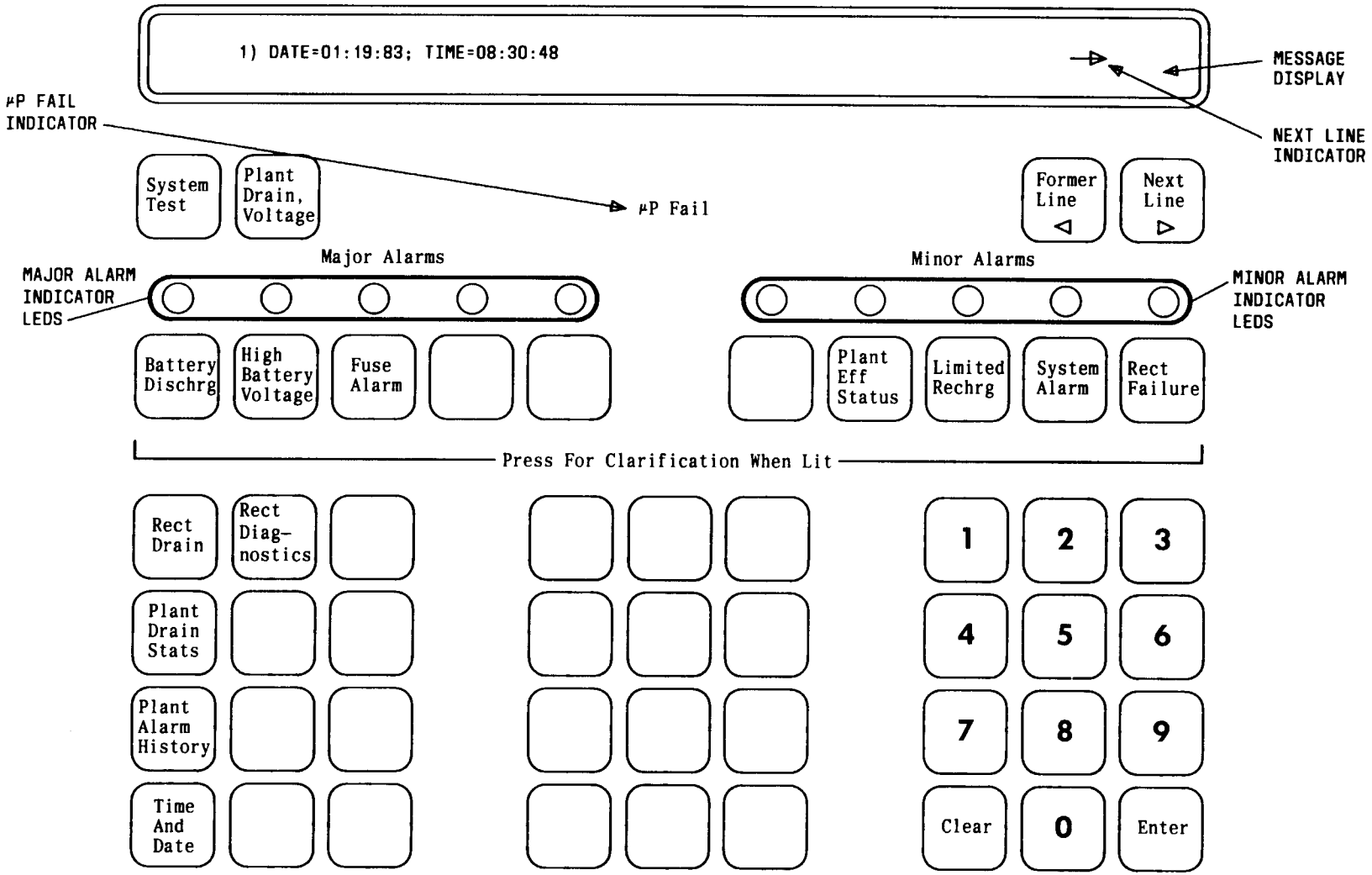

Fig. 6—Smart Plant Controller Controls

- MINOR SENSE (F18)—The MINOR SENSE fuse provides battery voltage for minor circuit functions.

- MINOR PWR FEED (F19)—The MINOR PWR FEED fuse provides power for converter circuit packs [ED-83010 (CP6) or ED-83011 (CP7)] in the standard card cage.

- BAT (F20)—The BAT fuse supplies battery voltage to all connected rectifiers.

- ABS (F21)—The ABS fuse provides power for Electronic Switching System alarms.

- F22—Reserved for future options converter circuit pack [ED-83010 (CP6) or ED-83011 (CP7)] in the optional card cage.

3.06 Discharge fuse and circuit breaker panels are monitored for operated fuses and tripped circuit breakers. Plant control and REG fuses are monitored for operated fuses.

3.07 A maximum of 16 rectifiers may be controlled by the smart plant controller. If there are eight or less rectifiers, one ED-83008 (smart plant) rectifier signals circuit pack (CP4) is required. If 9 to 16 rectifiers are in the plant, two ED-83008 (smart plant) rectifier signals circuit packs (CP4) are required.

3.08 ***Plant Voltage Alarms and Shutdown Levels:*** The plant is equipped with two low-voltage alarms and one high-voltage shutdown. The voltage alarms and shutdown are as follows.

(a) ***Battery Dischrg:*** The plant issues a Battery Dischrg alarm if the battery voltage drops to 25.5 volts for a 24-volt plant or 51.25 volts for a 48-volt plant.

(b) ***Low Voltage 2:*** The plant issues a Low Voltage 2 alarm if the battery voltage drops to 24 volts for a 24-volt plant or 48.25 volts for a 48-volt plant.

(c) ***High Battery Voltage:*** The plant will shut down any rectifier(s) which drive the voltage high (26.75 volts for a 24-volt plant or 53 volts for a 48-volt plant).

3.09 ***Plant Alarm Output:*** The smart plant controller is equipped with alarm outputs in fours. Plant alarm outputs may be connected to local office audible alarms, local office visual alarms, status indicator (SI) leads, Electronic Switching System alarm scanners, and/or other locally selected alarm systems. When connecting alarm leads to the controller, contact protected relays are required.

3.10 ***Plant Efficiency Algorithm:*** The smart plant controller compares the actual current requirement (the current drain for the loads plus recharge current for the battery), with the number, capacity, and types of rectifiers on line. The controller then turns off any rectifier (the least efficient first) not needed to supply the load. When the load current increases, the controller turns on rectifier(s) (the most efficient first) to meet the demand. As a fail-safe system, should the microprocessor system ever fail, the efficiency algorithm turnoff signal is removed, and rectifiers (turned off by the smart plant controller) automatically turn on. In addition, each rectifier is turned on at least once a month. The plant efficiency algorithm may be disabled by operating EFF DIS switch (S1) on the ED-83009 PLANT SIGNAL circuit pack (CP5). All rectifier turnoff signals will be removed as long as the plant efficiency algorithm is disabled.

3.11 ***Peg Count Output:*** The smart plant controller will interface with the Engineering Administrative Data Acquisition System (EADAS) to provide peg count. The controller sends 1000 pulses per hour (pph) at full load, 500 pph at half load, etc. The controller averages the load every minute and sends 16.6 pulses per minute (ppm) at full load, and 8.3 ppm at half load, etc. The contact will be closed for 1 second and opened for 2.6 seconds at full load. The contact will be closed for 1 second and opened for 6.2 seconds at half load, etc.

3.12 ***Rectifier Interface and Addressing:*** The smart plant controller interfaces with the rectifiers by the CPS SP7 circuit pack in each rectifier. The CPS SP7 circuit pack in the rectifier receives commands from the controller to turn off and turn on the rectifier. The CPS SP7 circuit pack also receives REG+ and REG− from the REG fuses, and battery voltage from the BAT fuse in the controller. The CPS SP7 circuit pack transmits data from the rectifier to the controller regarding type, capacity (size) of rectifier, circuit breaker open/close, power switch ON/OFF, fuse operated (blown), phase loss or ac input

loss, rectifier alarm, rectifier shutdown, and rectifier current drain. If the control path from the controller to the rectifier is lost (open), the rectifier (if rectifier is turned off by the efficiency algorithm) is automatically turned on. Also, if the microprocessor fails, all rectifiers receive a turnon signal.

3.13 ***Rectifier Monitoring:*** The smart plant monitors each individual rectifier for the following:

- OUTPUT CIRCUIT BREAKER ON or OFF
- POWER switch ON or OFF
- Rectifier fuse operated (blown)
- Rectifier current drain
- Rectifier alarm
- Rectifier shutdown
- Type of rectifier
- Rectifier turned off by efficiency algorithm
- Phase failure (3-phase) or loss of ac (single-phase).

3.14 ***Accessing Smart Plant Information:*** To access information from the smart plant, press and release the desired switch, and observe the message display for data and/or instructions. If two switches are pressed at the same time, or if a second switch is pressed before the audible feedback (beep) occurs, a microprocessor lockup may occur.

3.15 The proper procedure to access information from the smart plant is as follows:

(1) Press and release the desired switch.

(2) Wait for the audible feedback (beep).

(3) Observe the message on the message display.

3.16 ***Plant Control and Routine Switches:*** The following controls and switches are nonalarm plant control and routine switches.

(a) ***Numeric Keypad:*** The numeric keypad is the blue keypad on the plant control panel. The keypad is used to set the time and date, perform certain alarm cutoff (ACO), and to specify the rectifier or feeder to be checked.

(b) ***System Test:*** When the System Test switch is pressed and released, the processor runs a self-diagnostic test and a system test. If a fault is found, the fault is reported on the message display. During the system test, each dot of the message display, all five major alarm and all five minor alarm indicator Light Emitting Diodes (LEDs) are lighted. If no faults are found, DIAGNOSTICS COMPLETE NO ERRORS followed by a prompt arrow appears on the message display, and all indicator LEDs are off.

(c) ***Plant Drain, Voltage:*** When the Plant Drain, Voltage switch is pressed and released, the battery voltage and plant load current (normal default display) appear on the message display. The plant controller will revert to the normal default display 1 minute after any other switch is used. The information is updated by the controller every 5 seconds.

(d) ***Next Line:*** The Next Line switch is used to view the next line in a multiline message. The prompt for a multiline message is an arrow on the right side of the message display.

(e) ***Former Line:*** The Former Line switch is used to view the preceding line in a multiline message.

(f) ***Rect Drain:*** The Rect Drain switch is used in conjunction with the blue numeric keypad to read the current drain of individual rectifiers. To observe the current drain of a rectifier, press and release Rect Drain switch, enter the number of the rectifier on the numeric keypad, then press and release Enter. The rectifier current drain is displayed on the message display for 1 minute unless another switch is used. To obtain the rectifier physical location, refer to the Rect and Feeder Assignment Cross Reference List.

(g) ***Plant Drain Stats:*** The Plant Drain Stats switch is used to access the three highest hourly average current drains and the three highest peak current drains. No more than one peak per hour is saved (starting on the hour). Peak is defined as the highest 5-second average. Average is defined as the average of all 5-second aver-

ages. To view the drain statistics, press and release the Plant Drain Stats switch. When the Plant Drain Stats switch is pressed, the first hourly average current drain is displayed. Pressing the Next Line switch once causes the second hourly average current drain to be displayed. Pressing the Next Line switch twice causes the third hourly average current drain to be displayed. To view the three highest peak current, press and release the Next Line switch three more times. The last line gives instructions on resetting the statistics.

(h) ***Plant Alarm History:*** The Plant Alarm History switch is used to access the short-term memory for the last ten events. Refer to list of plant alarms and definitions in Table A. When the Plant Alarm History switch is pressed and released, the type(s) of alarm and the alarm(s) date and time appear on the message display. The oldest alarm is displayed first. When the short term memory has accumulated ten alarms and another alarm occurs, the alarm is written into the most recent alarm location. The existing alarms are moved to the next oldest alarm location (except for the existing oldest alarm which is lost). The Next Line and Former Line switches are used to scan through the alarm history memory.

(i) ***Time and Date:*** The Time and Date switch is used to display the processor real time and date, and to change the real time and date. The system uses a 24-hour clock instead of a 12-hour clock which uses am and pm. For example, with a 24-hour clock, 2:00 pm in the afternoon would be 14:00 hours. The processor assigns and stores the time and date of alarms and drains and stores the data in the alarm and drain history memory. When alarms and history memories are accessed, the operator may determine when the event(s) occurred.

(j) ***Rect Diagnostics:*** The Rect Diagnostics switch is used to access detailed probable cause(s) of rectifier failure and may allow manual restarting of rectifier that has failed.

3.17 ***Major Alarm Indicators and Controls:*** The following controls and switches are for use during major alarm conditions.

(a) ***Battery Dischrg:*** When the battery voltage is greater than a specified low voltage and the Battery Dischrg switch is pressed and released, BATTERY NOT DISCHARGING PRESENTLY appears on the message display. If the battery voltage drops below the specified low voltage, (25.5 volts for a 24-volt plant or 51.25 volts for a 48-volt plant), the alarm indicator LED above Battery Dischrg lights and a major alarm is activated. When the Battery Dischrg switch is pressed and released during discharge, the following message appears: BATT DISCH AT (X) A FOR (Y) MINUTES. The X refers to the present current drain in amperes, and Y is how long the battery has been on discharge in minutes. The message display is updated every 5 seconds with the average drain current and the time elapsed since discharging started. When the discharge problem disappears, the LED is turned off and BATTERY NOT DISCHARGING PRESENTLY appears on the message display.

(b) ***High Battery Voltage:*** When the battery voltage is less than a specified high voltage and the High Battery Voltage switch is pressed and released, NO HIGH VOLTAGE appears on the message display. If a rectifier drives the voltage high (26.75 volts for a 24-volt plant or 53 volts for a 48-volt plant), the controller will:

(1) Light the alarm indicator above the High Battery Voltage switch.

(2) Activate the major alarm.

(3) Turn off the rectifier. This will remove the rectifier causing the high voltage, resulting in a minor alarm.

When the High Battery Voltage switch is pressed and released during a high-voltage condition, information is displayed describing the nature of the problem and which rectifier(s) turned off. When the problem condition is corrected, the alarm indicator LED is turned off and the normal message reappears on the message display.

(c) ***Fuse Alarm:*** When a fuse or circuit breaker assigned to the major alarm bus operates, the indicator LED above the Fuse Alarm switch is lighted and a major alarm is activated. When the Fuse Alarm switch is pressed and released, a diagnostic message appears on the message display. The following will activate the Fuse Alarm when:

- A discharge fuse operates

TABLE A

PLANT ALARM HISTORY GLOSSARY

PLANT MESSAGE	DEFINITION
BD	Battery on discharge
HV	High voltage alarm
TR	'TR' signal from the engine has turned down rectifiers
LIM RCHG	Limited recharge alarm
EFF DSBL	Efficiency disable alarm present
CTRL FUSE	Control fuse failure (blown)
REG FUSE	Rectifier regulation fuse failure (blown)
EXCS LOAD	Plant shunt rating was exceeded
AC FAIL	AC input failure (PH on all rectifiers)
RFA — #( )*	Rectifier fail alarm on rectifier number ( )
PH — #( )	Phase failure on rectifier number ( )
CB — #( )	Circuit breaker tripped on rectifier number ( )
EX DRN — #( )	Excess drain (over 120% of rated capacity) on rectifier number ( )
MAN — #( )	Rectifier number ( ) manually turned down
MN FUSE	Minor fuse alarm
"TRAP ALM"	Software trap occurred

*( ) is a number which denotes source of alarm

- A discharge circuit breaker trips
- The CTF fuse (F17) operates
- The BAT fuse (F20) operates
- The ABS fuse (F21) operates.

3.18 ***Minor Alarm Indicators and Controls:*** The following controls and switches are for use during minor alarm conditions.

(a) ***Plant Eff Status:*** The Plant Eff Status switch is used to check the efficiency algorithm that the controller implements to turn off unnecessary rectifier(s). When the efficiency algorithm is active and the Plant Eff Status switch is pressed and released, RECTIFIER EFFICIENCY ROUTINE ACTIVE appears on the message display. When the efficiency algorithm is disabled, the Plant Eff Status indicator LED is lighted and a minor alarm is activated. When the efficiency algorithm is disabled and the Plant Eff Status switch is pressed and released, RECTIFIER EFFI-

CIENCY ROUTINE DISABLED along with instructions to retire the minor local audible alarm (ACO) if desired, appear on the message display. The EFF DIS switch (S1) on the ED-83009-30 PLANT SIGNAL circuit pack (CP5) is used to enable and disable the efficiency algorithm. When the EFF DIS switch is up, the efficiency algorithm is disabled. When the EFF DIS switch is down, the efficiency algorithm is enabled.

(b) ***Limited Rechrg:*** The function of the Limited Rechrg switch is to alert the operator that there is limited recharge capacity, ie, the load is using the capacity of the spare rectifier. If the load requires the capacity of the spare rectifier, the indicator LED above the Limited Rechrg switch is lighted and a minor alarm is activated. When the Limited Rechrg switch is pressed and released, the message display indicates the average hourly drain at the time insufficient rectifier capacity occurred (compare this to total plant, recharge capacity). Pressing and releasing the Next Line switch displays the total plant recharge capacity, if all rectifiers in the plant are operational. Using Next Line switch again displays how many rectifiers are turned off. Using Next Line switch again displays USE RECT FAILURE KEY TO OBTAIN MORE INFORMATION. The Limited Rechrg condition disappears when sufficient battery recharge capacity is restored.

(c) ***System Alarm:*** If there are no minor alarms and the System Alarm switch is pressed and released, NO ALARMS PRESENT appears on the message display. When there is a minor alarm, the indicator LED above System Alarm is lighted and a minor alarm is activated. When the System Alarm switch is pressed and released during a minor alarm, the cause of the minor alarm appears on the message display. When the cause of the minor alarm is removed, the minor alarm is retired, the System Alarm LED is off, and NO ALARMS PRESENT appears on the message display.

(d) ***Rect Failure:*** The Rect Failure switch is used to identify the failed rectifier(s), if any, and the nature of the failure. If no alarms are present on any rectifier(s), and the Rect Failure switch is pressed and released, the message NO ALARMS IN THE RECTIFIERS appears on the message display. If trouble develops on any rectifier, the alarm indicator LED above Rect Failure is lighted. When a rectifier failure occurs, and the Rect Failure switch is pressed and released, RECT #X: YYY appears on the message display. (The X refers to rectifier number and YYY refers to the alarm description.) The lowest numbered rectifier with an alarm appears first on the message display. When the rectifier is identified, the Rect Diagnostics switch can be used to access detailed probable cause(s) of rectifier failure and may allow manual restarting of rectifier that has failed.

3.19 ***Microprocessor Failure (μP Fail) Indicator:*** When the microprocessor failure (μP) indicator is lighted, a controller system failure is indicated. When a μP failure occurs, the efficiency algorithm turnoff signal is removed and rectifiers automatically turn on. A μP failure also activates a minor alarm. To reset the system, open the controller panel and press and release the RESET switch on the MC-80013-A1 central processor unit (CPU) circuit pack (CP3). The RESET switch on the CPU circuit pack also resets the MC-830013-B1 remote interface circuit pack (CP8) (if present).

C. Smart Plant Options

3.20 ***General:*** The smart plant controller may be upgraded by installing option circuit packs in the smart plant controller optional card cage. When option circuit packs are installed, new keypad inserts (if necessary) are placed in the controller faceplate to identify switches to be used to access the new option.

3.21 ***Remote Interface Option:*** The MC-80013-B1 remote interface (Option T) circuit pack (CP8) and data set (modem) (Option M), provides access to power plant data, status, major alarms, minor alarms, and diagnostic messages from remote terminals anywhere in the world (Fig. 7). The remote interface circuit pack (CP8) may be plugged into any position (P2 through P7) in the optional card cage and the connection to the modem must be in the corresponding position.

3.22 The remote interface system consists of:

- An MC-80013-B1 remote interface circuit pack (CP8) plugged into the smart plant controller optional card cage

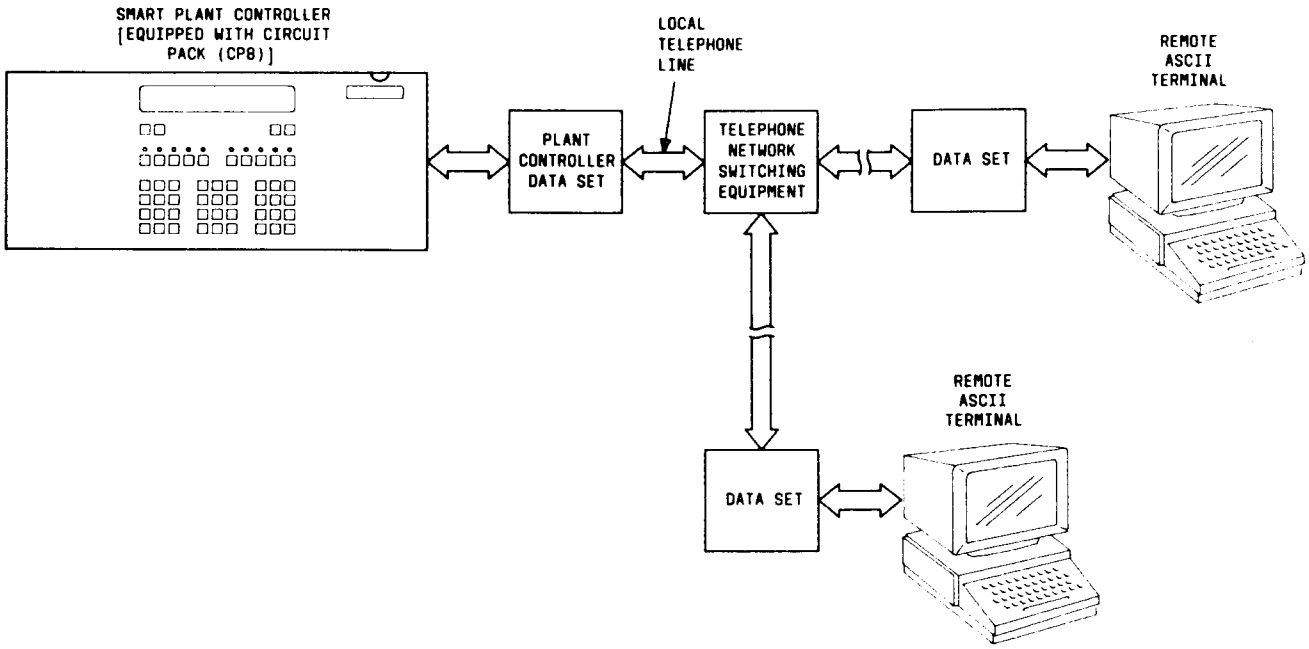

Fig. 7—Smart Plant Remote Interface

- Connections from the smart plant controller optional card cage to a data set (modem) (Option M) in the initial bay
- Connections from the data set to the local telephone switching network via the local telephone lines
- An American Standard Code for Information Interchange (ASCII) terminal and data set (not supplied with remote interface option) at the location accessing the plant.

3.23 To interface with the plant, perform the following:

- Establish a data link and login at the terminal.
- Enter password.
- Type MENU for list of commands (Fig. 8).
- Enter desired command.

3.24 In the event a logic lockup occurs in the MC-80013-B1 remote interface circuit pack (CP8), it is necessary to reset the remote interface circuit pack. The RESET switch or CP8 is used to reset the remote interface without resetting the MC-80013-A1 CPU circuit pack. Either RESET switch will cause the remote interface circuit pack to revert to the default password.

D. Conventional Plant Controller

3.25 ***General:*** The conventional plant controller manages the plant to provide load current and battery float voltage and recharge capacity. The plant voltage and load current are displayed on the analog PLANT VOLTAGE and PLANT LOAD CURRENT meters on the front panel. (See Fig. 3.) Refer to Fig. 9 for the conventional plant controller interface block diagram. Behind the panel faceplate (hinged to open downward) (Fig. 4) are 16 fuse positions (F1 through F16) for rectifier REG fuses. Below the REG fuses are six fuse positions to provide the following:

- CTF (F17)—The CTF fuse provides battery sense voltage for major circuit functions.
- MINOR SENSE (F18)—Not used in conventional plant controller.

```
ENTER PASSWORD



TYPE 'MENU' FOR LIST OF COMMANDS

THERE ARE NO ALARMS PRESENT



MENU

--------MENU--------

ALMS      : LISTS ACTIVE ALARMS
VI        : GIVES BATT VOLTAGE & PLANT DRAIN
BD        : GIVES STATUS OF BATT DISCHARGE ALARM
HV        : GIVES STATUS OF HIGH VOLTAGE ALARM
FAJ       : GIVES STATUS OF MAJOR FUSES OR BREAKERS
EFF       : GIVES STATUS OF EFFICIENCY DISABLE ALARM
LIMR      : GIVES STATUS OF LIMITED RECHARGE ALARM
MN        : GIVES STATUS OF MINOR SYSTEM ALARMS
RECT      : GIVES STATUS OF RECTIFIERS
LOADST    : PRINTS LOAD STATISTICS
RCTDR     : PRINTS RECTIFIER DRAINS
  .          .          .          .
  .          .          .          .
  .          .          .          .
MENU      : PRINTS LIST OF POSSIBLE COMMANDS
```

Fig. 8—Typical Smart Plant Remote Interface Menu

- MINOR PWR FEED (F19)—Not used in conventional plant controller.
- BAT (F20)—The BAT fuse supplies battery voltage to all connected rectifiers.
- ABS (F21)—The ABS fuse provides power for Electronic Switching System alarms.
- F22—Not used in conventional plant controller.

3.26 Discharge fuse and circuit breaker panels are monitored for operated fuses and tripped circuit breakers. Plant control and REG fuse panels are monitored for operated fuses.

3.27 Each ED-83017 (conventional plant) rectifier signals circuit pack (CP11) controls and monitors alarms for up to eight rectifiers. If 9 to 16 rectifiers are used, two CP11 circuit packs are required. The circuit pack(s) monitor the Rectifier Failure Alarm (RFA), Circuit Breaker, and Low Output Alarm (LOA) signals for alarms. The circuit pack(s) receive shutdown signals from rectifiers, the plant waits approximately 5 seconds and then issues a rectifier restart signal. If another turnoff occurs within 5 minutes, no restart will be attempted.

3.28 ***Plant Voltage Alarms and Shutdown Levels:*** The plant is equipped with two low-voltage alarms and one high-voltage shutdown. The voltage alarms and shutdown are as follows.

(a) ***Battery Dischrg:*** The plant issues a Battery Dischrg alarm if the battery voltage drops to 25.5 volts for a 24-volt plant or 51.25 volts for a 48-volt plant.

(b) ***Low Voltage 2:*** The plant issues a Low Voltage 2 alarm if the battery voltage drops to 24 volts for a 24-volt plant or 48.25 volts for a 48-volt plant.

(c) ***High Battery Voltage:*** The plant will shut down any rectifier(s) which drive the voltage high (26.75 volts for a 24-volt plant or 53 volts for a 48-volt plant).

3.29 ***Major Alarm Indicators:*** The three major alarm indicators (red indicator LEDs) on the conventional plant controller are as follows:

(a) ***HIGH VOLTS:*** The HIGH VOLTS indicator lights when a high-voltage condition occurs. When the controller detects the high-voltage condition, a shutdown signal is transmitted to the rectifier, causing the condition, and a major alarm is activated.

(b) ***BAT DISCH:*** The BAT DISCH indicator is lighted when the battery voltage drops below a specified voltage level.

(c) ***FUSE ALARM MAJOR:*** The FUSE ALARM MAJOR indicator is lighted when one of the following circuit breakers trip or fuses operate (blow):

- Discharge circuit breaker
- Discharge fuse

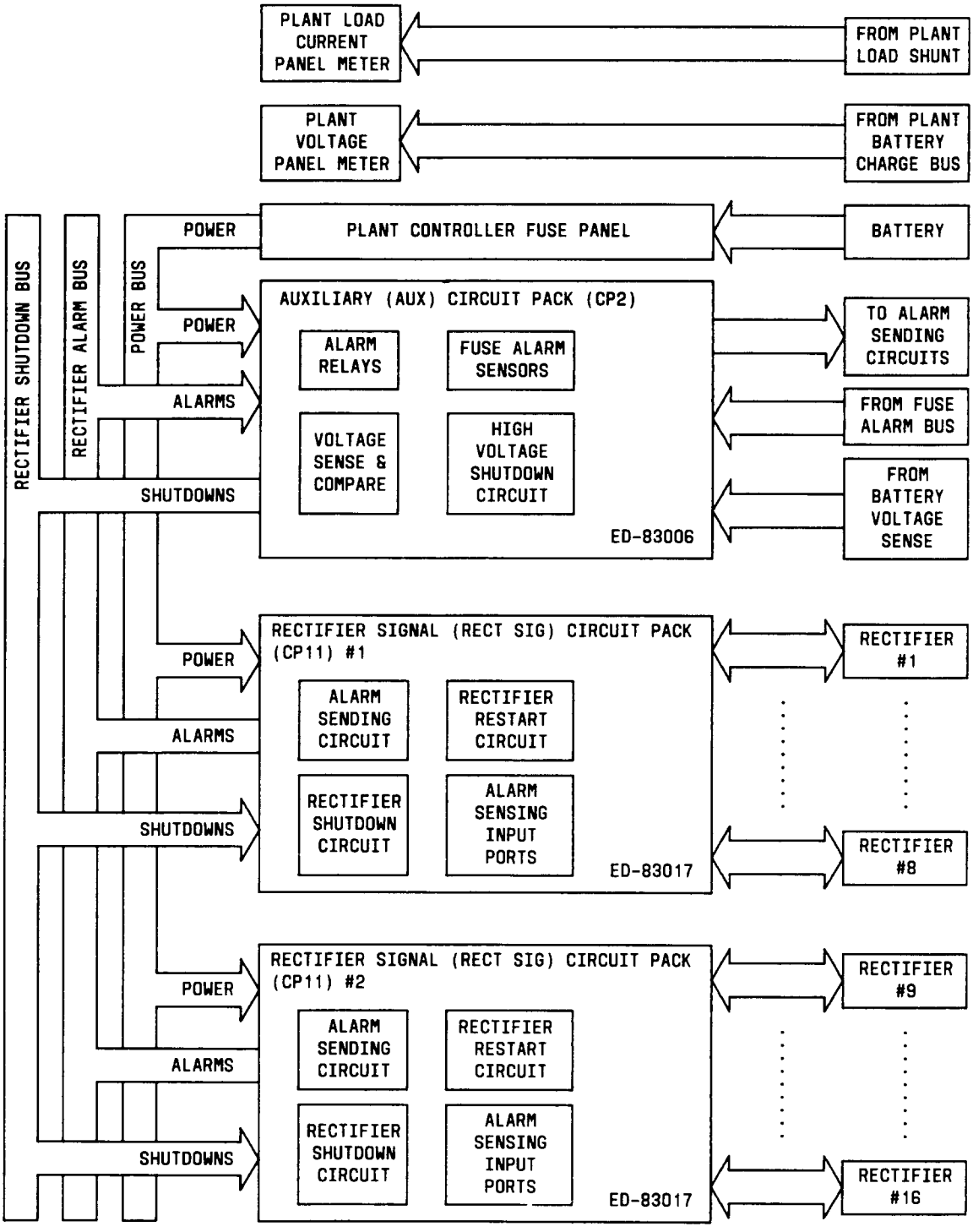

Fig. 9—Conventional Plant Controller Block Diagram

- CTF fuse (F17)
- BAT fuse (F20)
- ABS fuse (F21).

3.30 ***Minor Alarm Indicator:*** The two minor alarm indicators (yellow indicator LEDs) on the conventional plant controller, are as follows:

(a) ***RECT FAIL:*** RECT FAIL indicator is lighted when an individual rectifier failure occurs.

(b) ***FUSE ALARM MINOR:*** The FUSE ALARM MINOR indicator is lighted when one of the following fuses operate (blow):

- REG fuse (F1 through F16)
- MINOR SENSE fuse (F18)
- Capacitor Filter Charger (CHARGE) fuse (part of Option S).

3.31 ***Plant Voltage Meter Calibration:*** Two test jacks [VM CAL (+) and (−)] located on the panel are used to measure plant battery bus voltage and calibrate the PLANT VOLTAGE meter.

3.32 ***Rectifier Interface and Addressing:*** The conventional plant controller is interfaced with the rectifiers by the CPS SP1 circuit pack in each rectifier. The circuit pack receives signals from the plant controller to turn off and restart the rectifier. The circuit pack transmits signals to the controller in the event of a rectifier alarm.

4. GROWTH OF CONVENTIONAL TO SMART PLANT

4.01 ***Upgrading Plant:*** The conventional plant controller may be equipped with smart plant components. The following components are required to upgrade a conventional basic plant to a smart plant.

- One ED-83005 display circuit module (CP1).
- One ED-83006 auxiliary circuit pack (CP2) (already used in conventional plant).
- One MC-80013-A1 central processor unit (CPU) circuit pack (CP3).
- One or two ED-83008 (smart plant) rectifier signal circuit pack (CP4) (two required for 9 to 16 rectifiers).
- One ED-83009 plant signal circuit pack (CP5).
- One 24-volt or one 48-volt converter circuit pack [ED-83010 (CP6) or ED-83011 (CP7)].
- Smart plant control panel.
- One CPS SP7 circuit pack to replace the CPS SP1 circuit pack in each rectifier in the plant, with a connection between the rectifier shunt and the CPS SP7 circuit pack.
- Plant interface cables to connect the CPS SP7 circuit pack in each rectifier to the smart controller.