# SECTION 6. TROUBLESHOOTING

## 6-1. INTRODUCTION

Troubleshooting is the process of logically analyzing a system's performance in order to detect specific areas where operation does not meet requirements. The actual repair or corrective action to the equipment is generally the last step of the troubleshooting process. A logical, systematic approach to system troubleshooting should consist of the following steps:

- System Recognition. The user's operator and/or maintenance personnel must be aware of the proper system operation so that undesired operation can be easily recognized.
- System Evaluation. Once a problem is recognized, the system should be further tested to establish the extent of the malfunction.
- Fault Definition. After symptoms have been evaluated and defined, the probable fault(s) may be determined in a logical manner.
- Fault Isolation. Each suspect function is to be tested in an attempt to isolate the actual cause of the malfunction.
- Corrective Action. Upon isolating the fault, a single component or subassembly chain can be checked, and the malfunctioning unit can then be replaced.

**CAUTION**

**During the troubleshooting procedures, when a programmable controller component is determined to be the cause of the malfunction, it is recommended that the item be replaced and sent back to Westinghouse for repair. Any user troubleshooting of a programmable controller should be done through prior agreement with Westinghouse.**

This section is restricted to recommended troubleshooting procedures for the PC-1100/1200 programmable controller. Keep in mind that the controller is usually one small part of the equipment that makes up the application. Also, external factors can affect the controller's performance. Therefore, the procedures given in this section should be used in conjunction with other system component documentation and overall system-level documentation when performing troubleshooting for a specific application.

The procedures in this section should be used when the controller is determined to be the probable cause of the malfunction. Also, these procedures assume that the user is familiar with the system, system components, program loader and related peripherals. If this is not the case, the user should study all related documentation before proceeding with these procedures.

No specialized training in electronics and complex test equipment is required to perform the troubleshooting procedures outlined here. These procedures emphasize the exchange, or replacement, of components such as the controller, I/O racks, etc. In this way, troubleshooting and downtime are held to a minimum.

**CAUTION**

**Any attempt by the user to repair circuitry associated with the PC-1100/1200 voids the warranty on the programmable controller.**

Indicating lights are provided on the controller and I/O modules for quick and easy verification of the operation of system subassemblies. Additionally, the system's program loader functions as a diagnostic tool, as described in Paragraph 6-6 below.

**WARNING**

**WHILE TROUBLESHOOTING A SYSTEM AND ITS COMPONENT EQUIPMENT, TAKE ALL STEPS NECESSARY TO PREVENT ACCIDENTAL INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. EXTREME CAUTION SHOULD BE USED WHEN ENERGIZING INPUTS OR OUTPUTS OF THE PROGRAMMABLE CONTROLLER. ALWAYS REMOVE THE POWER FROM CONTROLLER BEFORE INSERTING I/O MODULES. DISCONNECT THE POWER FROM THE TERMINALS PRIOR TO I/O MODULE REPLACEMENT. PERSONNEL INJURY MAY OCCUR IF THESE STEPS ARE NOT TAKEN.**

**CAUTION**

**Controller failure can result from electrostatic discharge damage due to improper handling of components. Handle components only in a static-safe environment.**

If a problem remains after performing the procedures given in this section, contact your Westinghouse representative for further technical assistance.

## 6-2. TROUBLESHOOTING PROCEDURES

The following troubleshooting procedures are provided to assist the user in isolating a failure at the module or system subassembly levels. Two basic types of failures may occur in PC-1100/1200 systems: complete or partial. By using the following recommended procedures, and by visual inspection of controller and I/O module indicators, the user can easily determine the type of failure, isolate its source and restore the system to proper operation.

## 6-3. Complete Failure

The complete failure of the PC-1100/1200 system occurs when either of the following two sets of conditions exists:

- The programmable controller is in a fault condition; all four LEDs are OFF; and all outputs are OFF. This generally indicates a power supply problem.

- The programmable controller is in a fault condition; the FAULT LED is ON; and all outputs are either OFF or in the last valid state (depending on the position of the Last Valid State/All OFF DIP switch).

  Note that if the Last Valid State function is selected, outputs are held in their last valid state (unless the power is off). Turning the keyswitch to STOP (the programming position) causes the outputs to go OFF. Returning the keyswitch to the RUN position will not return outputs to the ON state.

A complete failure with the symptoms described above may result from failure of the power supply or the controller processor. In either case, first check for the proper line voltage and power supply connections before proceeding with troubleshooting procedures.

Depending on the specific condition, it may be possible to recover from a fault. Refer to Paragraph 6-12 for additional information on identifying faults.

## 6-4. Partial Failure

Typically, partial failure of the PC-1100/1200 system occurs when some outputs fail to operate or when inputs are not recognized. A partial failure of a programmable controller, along with the process or machine it controls, is generally detected when an expected event fails to occur at a given time in the sequence of operations. A partial failure can originate in either the external wiring or in the programmable controller system. If the partial failure does not originate externally, it must be isolated to either the controller, or to the I/O modules, cable, or racks.

Example: As an example of a partial failure, assume that a motor fails to rotate when its corresponding START pushbutton is pressed. By examination of the associated input module's LED indicator, it can be determined whether or not the pushbutton is operating properly. The LED on the output module is located on the user-powered side of the module. A lit LED indicates that voltage is applied to the load. If the LED is OFF, the load is not powered. Checking the associated output module's LED indicator determines whether or not the output is conducting. If it is, the motor starter should be energized.

Depending upon the condition of these I/O indicators, the user can determine whether the source of a failure is external (in the process or machine being controlled) or internal (in the programmable controller system or user program).

## 6-5. Common Failures

The most common causes of failure are external to the programmable controller system. External failures are usually caused by malfunctioning field sensing devices, actuators or indicators. Also, blown fuses, shorts or open circuits may be encountered during installation, startup or during normal operations. Miswired connections may occur during startup. Close examination of the I/O modules and external devices is often sufficient to isolate the cause of this type of failure.

All probable external causes of failure should be eliminated before proceeding with the troubleshooting procedures.

## 6-6. Program Loader Diagnostic Capabilities

The program loader has a number of capabilities which are useful in troubleshooting:

- Input values can be monitored
- Outputs can be forced ON or OFF
- Controller/program error codes can be displayed

The monitoring and forcing capabilities can be used to verify the addressing and function of discrete I/O modules.

**Caution**

**When forcing outputs, take precautions to prevent system damage or personnel injury.**

The fault register error codes are described in Paragraphs 6-10 through 6-12. For additional information on the program loader capabilities, refer to the applicable program loader documentation.

## 6-7. Front Panel Controls and Indicators

The PC-1100/1200 controller's front panel controls and indicators are shown in Figure 6-1. Each of the front panel controls and indicators are described below.

### DC OK LED

When this indicator lights, it indicates that the controller's internal power supply voltages are within specified tolerances. When not lit, all outputs are OFF. In this case, check the power connections and the associated internal and external fuses.

**WARNING**

**WHEN CHECKING POWER CONNECTIONS AND FUSES, PERSONNEL MAY BE EXPOSED TO APPLIED POWER. THIS COULD RESULT IN INJURY OR DEATH. ENSURE THAT THE POWER IS REMOVED FROM THE CIRCUITS BEING CHECKED, OR EXERCISE EXTREME CAUTION WHEN CHECKING "LIVE" CIRCUITS.**

### RUN LED

When the RUN indicator is lit, the controller is scanning memory and controlling outputs. When it is not lit, all outputs are OFF (or in their Last Valid State, depending on the setting of the LVS switch).

When the keyswitch is in the STOP position, this indicator (and all outputs) should be OFF. If this indicator remains OFF when the keyswitch is in the RUN position, check the state of the DC OK and FAULT LED.

### BATTERY OK LED

The BATTERY OK indicator lights while the controller is powered up, if the batteries are charged and operational. If this indicator goes out during normal operation, the batteries will maintain memory for under one week. The batteries should be replaced immediately when the indicator does not light, to avoid loss of data in the event of a power outage.

### FAULT LED

The FAULT indicator, when lit, indicates that a controller failure has occurred. (See Paragraph 6-10 for procedures to locate and correct the problem.)

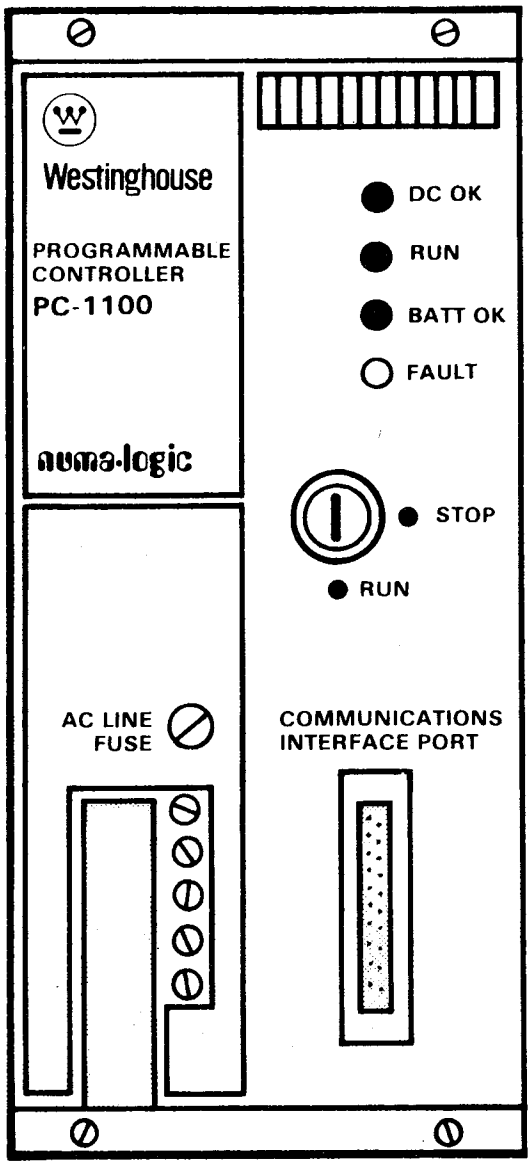


**Figure 6-1. Controller Front Panel Controls and Indicators**

### Keyswitch

Placing the keyswitch in the STOP position stops controller scanning and disables all outputs. This keyswitch position enables lines of reference ladder diagram to be entered, deleted and altered. Also, register data can be modified in this keyswitch position.

Placing the keyswitch in the RUN position enables the controller to scan memory and control outputs. This position prevents normal reference ladder diagram programming. The program loader is used, in this keyswitch position, only to monitor I/O and register data, to force I/O, and to make register data changes.

Note that a DIP switch behind the controller's front panel allows the user to select the On-Line Programming function. (See Paragraph 3-17.) With this function selected and with the keyswitch in the RUN position, the controller continues to scan the existing program while also allowing modification and editing of that program. In this mode, newly programmed logic is not acted upon until a complete and logical line has been entered.

The on-line programming function can be permanently disabled by removing a resistor (R2 in the PC-1100 or R70 in the PC-1200). (See Paragraph 3-19 for details.)

**WARNING**

**WHEN MAKING PROGRAM CHANGES WHILE THE SYSTEM IS RUNNING, IT IS THE OPERATOR'S RESPONSIBILITY TO ENSURE THAT THE CHANGES BEING MADE DO NOT CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.**

## 6-8. Power Supply Fuse

The PC-1100/1200 controller and its internal power supply are protected by one replaceable fuse located on the front panel. The fuse is in an easily removable carrier. Figure 6-2 shows this front panel-mounted line fuse.

Since the PC-1100/1200 offers three input power options, there are three types of fuses. The fuse requirements are as follows:

- 240 VAC operation - 2 A, 250 V, Type 3AG
- 120 VAC operation - 2 A, 250 V, Type 3AG
- 24 VDC operation (PC-1100 only) - 3 A, 250 V, Type 3AG

To replace the fuse, follow these instructions:

1. Ensure that the AC input power is removed from the controller.
2. Use a screwdriver to remove the fuse carrier located on the controller cover. Place the end of the screwdriver in the slot on the fuse carrier, push in slightly, and turn one quarter-turn.
3. Remove the blown fuse. Place a new fuse in the carrier and replace in the front panel.
4. Replace with the appropriate fuse, depending on input power requirements.

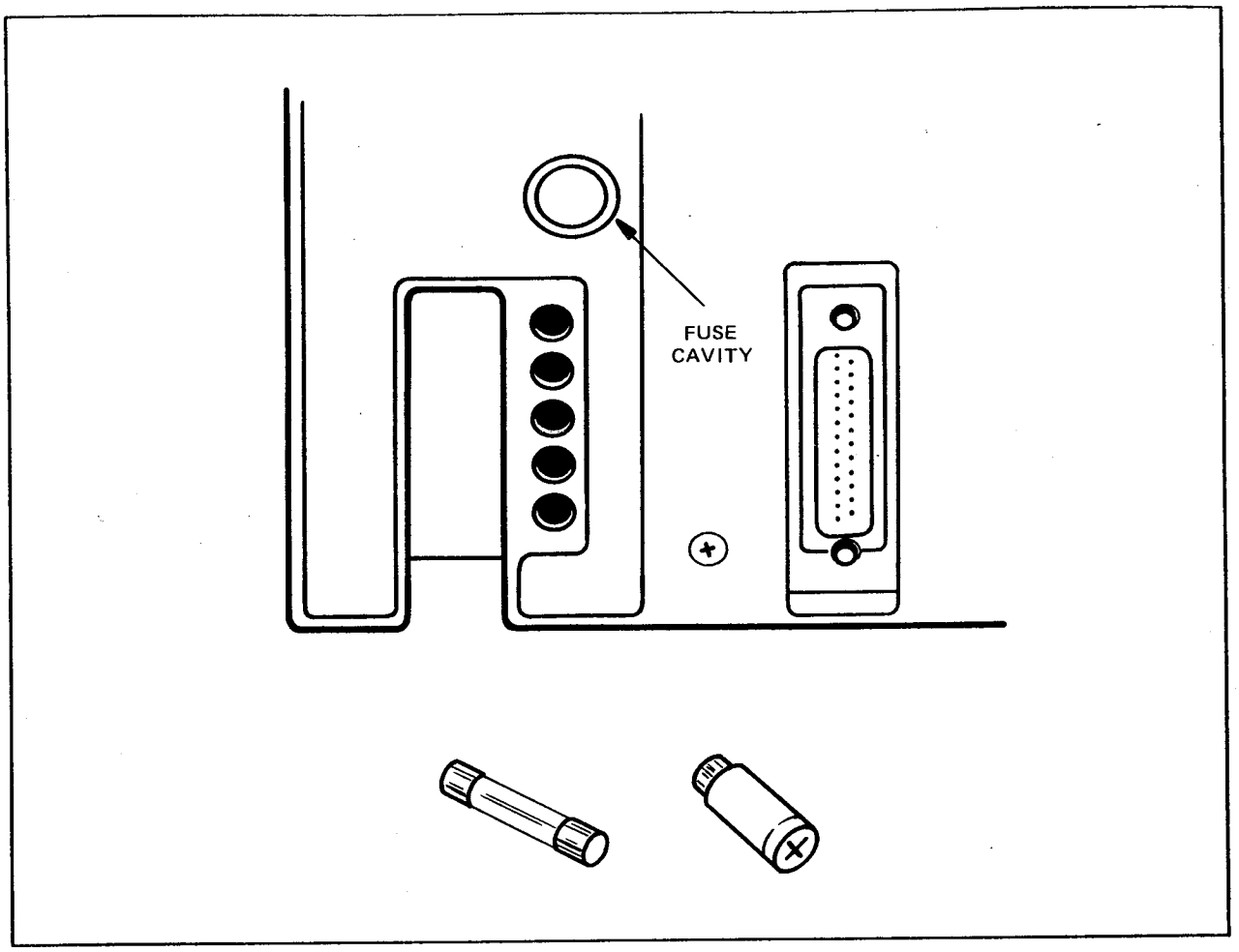


**Figure 6-2. Power Supply Fuse Replacement**

**Note**

Depending on the version of the PC-1100/1200, different fuse carriers and holders may be used. The fuse carriers for early models of the PC-1100 are not interchangable with the ones currently used.

## 6-9. Battery Replacement

**CAUTION**

**Power must remain applied to the PC-1100/1200 controller during backup battery replacement. If power is removed, the user memory is lost, and the controller must be initialized and the program reloaded.**

To replace the backup batteries in the PC-1100 programmable controller, use the following procedure:

1. Remove the PC-1100 controller's front panel. The backup batteries are located as shown in Figure 6-3.

2. Remove the battery holder.

3. Remove the old batteries.

4. Insert the new batteries into the battery sockets. Ensure that the polarity is correct. Use Type AA alkaline cells (NLB-1100).

5. Observe that the BATTERY OK indicator lights. If this indicator does not light, check the polarity and condition of the new batteries. A new battery should measure 1.1 VDC, minimum.

6. Replace the PC-1100 controller front panel.

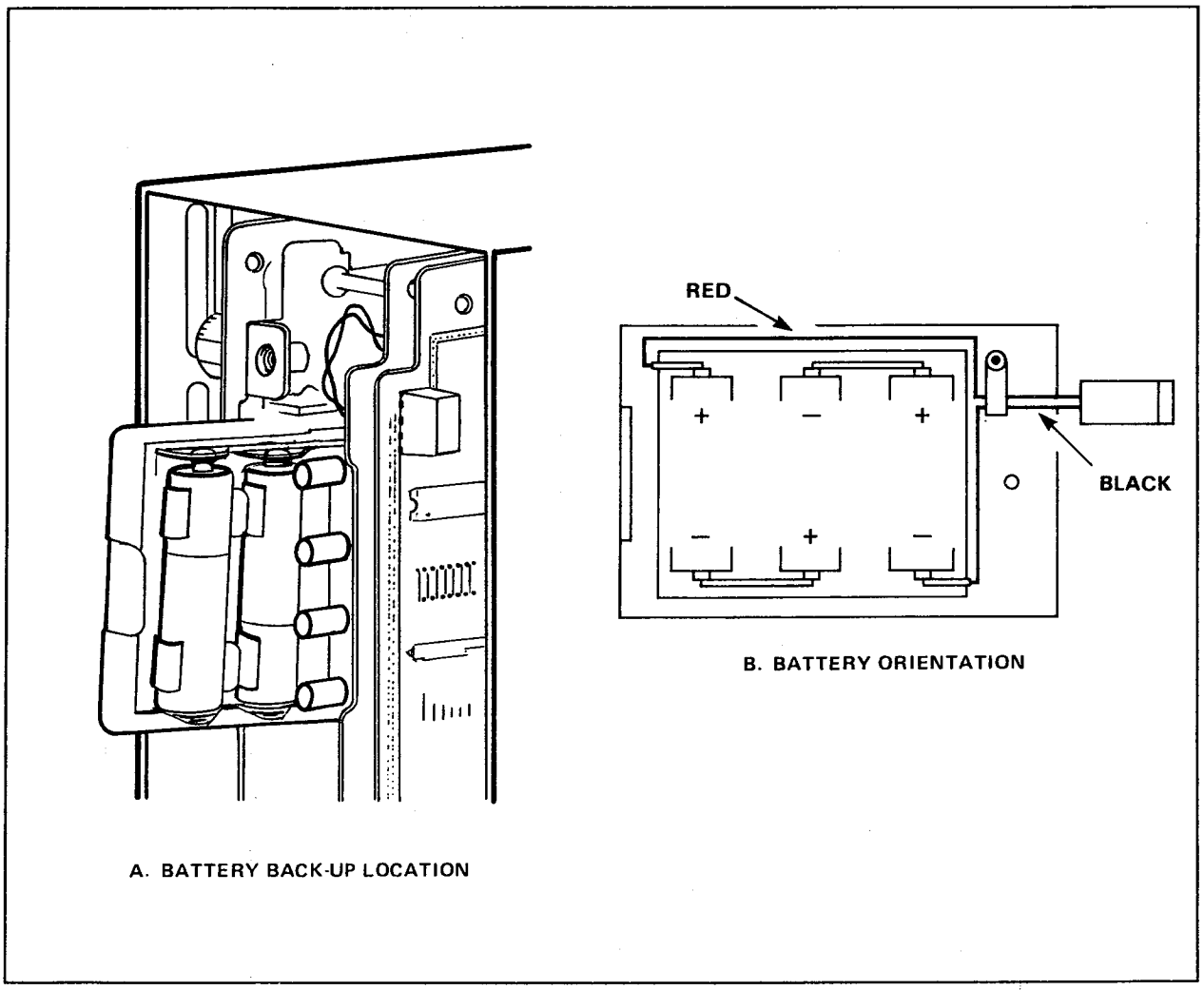


**Figure 6-3. Replacing Backup Batteries (PC-1100)**

To replace the backup battery in the PC-1200 controller, use the following procedure:

1. Remove the PC-1200 controller's front panel. The backup battery is located as shown in Figure 6-4.

2. When the unit is shipped from the factory, the battery is held in place with tie-wrap. If this tie-wrap is still in place, it must be clipped before the battery is removed.

3. Remove the old battery by grasping the pull-tab and pulling gently.

4. Insert the new battery into the battery socket. Ensure that the polarity is correct. Use a Type AA lithium cell (NLB-1200).

5. Observe that the BATTERY OK indicator lights. If this indicator does not light, check the polarity and condition of the new battery. A new battery should measure 3.5 VDC, minimum.

6. Replace the PC-1200 controller front panel.

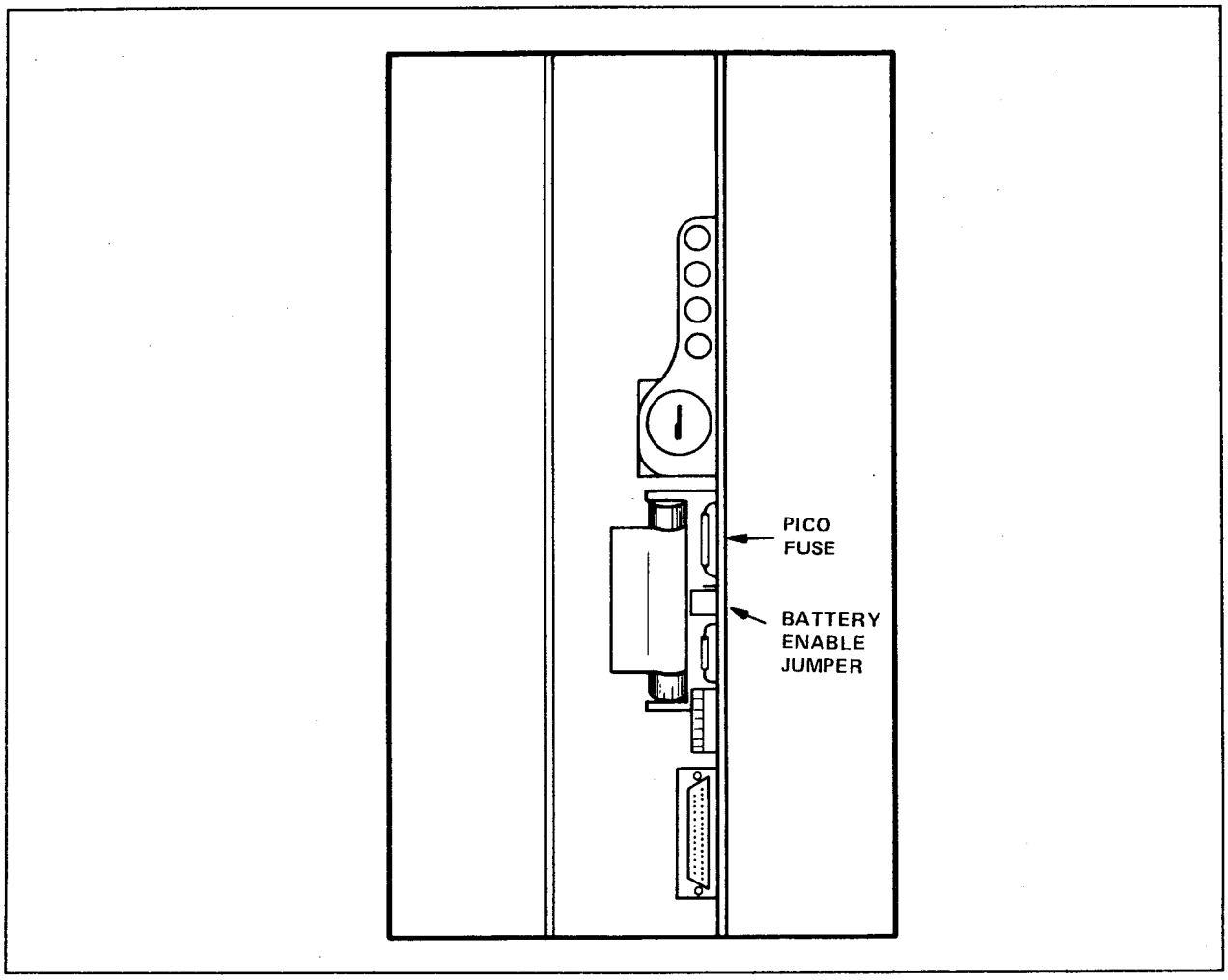


**Figure 6-4. Replacing Backup Battery (PC-1200)**

**Battery Fuse (PC-1200)**

In the PC-1200, the lithium battery is protected by a replaceable PICO fuse (rated at 0.125 A), as shown in Figure 6-4. Under normal conditions, this fuse will never need to be replaced.

## 6-10. FAULT REGISTER DATA

PC-1100/1200 programmable controller provides a program loader display of fault register messages. This register contains the results of the controller's internal self-diagnostic tests, and can indicate that a specific fault exists. This fault register display feature enables the user to rapidly diagnose and correct system problems. The procedures for interpreting fault register messages are provided in the following paragraphs.

### 6-11. Pre-Check Procedure

Prior to interpreting the fault register display, complete the following checks:

1. Check to see that the controller is correctly connected to the AC line power or DC power supply. Check the wiring and grounding circuits associated with both the controller and I/O system. Improper grounding can cause sporadic "nuisance faults" within a system.

2. Check for blown fuses or tripped circuit breakers in the associated wiring.

3. Check to see that all module I/O switches (if any) are set correctly.

4. Check to see that all modules are properly seated and in the appropriate socket.

5. If a two-rack system is used, check to see that the I/O rack expander cable is properly connected at both ends.

6. Check the condition of the front panel indictors to verify the power source and battery condition.

### 6-12. Fault Register Interpretation

The display field for the PC-1100/1200 16-bit fault register is shown in Figure 6-5. Bits 1 and 2 act as an I/O monitor field, indicating errors within the I/O structure of a PC-1100/1200 system. Bits 3 through 8, 10, and 12 through 16 display other error conditions within the system (bit 8 is not used by the PC-1100; bits 9 and 11 are not used by the PC-1100 or -1200).

Table 6-1 lists each fault and a suggested action for each bit displayed in the fault register. If a fault condition associated with a specific bit exists, it is represented by the digit 1.

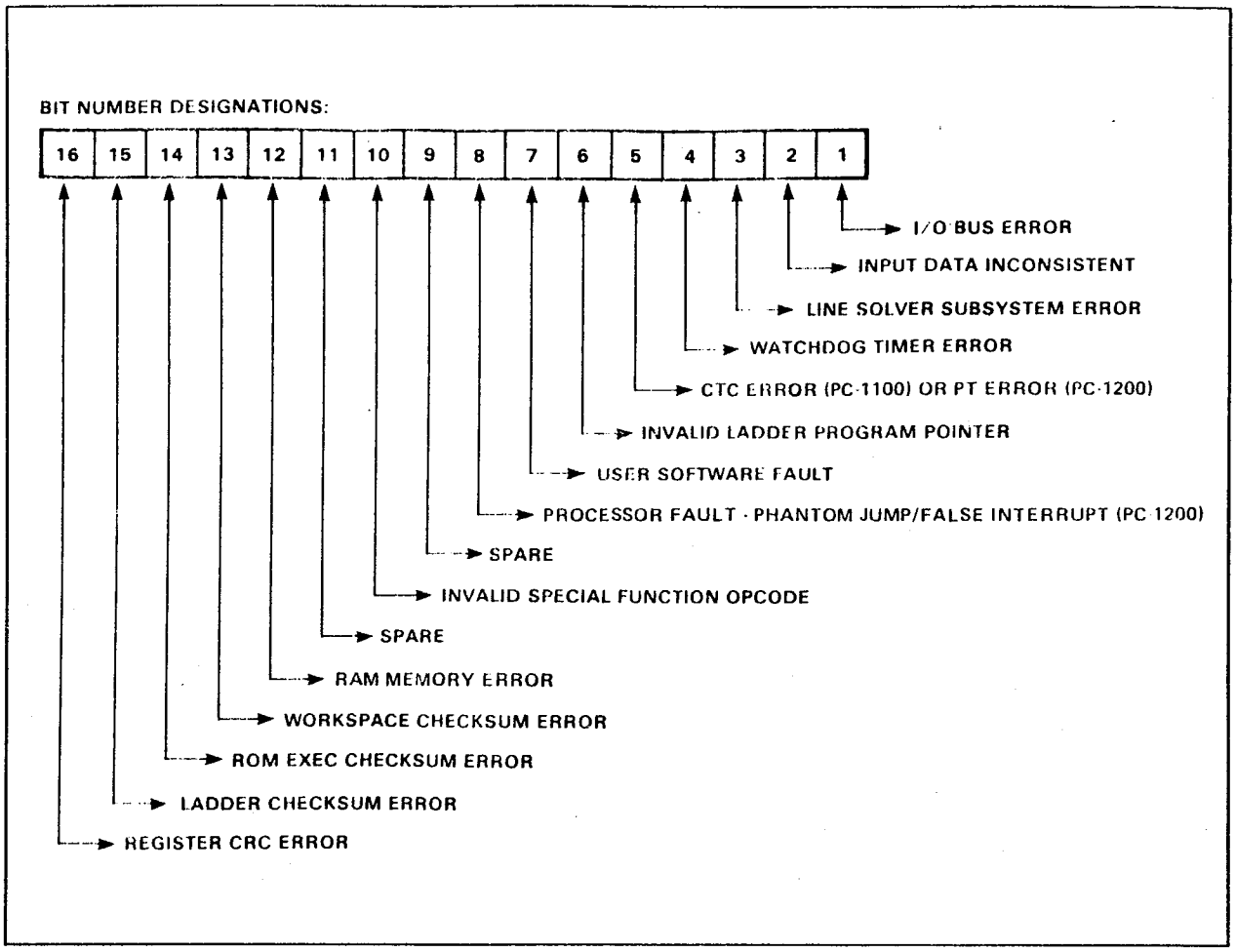


**Figure 6-5. Fault Register**

## 6-13. COMMUNICATIONS ERROR

In PC-1100/1200 applications, an error in communication can occur between the program loader and controller. A communications error occurs when the program loader cannot acquire and present requested data, including fault register data, for evaluation. Typically, communications errors occur on power-up due to the reframe sequence (approximately 2 to 4 seconds.)

Use the following procedure to evaluate and correct this type of error.

1. Ensure that the correct power is present for both the controller and program loader.

2. If using the CRT program loader or mini loader, when a communications error occurs, ir must be cleared by turning the program loader OFF and then back ON.

   If using the APL, a temporary communications error will clear automatically. If a permanent communications error exists, the APL will continually retry to clear the error (to break out of this retry cycle, press Control-Break on the APL keyboard).

## TABLE 6-1. FAULT REGISTER INTERPRETATION

| Bit No. | Indicated Fault | Suggested Action |
|---|---|---|
| 1 | 1 = I/O Bus Error | This fault means that the I/O data lines are shorted or open. To correct, follow the procedure below.<br><br>1. Using a program loader, retest the controller in the I/O rack. (After retesting, turn the controller keyswitch to RUN.) If this does not clear the fault, proceed with step 2.<br><br>Note: Each time the controller is retested, the keyswitch must be turned to the RUN position to verify that the fault has been cleared.<br><br>2. Retest the controller while it is not connected to the I/O rack. If this does not clear the fault, replace the controller (it is the cause of the problem). If the fault is cleared, re-install the controller onto the I/O rack. Proceed with step 3.<br><br>3. Inspect any unused rack edge connectors for shorts. If no shorts exist, proceed with step 4.<br><br>4. Remove the modules from the rack one by one, retesting each time. If the fault is cleared after removing a module (and retesting), inspect that module's rack edge connector for a short. If no problem exists with the rack edge connector, the module may be at fault. Replace the module.<br><br>If all modules have been removed and the fault still exists, then the I/O rack is malfunctioning. Replace the rack. |
| 2 | 1 = Input Data Inconsistent | 1. Using a program loader, retest the controller. (After retesting, turn the controller keyswitch to RUN.) If this does not clear the fault, proceed with steps 2 through 4.<br><br>2. Make sure that there is a good system ground.<br><br>3. Make sure that the modules and controller are secure and not loose.<br><br>4. Remove the modules from the rack one by one, retesting each time. If the fault is cleared after removing a module (and retesting), replace that module. If all modules have been removed and the fault still exists, consult the Westinghouse Service Representative. |

TABLE 6-1. FAULT REGISTER INTERPRETATION (Cont'd.)

| Bit No. | Indicated Fault | Suggested Action |
|---|---|---|
| 3 | 1 = Line Solver Subsystem Error | Using a program loader, retest the controller. If the fault remains, replace the controller. |
| 4 | 1 = Watchdog Timer Error | This fault normally results from:<br><br>1. A program that takes longer to execute than the allowed timeout period (100 msec for the PC-1100; selectable from 100 to 300 msec for the PC-1200, as described in Paragraph 3-18).<br><br>2. Possible cause: A program with too many complex functions being performed on the same scan.<br><br>If this fault occurs during programming, installation and checkout, re-examine the program and re-program, as necessary. If using an advanced PC-1100 or PC-1200, use the LS and MV special functions to trap the worst case time. The execution time should be less than the timeout period. If not, the program takes too long to solve.<br><br>If this fault occurs after a program has run successfully for an extended period of time, or if the worst-case scan time determined with LS and MV is within the allowable range, then the program should not be at fault, and the following steps should be taken:<br><br>1. Using a program loader, retest the controller. If the fault remains, go on to step 2.<br><br>2. Initialize the controller and reload the program. If the fault remains, go on to step 3.<br><br>3. Replace the controller. |
| 5 | 1 = CTC Error<br><br>or<br><br>PT Error | For the PC-1100, this fault means that there is a hardware error within the controller. Replace the controller.<br><br>For the PC-1200, this fault will only occur if the controller has a unit address of 0 and it is placed into an active network or a network that is being tested (i.e., the PT TEST input is toggling). |

**TABLE 6-1. FAULT REGISTER INTERPRETATION (Cont'd)**

| Bit No. | Indicated Fault | Suggest Action |
|---|---|---|
| 6 | 1 = Invalid Ladder Program Pointer | Using a program loader, retest the controller. If the fault remains, re-examine the program. Specifically, examine the Restore Program Counter (RP) function to make sure that another function is not changing operand 1 of the RP function (which would initiate this fault).* |
| 7 | 1 = User Software Fault | This fault indicates that the user has misprogrammed a Literal (LT) function or a mnemonic function with indirect operands (e.g., PT or AR). When this occurs:<br><br>1. Use the program loader, and retest the controller to clear the fault.<br><br>2. Re-program the function correctly.<br><br>**CAUTION**<br><br>If the fault is only cleared and this function is not re-programmed correctly, the fault will recur. |
| 8 | 1 = Processor Fault (PC-1200 only) | The processor has taken a phantom jump or generated an invalid interrupt. If re-initialization fails to clear this fault, replace the PC-1200 controller. |
| 9 | ~~Spare~~ DMA XFER FAULT | COULDN'T COMPLETE BM FUNCTION DURING POWER FAIL SEQUENCE (V1.6 AND LATER) |
| 10 | 1 = Invalid Special Function Opcode | This fault indicates that a special function is resident in memory, but is not supported by the controller. The fault can occur when loading a tape and an unsupported special function is overwritten. To clear this invalid special function:<br><br>1. Use the program loader and retest the controller.<br><br>2. With the keyswitch still in the STOP (program) position, find the rung containing the invalid special function.<br><br>3. Delete the invalid special function.<br><br>Note: Use the controller with the software version that supports the special function. |
| *Note that RP is an advanced function, not available on all PC-1100 controllers. | | |

TABLE 6-1. FAULT REGISTER INTERPRETATION (Cont'd)

| Bit No. | Indicated Fault | Suggested Action |
|---|---|---|
| 11 | Spare | -- |
| 12 | 1 = CMOS/RAM Memory Error | Using a program loader, retest the controller. If the fault is still present, replace the controller. (It contains malfunctioning RAM chips.) |
| 13 | 1 = Workspare Checksum Error | Check BATTERY OK LED. If it is OFF, replace the batteries before initializing the controller and reloading the program.<br><br>If the battery is OK, use a program loader to retest the processor.<br><br>If the fault remains, replace the controller. |
| 14 | 1 = ROM Exec Checksum Error | Using a program loader, retest the controller. If the fault is still present, replace the PC. |
| 15 | 1 = Ladder Checksum Error | Check the BATTERY OK LED. If it is OFF, replace the batteries before initializing the controller and entering the program. If the battery is OK, use a program loader to retest the controller. If the error is still present.<br><br>If the fault continues, replace the controller. |
| 16 | 1 = Register CRC Error | Check the BATTERY OK LED. If it is OFF, replace the batteries before initializing the controller and entering the program.<br><br>If the battery is OK, use a program loader to retest the controller. If the fault is still present, initialize the controller, and reload the program.<br><br>If this does not clear the fault, replace the controller. |

3. If a communication error occurs during initialization, repeat the initialization before taking other corrective actions. Momentary communications errors normally occur at the end of initialization sequences, or during tests that can cause the loader to reframe. If the error exists more than 10 to 15 seconds, communications have failed. Therefore, check the baud rates.

4. Check that the communications cable runs from the proper controller port to the appropriate portion of the program loader. Check that communications cable connectors are seated properly.

5. If the DC OK indicator does not light, the power supply is defective. Replace the controller. If a spare controller is not available, contact the Westinghouse Service Representative for a replacement.

6. The default baud rate and parity for program loader-to-controller communications (Port A) is determined by DIP switch. Check to see that the appropriate settings have been selected. The controller and program loader must operate (send/receive) at the same baud rate and data frame. If the loader screen shows a constant "reframing" message which never changes to "communications error", then check the communications settings.

7. Check to see that both the program loader and the controller use the same AC line power. When different power sources are used, improper line phasing can occur, which can damage the controller's and program loader's communications port logic.

8. If the preceding steps have not cleared the communications error, replace the programmable controller and return it to Westinghouse for repair.

The program loader can communicate with the controller, yet not give a fault register display. Under these circumstances, it is difficult to locate faults. If this situation occurs, ensure that there is not an "improper keyswitch" error message present. If an improper keyswitch error has occurred, either a wire to the keyswitch has become disconnected or the keyswitch has failed. If there is not a keyswitch error, check the program loader as the probable source of this problem.