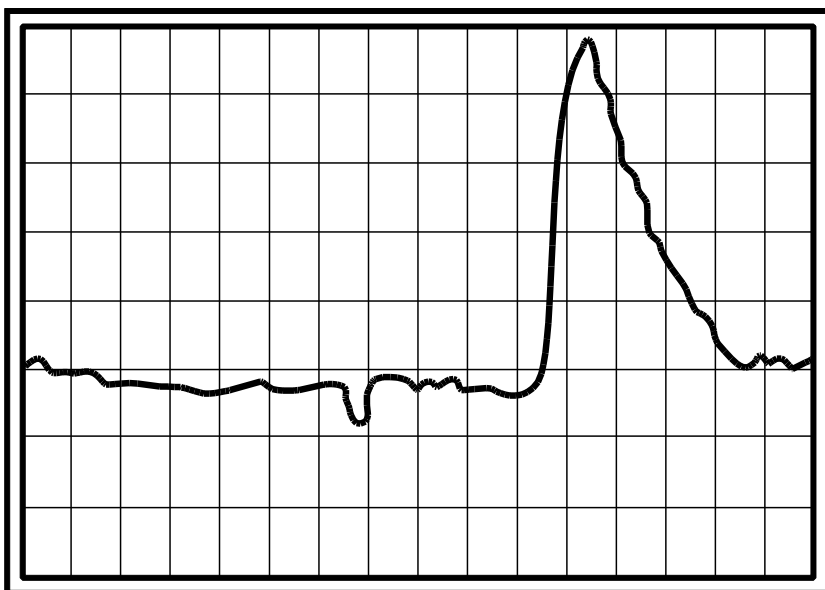


# PAL-AT<sup>®</sup>

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## OPERATING MANUAL



**PERMALERT**  
Environmental Specialty Products, Inc.



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**Caution --This manual may not be up-to-date.**

Please check the PermAlert website, [www.permalert.com](http://www.permalert.com), for the latest revision of this manual.

The manual is typically revised at least once a year. The revision date is on the back cover.

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# 1 Introduction

## 1.1 Theory of Operation

**PAL-AT** uses a *pulsed cable-radar technology to detect leaks*. PAL-AT sends low voltage pulses on a cable and monitors reflections received at the panel. PAL-AT electronically divides the cable into short increments and measures the reflections from each. It stores the measured values in memory during the reference procedure in a permanent record called the "master" map. When in monitor mode, PAL-AT compares the current condition with the master map. Significant changes from the master, for instance when the cable gets wet, cause PAL-AT to enter the alarm mode.

This method of comparing the current condition with a baseline map allows PAL-AT to monitor a system with minor installation inconsistencies and small amounts of wet cable. This capability enables PAL-AT to accept initial field conditions that would force other systems to reduce their sensitivity or be inoperative. It also allows the system to locate additional leaks that occur past acknowledged leaks.

### PAL-AT detects and locates six types of changes:

1. Leak
2. Cable Drying
3. Cable Short
4. Cable Break
5. Probe Activated
6. Probe Reset

Normally, PAL-AT is set to activate alarms for leaks, shorts, breaks, and probes activated but not for a drying cable or probe reset (see Section 2.9.3.2). The system first checks for a break or short. If none is found, the cable is checked for the remaining four conditions.

As explained above, PAL-AT will accept and monitor a system that initially has a small amount of wet cable. This normally occurs only in secondary containment applications. To maintain the long-term integrity of the containment and insure the proper operation of PAL-AT, you must dry the containment either before or immediately after the system is on-line.

## 1.2 Power Up

PAL-AT has a power switch inside the cabinet on the power supply cover. Power should be fed directly from a dedicated circuit breaker to PAL-AT. If the green power light on PAL-AT is not lit, check the circuit breaker and the power switch to be sure PAL-AT is getting power. Make sure all cards are installed properly before you turn on PAL-AT. **DO NOT INSTALL OR REMOVE CARDS WHEN THE POWER IS ON** (see Section 5.1).

### 1.2.1 Initial Display

PAL-AT uses a twelve (12)-digit keypad for menu selection and data entry. A two-line liquid-crystal display (LCD) shows information about the operation of the system. PAL-AT displays the following message when it is turned on:

LCD01:

**PAL-AT LEAK DETECTION SYSTEM, VX.XX**  
**PERMALERT ESP INC. "TIME" "DATE"**

"VX.XX" is the firmware version PAL-AT is using. The "DATE" is displayed with 4 digits for the year in this initial display. The message is displayed during a 5 minute warm-up period and then PAL-AT attempts to enter monitor mode. The warm-up delay can be bypassed by pressing the \* or # key.

# 1 Introduction

---

If the \* key is pressed, PAL-AT goes immediately to the Main Menu and displays the message:

LCD02:

**1# TO SETUP CABLE, 2# TO TAKE REFERENCE  
\* TO EXIT, # FOR NEXT MENU**

If the # key is pressed, PAL-AT goes directly to Monitor mode if any cables are setup for monitoring.

## 1.2.2 Contrast Adjustment

The contrast of the LCD can be adjusted by turning the adjustment screw on the processor card (see Figures 2.1.3A, 2.1.3B or 2.1.3C). This may be necessary to get the best viewing angle, depending on the mounting height of the PAL-AT panel.

## 1.2.3 Installation Instructions

Detailed Installation Instructions are provided in the PAL-AT Installation Manual (PA 1000).

## 1.2.4 Manual Updates

Refer to the PermaAlert (Perma-Pipe) web site, [www.permaalert.com](http://www.permaalert.com), for the latest version of this manual. The leak detection information can be found by selecting: Product Catalog---Industry Applications---Leak Detection.

**\*\* ALL APPLICABLE MANUALS MUST BE REVIEWED AND UNDERSTOOD PRIOR TO INSTALLATION \*\***

## 2 Operating PAL-AT

PAL-AT lists the primary functions in the Main Menu. The LCD displays two menu functions at a time. **Read the display carefully. PAL-AT prompts for the information it needs.** Press the # key to step through the Main Menu and display the next two menu functions.

PAL-AT has a password system to prevent unauthorized access. Password access time is very short, ranging from 2 minutes to 60 minutes for selected functions. PAL-AT requests a password if: (1) the current password is not authorized to enter the selected function or (2) the allowable time for the selected function expires without any keypad input.

This manual uses examples of display messages. In the examples, question marks (?) represent numbers on the LCD. "TIME" and "DATE" represent a display of a specific time or date.

**The Main Menu Functions available in PAL-AT are:**

- |                  |                      |
|------------------|----------------------|
| 1. Setup         | 6. History           |
| 2. Reference     | 7. Set Clock         |
| 3. Verify        | 8. Password Entry    |
| 4. Monitor       | 9. Special Functions |
| 5. Display Setup |                      |

The normal procedure for setting up a new system is to proceed through functions 1 and 2. Select a menu function and then answer the questions displayed on the LCD.

### 2.1 Setup

PAL-AT uses this function to enter sensor cable data into the PAL-AT memory. A level 200 password is required (see Section 2.8). If an AT-ORC Output Relay Controller panel is installed, refer to Section 6 of this manual for additional information for setup. To select this function from the Main Menu, press 1 and #.

#### 2.1.1 Multiple Cable System

If the system is a model AT20K, AT40K or AT80K monitoring more than one cable, the first message is:

LCD03:

**ENTER CABLE NUMBER [1-?], THEN #:  
FOR SETUP \* TO EXIT**

Models with a single cable skip this message. **When PAL-AT is in the setup function, it is not monitoring any cables that were previously setup.**

#### 2.1.2 Exit Setup

The next message is:

LCD04:

**ALL CALIBRATION AND MAPS WILL BE LOST  
\* TO ABORT, # TO CONFIRM SETUP DESIRED**

This is a warning that you going to enter new setup data. If you entered the setup function accidentally, you can exit this function by pressing the "\*" key. **Warning: Do not press # except to setup a new system which will erase all previous setup data and reference maps for the selected cable.**

## 2 Operating PAL-AT

### 2.1.3 Baseline Check

The next message is:

LCD05:

STANDARD RESOLUTION, BASELINE = ??  
ENTER \* FOR MENU, # TO CONTINUE

The baseline is a number between 25 and 35. If the unit displays a value outside this range it shows a hardware failure. A value of zero may mean the cable card or pulse card is not properly installed. If so, turn off the power and carefully seat the cards firmly in their slots (see Section 5.1). Press # to move to the next item or press \* to cancel setup and return to the Main Menu.

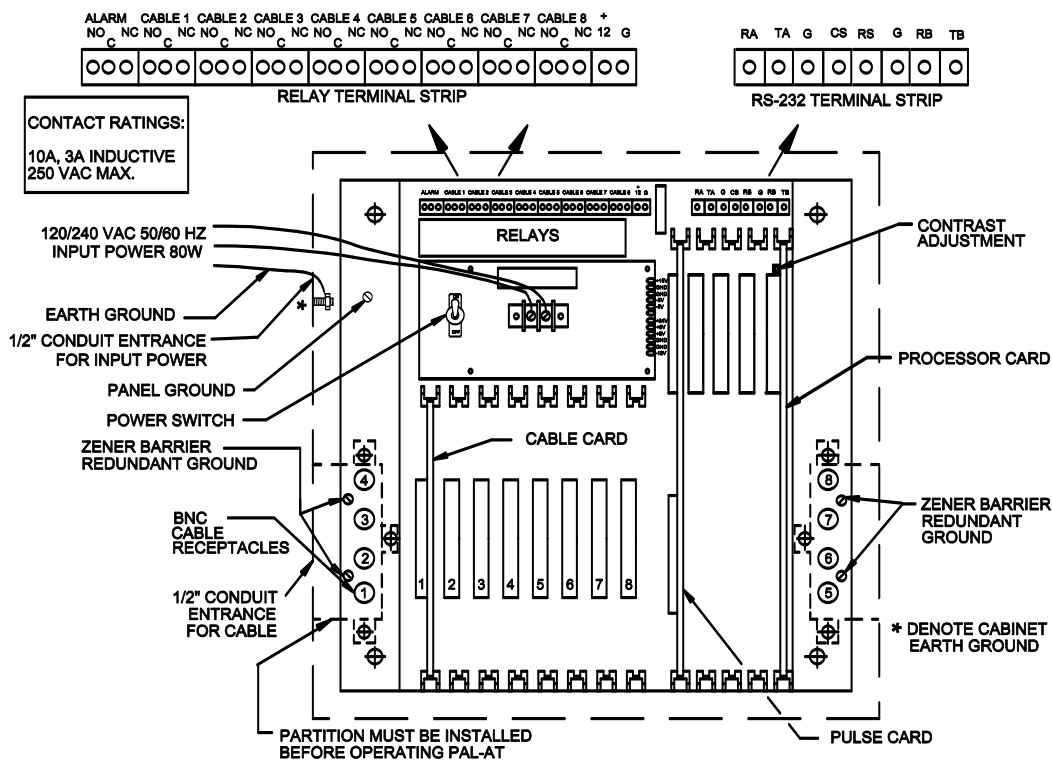


Figure 2.1.3A: AT40K and AT80K Component Layout

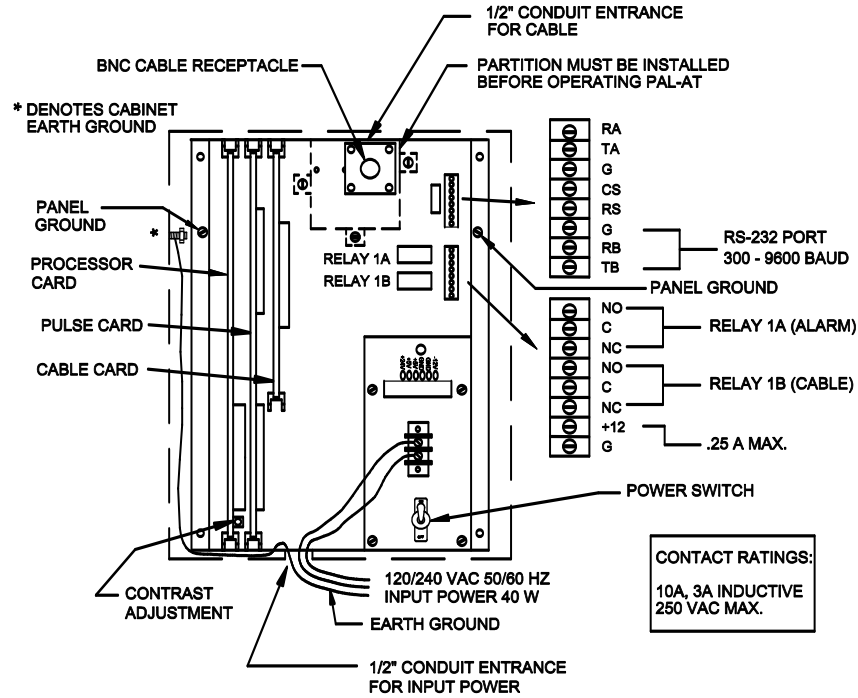


Figure 2.1.3B: AT20C and AT50C Component Layout

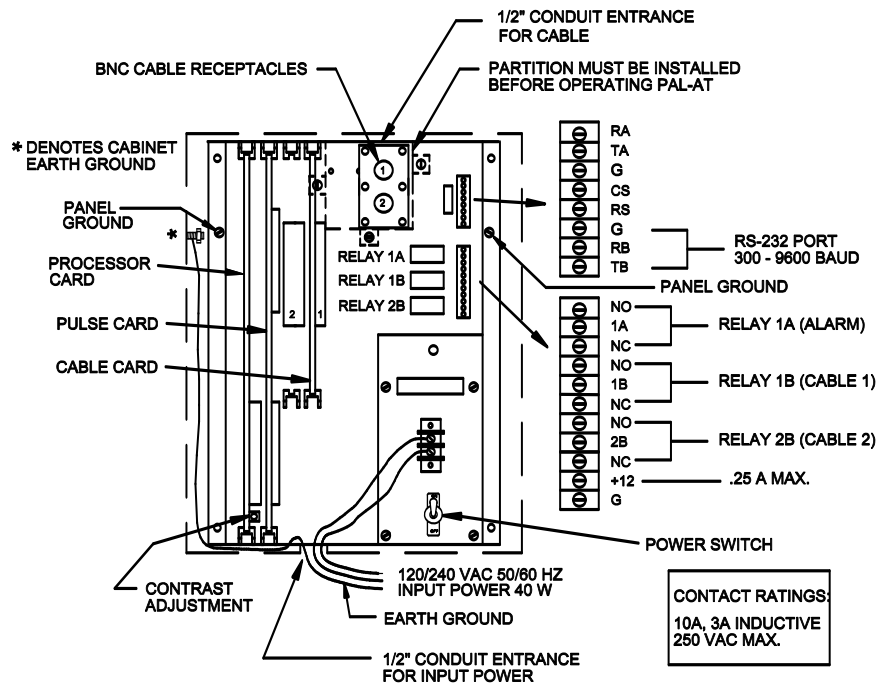


Figure 2.1.3C: AT20K Component Layout

## 2 Operating PAL-AT

### 2.1.4 Hydrocarbon Liquids

Next PAL-AT displays the message:

LCD06:

CABLE ? MONITORING HYDROCARBONS? (FUELS)  
ENTER # FOR YES, \* FOR NO

Press # if any section of the sensor cable (not probes) is monitoring for hydrocarbon liquids (gas, oil, fuel, solvents, etc.). This will increase the sensitivity of PAL-AT. **The sensitivity jumper on the cable card should be set to “H” or “High” for maximum sensitivity when monitoring for hydrocarbons.**

### 2.1.5 Sensor String Sections

The sensor string is a combination of lengths of jumper cable, sensor cable, and probes connected in series to PAL-AT and monitored for leaks, breaks, etc. During the setup function, the sensor string is broken into several sections. The end of each section is called a calibration point. Two rules are used to find the required number of sections or calibration points.

**The first rule is there must be a new section or calibration point at every change in cable type.** For example, a sensor string consisting of 50 feet of jumper cable, 400 feet of AGW-Gold cable, and then 20 feet of jumper cable should be set up as 3 sections. There may be several cable connectors within one section. The 400 feet of AGW-Gold may consist of 10 lengths of cable, each 40 feet long, but they should be connected and entered as 1 section.

An exception to this rule is if the length of a cable is 15 feet or less. For example, one area of a sensor string has 200 feet of AGW-Gold, then 15 feet of jumper going through a manhole, and finally 200 feet of AGW-Gold. These lengths of cable can be setup as 1 section of AGW-Gold cable 415 feet long instead of 3 sections.

**The second rule for locating sections or calibration points concerns long lengths of 1 type of cable.** Make additional calibration points at cable connectors approximately every 500 feet. Consider a sensor string consisting of 50 feet of jumper, 700 feet of AGW-Gold, and 20 feet of jumper. Instead of setting this up in 3 sections, make an additional calibration point in the 700 feet of AGW-Gold to improve the accuracy of the system. In this example, the 700 feet of AGW-Gold should be 2 sections, approximately 500 feet and 200 feet long.

The setup procedure requires the sequential addition of sections to the sensor string. **This procedure should be carefully planned to assure an accurate calibration.**

### 2.1.6 Create Setup Table

The next message asks for data about each section of the sensor string. PAL-AT uses it to create a setup table in its memory. Two pieces of data are necessary for each cable section: (1) the **type of cable** and (2) the **cumulative distance to the end of the section**.

#### 2.1.6.1 Select Cable Type

There are several types of sensor cables and jumper cables. PAL-AT displays a message requesting the cable type.

LCD07:

ENTER SECTION ?? CABLE TYPE, THEN #  
0=END, 1=ATP, 2=AGW, 3=JMP, # FOR MORE

PAL-AT lists several types of cable at a time. Press #, if needed, to display additional cable choices. Currently the choices are: 0=End, 1=ATP, 2=AGW, 3=JMP, JMP-U or JMP-UD, 4=FGH, 5=TFH, 7=AGT, 8=JPL-U or JPL-UD, 9=JPP, 10=Probe, 11=Special, 13=AGW-Gold, 14=AGT-Gold and 15=TFH-Gold. Additional choices may be added as new cables are developed and some choices may be discontinued. Earlier firmware may not list ATP as type 1. For those systems, enter type 14. Press a number to select the appropriate cable type, and then press # for PAL-AT to accept that number.

**The first section connected to PAL-AT is always a jumper cable at least 50 feet long.** It is

important to include this piece of jumper cable in the sensor string, even if the first location to be monitored may be less than 50 feet from PAL-AT. For the first section, press 3 and #, if type JMP-U jumper cable is used. If the first section is JPP jumper cable, type 9, it should be at least 65 feet long.

## 2.1.6.2 Enter Cable Distance

The next message asks for the distance to the end of the section:

LCD08:

**ENTER DISTANCE TO SECTION ?? END:  
\* TO CLEAR, 0 FOR AUTOEND, # TO START**

The distance to the end of the section is the cumulative length of the previously entered sections plus the length of the new section. It is not the length of the new section only. For example: if you are setting up section 2, which is 500 feet of type AGW-Gold cable, and section 1, is 50 feet of jumper cable, the distance to the end of section 2 is 550 feet. There are two methods to enter the distance: (1) use Autoend or (2) enter the estimated distance. Select Autoend by pressing 0 and #, or just #, and PAL-AT finds the distance to the end of the section automatically. Otherwise enter the distance and press #. In either case, PAL-AT displays:

LCD09:

**LOCATING END OF SECTION ????, PLEASE WAIT**

If you select Autoend, the next display is:

LCD10:

**END FOUND AT ????  
\* TO REENTER, # TO ACCEPT**

Press # to accept the distance determined by PAL-AT. If an estimated distance is entered for a section, PALAT finds the end of the section and checks if the measured section length is within tolerance of the estimated distance. If it is, PAL-AT accepts the entry and repeats message LCD07 for the next section. If the estimated distance is incorrect, then the following message is displayed:

LCD11:

**END FOUND AT ???? INSTEAD OF ????  
\* TO REENTER, # TO ACCEPT**

Press # to accept or \* to reenter the distance determined by PAL-AT. The most likely reason for displaying this message is you entered the wrong information (cable type or length).

LCD12:

**ENTRY OF ???? IS INVALID - \* TO REENTER  
MUST BE BEYOND SECTION ?? END AT ????**

There are two reasons for displaying message LCD12. Either the next section was not connected to the cable as intended or the connector on the new section was not installed correctly. Enter \* and reenter the data after the problem is corrected.

## 2.1.6.3 No End Found

If PAL-AT cannot find the end of the cable, one of the following messages is displayed:

LCD13:

**PROBABLE SHORT FOUND IN CABLE ? AT ????  
\* OR # TO REENTER**

This message shows a short in the cable. Check the cable connectors at the displayed distance. When the cable is disconnected from PAL-AT an ohmmeter should show an open circuit between the center

## 2 Operating PAL-AT

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pin of the cable connector and the housing of the connector. A short in the cable must be repaired before PAL-AT can monitor the sensor string. Refer to Section 5.2 for cable connector tests.

OR

LCD14:

<p><b>NO END FOUND IN CABLE ? IN ???? FEET</b> <b>* OR # TO REENTER</b></p>
---

This message is displayed if: (1) the actual end of the section is more than 100 feet longer than the estimated distance entered, (2) the end is longer than the maximum length of the system, or (3) the sensor string is disconnected from the panel. Recheck all connectors and the resistance of the cable as described in Section 5.2.

### 2.1.6.4 End of Sensor String

PAL-AT repeats messages LCD07 through LCD12 for each new cable segment or probe. Each setup table has the capacity for over 50 sensor string sections.

The last section of each sensor string must be jumper cable. A system shorter than 2,500 feet uses at least 20 feet for JMP-U or JPL. However, if the previous section is a probe and the system is over 1,500 feet long, then the last section should be 30 feet long (35 feet for JPP) in addition to the 50 feet that comes with the probe.

Cable runs longer than 2,500 feet require a longer length of jumper cable for the last section. Those between 2,500 and 5,000 feet require 50 feet (65 ft. for JPP) and cables 5,000 - 7,500 feet require 100 feet (130 for JPP). Consult PermAlert for systems over 7,500 feet long.

If the length of the last section of jumper cable is determined by the PAL-AT to be shorter than the required lengths listed above, add additional jumper cable to the last section. This happens occasionally when matching the impedance of the last sensor cable section to the end jumper cable section. The end jumper cable lengths listed are the areas at the end of the cable used for system calibration and are not monitored for leaks.

After the last cable section data is entered, end the setup table by entering cable type zero (0) then # at message LCD07. The end of the last cable section must have a connector attached. Install the threaded plastic cap, supplied with PAL-AT, over the connector.

### 2.1.7 Probes

Probes are a special case. Probes can be connected to a PAL-AT sensor string anywhere along its length. PermAlert ESP supplies probes with 10 feet of jumper cable attached to the input and 50 feet to the output of the probe integrator. The probe section length is 60 feet for calculating the distance to the end of the section. PAL-AT automatically assigns an identification number (1-40) to each probe.

## 2.2 Reference

After a cable is setup, a reference, or "master", map must be taken before PAL-AT can begin monitoring. A master map is an electronic "snapshot" of the condition of the cable stored in memory. PAL-AT detects any change in the condition of the cable compared to the master map. PAL-AT models AT20C, AT50C and AT40K have memory space for five (5) maps and models AT20K and AT80K have eight (8) maps. If a leak is detected on a sensor string, a new master map may be taken so PAL-AT can continue to monitor the entire system during the current leak. Press 2 and # from the Main Menu to take a reference map. A level 100 password is required (see Section 2.8).

### 2.2.1 Multiple Cable System

If the system has multiple cable cards, the first message is:

LCD15:

**ENTER CABLE NUMBER (1-?), THEN # :  
FOR REFERENCE \* TO EXIT**

Other models skip this message.

### 2.2.2 Reference Process

If there is no fault on the cable, PAL-AT does not allow taking a map, except map 1, and displays:

LCD16:

**CABLE ? NO FAULT - REFERENCE NOT ALLOWED  
ENTER # OR \* TO RETURN TO MAIN MENU**

Also if there is a break or short in the cable, or if the end of the cable is not found, PAL-AT does not allow taking a new reference map. In these cases the problem on the cable must be corrected before a new reference is allowed. The messages are:

LCD17:

**CABLE ? BREAK - REFERENCE NOT ALLOWED  
ENTER # OR \* TO RETURN TO MAIN MENU**

OR

LCD18:

**CABLE ? SHORT - REFERENCE NOT ALLOWED  
ENTER # OR \* TO RETURN TO MAIN MENU**

OR

LCD19:

**CABLE ? NO END - REFERENCE NOT ALLOWED  
ENTER # OR \* TO RETURN TO MAIN MENU**

Otherwise, PAL-AT displays:

LCD20:

**REFERENCE READING ON CABLE ? IN PROGRESS**

The reference process for most cables takes less than 20 seconds. Then, PAL-AT automatically performs the verify function and monitors the cable. If any problems such as leaks or breaks are found during verify or monitor, refer to the appropriate sections of this manual, 2.3 or 2.4. When a reference map is taken after an alarm, PAL-AT checks the length of the cable. If a leak is detected on the cable but the cable appears shorter to the PAL-AT, the following warning message is displayed:

LCD21:

**LEAK AT ???? BUT CABLE ? LOOKS ????  
SHORTER DUE TO 2ND PROBLEM # TO CONTINUE**

Press the # key for the next message:

## 2 Operating PAL-AT

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LCD22:

**CHECK CONTINUITY TO END OF CABLE ?  
\* TO RETURN TO MENU, # CONTINUITY OK**

First check the continuity to the end of the cable to make sure all cable is connected and a length of cable was not removed for drying and then not replaced (see Section 5.2).

If the continuity is correct, the cable may appear shorter due to the cable drying past the current leak. In this case continue with reference mapping by pressing the # key.

Similar messages appear if a drying cable appears longer:

LCD23:

**DRYING AT ???? BUT CABLE ? LOOKS ????  
LONGER DUE TO 2ND PROBLEM # TO CONTINUE**

Press the key for the next message:

LCD24:

**CHECK CONTINUITY TO END OF CABLE ?  
\* TO RETURN TO MENU, # CONTINUITY OK**

Again, check continuity of the cable to make sure extra cable was not added to the system. If the continuity is correct, the cable may appear longer due to a leak past the current drying area. In this case, continue with reference mapping by pressing the # key to get the cable back on line. PAL-AT can then alarm if more cable gets wet.

### 2.3 Verify

The verify function checks if the cable matches a reference map and locates the end of the cable. Verify is also used to select a cable for automatic monitoring. Select the verify function from the Main Menu by pressing 3 and #. A level 200 password is required (see Section 2.8).

#### 2.3.1 Multiple Cable System

If the system has multiple cable cards, the first message is:

LCD25:

**ENTER CABLE NUMBER (1-?), THEN # :  
FOR VERIFY \* TO EXIT**

Other models skip this message:

#### 2.3.2 Select the Master Map

PAL-AT asks for the map number to verify. This is useful to see if the current condition of the cable matches any of the previous maps (see Section 3 for further details). The display shows the current master map number. This is the map used during monitoring. The next message is:

LCD26:

**MONITORING USES MAP ?  
ENTER # TO USE MAP ? , \* FOR ANOTHER**

If \* is pressed, PAL-AT displays:

LCD27:

**ENTER MAP TO VERIFY (1-?)**

Press the number of the map to compare to the current cable condition. Then press #.

### 2.3.3 Verify Process

The next message PAL-AT displays is:

**LCD28:**

**VERIFYING CABLE ?**

When the process is completed, PAL-AT displays the following message if the current system matches the selected map:

**LCD29:**

**CABLE ? MATCHES MAP ? , END AT ???? FEET  
MONITOR CABLE ? # FOR YES, \* FOR NO**

This means the cable is in the same condition now as when the reference map was made. If so, go to Section 2.3.4 for the next step.

If the sensor string does not match the selected map, one of several messages is displayed. The first line of the message shows the location and type of problem: leak, drying, short, break, probe activated, probe reset, etc. The second line asks to return to the Main Menu if the map number selected in LCD27 is not the one being monitored. A few examples are:

**LCD30:**

**LEAK DETECTED IN CABLE ? AT ???? FEET  
ENTER # OR \* TO RETURN TO MAIN MENU**

This message is displayed if a leak is detected.

**LCD31:**

**BREAK DETECTED IN CABLE ? AT ???? FEET  
BUT SETUP AS ???? FEET. # OR \* FOR MENU**

If the distance in the first line is shorter than the distance in the second line, there is a break. If the first distance is longer than the second distance, then the end of the cable is now longer than originally setup. This means an additional section of cable is attached to the end of the system. If a sensor string is extended, the additional cable must be added using the Display Setup function (see Section 2.5).

**LCD32:**

**CABLE ? MATCHES MAP 1, NO END DETECTED  
BUT SETUP AS ???? FEET. # OR \* FOR MENU**

This message is displayed when the cable is more than 500 feet longer than setup, or disconnected completely from PAL-AT.

### 2.3.4 Select to Monitor

If the map selected in Section 2.3.2 matches the cable or is the current one set for monitoring, the second line of the message asks if the cable should be monitored. Example messages are:

**LCD33:**

**CABLE ? MATCHES MAP ?, END AT ???? FEET  
MONITOR CABLE ? # FOR YES \* FOR NO**

**LCD34:**

**LEAK DETECTED IN CABLE 1 AT 600 FEET  
MONITOR CABLE ? # FOR YES, \* FOR NO**

Enter # to monitor the cable automatically or \* to take it off monitor and return to the menu. In a multi-cable PAL-AT, a cable may be removed from monitoring when a slow leak or construction in the area of

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a cable is causing repeated alarms. If a cable is put on/off-line for monitoring, the action is recorded in the archive history of events (see Section 2.6).

### 2.4 Monitor

Press 4 and # from the Main Menu to put PAL-AT into monitor mode. The display alternates several messages when PAL-AT is in this mode. It shows the cable number it is checking and if the cable is OK. The constantly changing display is a self-check by PAL-AT. **When the LCD is not changing, or is blank, it means PAL-AT is not monitoring for leaks.** If this occurs, notify appropriate personnel immediately. The green power LED also flashes when the PAL-AT is in the menu and not monitoring.

The system first checks for a break or short. If none is found, the cable is checked for the remaining five conditions: leak, drying, probe active, probe reset or cable OK.

#### 2.4.1 Normal Messages Displayed

LCD35:

**NO CABLES SET FOR CONTINUOUS MONITORING  
ENTER # OR \* TO RETURN TO MAIN MENU**

This message means no cables are selected for automatic monitoring or the initial reference map has not been taken. Select cables for monitoring with the Verify function (see Section 2.3).

LCD36:

**MONITORING CABLE "A", USING MAP "B"  
\* TO RETURN TO MENU "TIME" "DATE"**

"A" is the cable number being monitored and "B" is the master map it is compared to.

LCD37:

**CABLE "A" OK  
\* TO RETURN TO MENU "TIME" "DATE"**

This message is displayed when the cable matches the master map.

LCD38:

**RECHECKING CABLE "A", USING MAP "B"  
\* TO RETURN TO MENU "TIME" "DATE"**

PAL-AT displays this message when it first recognizes a fault condition. PAL-AT rechecks the cable three (3) times during the next few seconds before displaying an actual alarm condition and activating the alarm relays.

#### 2.4.2 Fault Messages Displayed

One of the following messages is displayed when a fault is detected:

LCD39:

**FAULT IN FIRST 50 FEET OF CABLE ?  
# TO SILENCE ALARM "TIME" "DATE"**

OR

LCD40:

**LEAK DETECTED IN CABLE ? AT ???? FEET  
# TO SILENCE ALARM "TIME" "DATE"**

OR

LCD41:

CABLE ? DRYING AT ???? FEET  
# TO SILENCE ALARM      "TIME" "DATE"

OR

LCD42:

BREAK DETECTED IN CABLE ? AT ???? FEET  
# TO SILENCE ALARM      "TIME" "DATE"

OR

LCD43:

SHORT DETECTED IN CABLE ? AT ???? FEET  
# TO SILENCE ALARM      "TIME" "DATE"

OR

LCD44:

PROBE # ? ACTIVATED IN CABLE ?  
# TO SILENCE ALARM      "TIME" "DATE"

OR

LCD45:

PROBE # ? RESET IN CABLE ?  
# TO SILENCE ALARM      "TIME" "DATE"

OR

LCD46:

NO END FOUND IN CABLE ? IN ???? FEET  
# TO SILENCE ALARM      "TIME" "DATE"

A display above is on for 5 seconds and then alternates with display LCD38.

### 2.4.3 Alarm Silence Feature

When PAL-AT detects a fault condition, it switches two relays. On the AT20K, AT40K or AT80K they are the alarm relay and the cable relay for the appropriate cable number (see Figures 2.1.3A and 2.1.3C). The AT20C and AT50C relays are labeled 1A and 1B (see Figure 2.1.3B).

**PAL-AT is shipped with the relays configured to operate in a normally energized mode, so they deenergize in the alarm state** (see Section 2.9.1 for setting relay configuration).

When any of the displays in 2.4.2 is shown, the # key can be pressed to switch the alarm relay (AT40K or AT80K) or relay 1A (AT20C, AT50C or AT20K) to its normal state. **An audible alarm is an option available for PAL-AT.** If the PAL-AT is purchased with an audible alarm, it is prewired to the processor card connector, leaving the relay contact available for additional devices. The cable relay (AT40K or AT80K) or relay 1B (AT20C, AT50C and AT20K) remains switched until the fault is cleared or a new reference map is taken and the system is monitoring the cable again. The alarm silence feature resets after a preset interval (normally 12 hours) if the fault is not corrected and reactivates the alarm (see Section 2.9.3.1).

### 2.4.4 Failure to Enter Monitor Mode

PAL-AT requires a master password before it can begin monitoring the first time. The password is unique. The password is issued when the PAL-AT warranty is registered. See the warranty registration at the back of this manual. Once the password is entered, it is not needed again. The message is:

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LCD47:

**MONITORING NOT ENABLED  
ENTER # OR \* TO RETURN TO MENU**

When the master password is issued, select the security function by pressing 8 and # from the Main Menu. The display is:

LCD48:

**ENTER SECURITY PASSWORD  
\* TO CLEAR, # TO ACCEPT ENTRY**

Enter the master password and press #. PAL-AT returns to the Main Menu. Choose the monitor function by pressing 4 and #. The message is:

LCD49:

**MONITORING NOT ENABLED  
ENTER # TO ENABLE, \* TO DISABLE**

Press # and PAL-AT returns to the Main Menu. Again, select the monitor function by pressing 4 and # and the system begins automatic monitoring.

### 2.5 Display Setup

This function allows you to inspect the setup data. The inspection feature provides an easy method to review the types and lengths of cable sections in the setup (calibration) table. This is useful to make sure they are entered correctly and to see what type of cable is at the location of an alarm. No password is required to view the setup data. Press 5 and # from the Main Menu.

If an Output Relay Controller panel (AT-ORC) is installed, refer to Section 6 of this manual for additional information for Display Setup.

This function also allows adding or changing cable sections at any point in the setup table. This provides for expanding a sensor string in the future without redoing the entire setup procedure. This is also useful if a system requires more than 1 day to setup. At the end of the first day, end the setup function by entering cable type 0. The next day, continue by using display setup as explained below to add the rest of the sections. A password of level 200 must be entered first to change the setup data. To do so:

- 1) Select function 8 (Password Entry)
- 2) Enter password
- 3) Select function 5 (Display Setup)

Once a section is changed, the section data for each section following it must also be entered. This applies to adding cable in the middle of an existing sensor string. If you decide to change a section, all the maps will be lost as well. **Do not choose to change the setup table unless you are setting up a new system and are prepared to lose the maps and part of the setup table!**

This function is also used to make a new map 1 for an existing system. This is required when the sensitivity is changed or a cable card is replaced (see Section 2.5.4).

#### 2.5.1 Multiple Cable System

If the system has multiple cable cards, the first message is:

LCD50:

**ENTER CABLE NUMBER (1-?), THEN # :  
FOR DISPLAY SETUP \* TO EXIT**

Other models skip this message.

## 2.5.2 Display Setup Data

If a password at level 250 is entered, the next message is:

LCD51:

HEREAFTER ENTER # TO SHOW NEXT SECTION  
OR \* TO ABORT OR REENTER SETUP DATA

Otherwise it is:

LCD52:

HEREAFTER ENTER # TO SHOW NEXT SECTION  
ENTER \* TO RETURN TO MENU

Press \* at any time to exit display setup and return to the Main Menu. Starting at section 1, each time # is pressed, PAL-AT displays the setup data for the next section of sensor string. The message is:

LCD53:

CABLE ? SO FAR    LENGTH=????? COUNT=????  
SECT. ?? TYPE=?    LENGTH=????? COUNT=????

The top line refers to the cumulative total of the sections, including the selected section. The second line refers to the selected section only. "COUNT" refers to an internal counter in PAL-AT. All this information is needed in case it is necessary to redo the setup table if the cable card fails or someone accidentally deletes the setup table (see Section 2.5.5).

## 2.5.3 Last Section

After all the sections are displayed the next message is:

LCD54:

CABLE ? END - ENTER \* TO ADD A SECTION  
ENTER # TO CHECK AUTOMATIC MONITORING

OR

LCD55:

CABLE ? END - ENTER \* TO RETURN TO MENU  
ENTER # TO CHECK AUTOMATIC MONITORING

If # is entered, PAL-AT displays either:

LCD56:

CABLE ? SET FOR AUTOMATIC MONITORING  
CRI ?? # OR \* TO RETURN TO MAIN MENU

OR

LCD57:

CABLE ? NOT SET FOR AUTOMATIC MONITORING  
CRI ?? # OR \* TO RETURN TO MAIN MENU

This shows whether the current cable is or is not set for automatic monitoring.

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### 2.5.4 Add Sections

If \* is pressed after message LCD53 and before message LCD56 and the password is level 250 or higher, then the next message is:

LCD58:

**ENTER # TO REENTER SECTION ? SETUP DATA  
ENTER \* TO RETURN TO MENU**

Enter \* to return to the Main Menu. If # is entered the message is:

LCD59:

**REST OF SETUP AND ALL MAPS WILL BE LOST  
\* TO ABORT, # TO CONFIRM REENTRY DESIRED**

This is a check that you want to change the data. **WARNING: Do not press # unless you are prepared to erase the maps and all or part of the setup table. Read Section 2.5.**

If you press #, PAL-AT enters the setup function with the section number displayed. Follow the procedures in Sections 2.1.5 through 2.1.7 to add sensor string sections from that point to the end of the system. After adding sections to the sensor string, it is necessary to take a new master map (see Section 2.2 - Reference).

In some instances, it is desirable to create a new map 1 without setting up the system again. This is usually done when a cable card is replaced. To set a system back to a new map 1, enter \* at message LCD54, # at message LCD58, and # at message LCD59. Select cable type 0. This ends the setup process without adding to the sensor string. Next take a new reference map 1 (see Section 2.2 - Reference).

### 2.5.5 Record the Setup Table

**A listing of the setup table, showing distances and counts for each section, must be recorded.** If the setup table is accidentally erased, the listing can be used to reenter the data without going through the setup process. Contact PermAlert for details. A form is provided in this manual that can be used to keep a permanent record of the setup table. A copy of the completed form should be kept in a safe location, in addition to the one in this manual.

## 2.6 History

PAL-AT records a history of events. This history, called the archives, is displayed by selecting menu function 6. Every significant event is recorded: alarms, power failures, security password entries, remapping, etc. The records are displayed in order, from most recent to oldest (LIFO). Press # to display the next oldest entry. Press 9 to change direction and display the next most recent entry. All messages display two lines of information.

### 2.6.1 History Messages – The First Line

LCD60:

**NO MORE ENTRIES IN HISTORICAL ARCHIVES**

This is displayed after the last entry.

LCD61:

**ARCHIVES CLEARED IN / "YEAR"**

"YEAR" is a two-digit number from 00-99.

**LCD62:**

**POWER LOST AT "TIME" ON "DATE", RESTORED**

This entry is made when a unit is turned on, recording when power was lost.

**LCD63:**

**CABLE "A" SETUP, WITH LENGTH OF "B" FEET**

This entry is made when a sensor string is setup, "A" is the cable number and "B" is the length of the sensor string.

**LCD64:**

**NEW CABLE "A" REFERENCE, STORED AS MAP "B"**

This entry is made when a new reference or master map is made. "A" is the cable number and "B" is the map number.

**LCD65:**

**CABLE "A" MONITORING ON, MAP "B" IN/"YEAR"**

This entry is made when a cable is put on automatic monitor status.

**LCD66:**

**CABLE "A" MONITORING OFF IN /"YEAR"**

This entry is made when a cable is taken off monitor status.

**LCD67:**

**CABLE "A" RETURNED TO NORMAL**

This entry is made when a fault clears or a new cable is put on line.

**LCD68:**

**SECURITY CODE "A" ENTERED, LEVEL "B"**

This entry is made when a security code is entered into the unit. "A" is the number of the security code (1-25) and "B" is the security level for that code (1-255). The master password is level 255.

**LCD69:**

**LEAK DETECTED IN CABLE "A" AT "B" FEET**

This entry is made when a leak is detected. "A" is the cable number and "B" is the distance where the leak is first detected.

**LCD70:**

**CABLE "A" DRYING AT "B" FEET**

This entry is made when a cable dries.

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LCD71:

**SHORT DETECTED IN CABLE "A" AT "B" FEET**

This entry is made when a short is detected.

LCD72:

**BREAK DETECTED IN CABLE "A" AT "B" FEET**

This entry is made when a break is detected.

LCD73:

**FAULT IN FIRST 50 FEET OF CABLE "A"**

This entry is made when a cable fault is detected in the first 50 feet of the cable.

LCD74:

**NO END FOUND IN CABLE "A" IN "B" FEET**

This entry is made when the cable is disconnected from PAL-AT or additional cable is improperly added to the sensor string. "B" is 500 feet longer than the sensing string setup.

LCD75:

**PROBE # "B" ACTIVATED IN CABLE "A"**

This entry is made when a probe is activated. "B" is the number of the probe.

LCD76:

**PROBE # "B" RESET IN CABLE "A"**

This entry is made when a probe resets to its initial condition, either normally open or normally closed.

LCD77:

**ALARM ON CABLE "A" SILENCED**

This entry is made when the alarm is silenced by entering the # key.

LCD78:

**CABLE "A" AUTOSELECT, NOW USING MAP "B"**

This entry is made when a previous map, "B", is selected by PAL-AT due to drying cable or a probe reset in the automapping mode.

LCD79:

**CABLE "A" AUTOREFERENCE, STORED AS MAP "B"**

This entry is made when a new map "B" is taken by PAL-AT due to drying cable or a probe reset in the automapping mode.

**LCD80:****AUTOMATIC MONITORING ENABLED IN / "YEAR"**

This entry is made when automatic monitoring is enabled using the "master" password.

**LCD81:****AUTOMATIC MONITORING DISABLED IN / "YEAR"**

This entry is made when automatic monitoring is disabled using the "master" password.

**LCD82:****TIME RESET TO "TIME", DATE TO "DATE"**

This entry is made when the clock is reset, "TIME" and "DATE" are the new time and date.

**LCD83:****YEAR CHANGED FROM "YEAR" TO "YEAR"**

This entry is made when the year is changed using "Set Clock", or automatically on January 1 of any year. The year is displayed with 4 digits.

## **2.6.2 History Messages – The Second Line**

The second line of the history message always reads:

**LCD84:****AT "TIME" ON "DATE", # FOR NEXT, \*FOR MENU**

"TIME" and "DATE" is when an entry is made to the history.

## **2.7 Set Clock**

PAL-AT has an internal clock and calendar. The current time and date are displayed when the unit is in monitor mode. PAL-AT has a battery that keeps the clock running, when power is off, for up to one year. If the battery fails, PAL-AT automatically sets the date to 1/1/2000 when power is restored (see Section 4.3).

### **2.7.1 Set the Time and Date**

Press 7 and # from the Main Menu to select this function. Security password level 50 is required for this function. The first line of the message is:

**LCD85:****CURRENT TIME: "TIME" DATE: "DATE"**

The second line steps through several displays. The second line displays are:

**LCD86:****ENTER HOURS (00-23), THEN #**

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LCD87:

ENTER MINUTES (00-59), THEN #

LCD88:

ENTER MONTH (01-12), THEN #

LCD89:

ENTER DATE (01-31), THEN #

LCD90:

ENTER YEAR (00-99), THEN #

**Note:** PAL-AT uses the 24-hour (military) time display.

### 2.8 Passwords

PAL-AT has several security levels. The following table shows the menu functions and the required security level:

Security Level	
<u>Required</u>	<u>Menu Function</u>
<b>None</b>	4 – Monitor
	5 - Display setup ( <i>read only</i> )
	6 – History
	Silence Alarm
<b>50</b>	7 - Set Clock
<b>100</b>	2 – Reference
	3 – Verify
<b>200</b>	1 - Setup Cable
	5 - Display Setup ( <i>add sections</i> )
<b>250</b>	8 - Security ( <i>add security passwords</i> )
	9 - Special Functions

**Table 2.8.1**

PAL-AT asks for a password and automatically selects menu function 8: (1) if a function is selected that requires a higher security level than the most recent password, or (2) a preset time elapses and cancels a previous password. After a password is entered, the display continues with the original menu function selected.

#### 2.8.1 Establish New Passwords

PAL-AT initially uses a password, 7089662190, that is assigned a security level of 250. Use this level 250 password to set up additional passwords at any security level from 50 to 250. PAL-AT allows 25 different user passwords. **After you establish another password at level 250, delete the initial password, 7089662190, to prevent unauthorized access to PAL-AT.**

To set up new passwords, select the security function by pressing 8 and # from the Main Menu. The message is:

**LCD91:**

**ENTER SECURITY PASSWORD  
\* TO CLEAR, # TO ACCEPT ENTRY**

Enter a level 250 password and #. Then press 8 and # again. The message is:

**LCD92:**

**ENTER PASSWORD TO ADD/DELETE  
MUST BE 6 TO 10 CHARACTERS LONG**

Enter 6 to 10 digits and #. After # is entered, either message LCD93 or LCD95 is displayed:

**LCD93:**

**NOT FOUND - ENTRY ?? AVAILABLE  
# TO ADD, \* TO RETURN TO MENU**

If the password is not assigned this is displayed, showing the number of the next space available in the table of 25 passwords. Press # and the message is:

**LCD94:**

**ENTER SECURITY LEVEL (1-250)**

Enter the security level corresponding to the Main Menu functions this password can access (see Table 2.8.1) and press #. The Main Menu is displayed. To add more new passwords, press 8 and # again and repeat LCD92 to LCD94.

## **2.8.2 Delete Password**

Follow the steps for messages LCD91 and LCD92. If the password entered in LCD92 is assigned, the message is:

**LCD95:**

**FOUND AS ENTRY ??, WITH LEVEL ???  
# TO DELETE, \* TO RETURN TO MENU**

Delete this password by pressing #. This is also used to change the security level of a password. First delete the password and then reenter it with the new security level as discussed above. If only # is entered at message LCD92 then PAL-AT returns to the Main Menu and ends the password editing session.

## **2.8.3 Enter Password**

Select a password by pressing 8 and # from the Main Menu. The display is:

**LCD96:**

**ENTER SECURITY PASSWORD  
\* TO CLEAR, # TO ACCEPT ENTRY**

Enter the password. The display shows X's instead of the actual numbers as they are entered. Press # after the password is entered to return to the Main Menu. Next select a function from the Main Menu.

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### 2.9 Special Functions

Several special system functions are listed in a separate menu.

- (1) To Set Relay Normal States
- (2) To Display Special Archives
- (3) To Set Special Options
  - Alarm silence - Automapping - Averaging Rate – Noise Factor - Power Save Delay
- (4) To Set Baud Rate
- (5) To Set System Identification
- (6) To Enter Phone Number (see PALCOM Operating Manual)
  - (Available in version 9.XX Firmware only)
- (7) To display Cable Data

Press 9 and # to select the Special Function Menu. A level 250 password is required. The first message is:

LCD97:

**1# TO SET RELAY NORMAL STATES  
\* = MAIN MENU, # = NEXT SPECIAL MENU**

#### 2.9.1 Set Relay Normal States

The PAL-AT relays can be set normally open (de-energized) or normally closed (energized). An alarm switches the relays to the opposite state. The labels on the relay terminal strips (see Figures 2.1.3A, 2.1.3B and 2.1.3C) refer to the form C contacts in their open or de-energized state.

**PAL-AT is shipped with the relays configured for normally closed (energized) operation.** To change the relay operation press 1 and # from the Special Function Menu. The message is:

LCD98:

**FIRST RELAY (ALARM) IS NORMALLY OPEN  
SET NORMAL STATE: \* = OPEN, # = CLOSED**

Press \* or # to select the desired state of the audible alarm relay, the relay controlled by the silence feature. The next message is:

LCD99:

**SET SECOND RELAY NORMAL STATE BY JUMPER  
ON NEWER CABLE CARDS \* OR # TO CONTINUE**

This message is displayed if any cable cards are version CSS 7102 I or later. (Version CSS 7102 I has 6 LEDs). The relay logic is set by moving the "Relay Setup" jumper on each cable card (see Figure 5.3A).

The cable relay can be set to activate in response to a "Leak" and ignore other faults, such as, "Break", "Short", "No End Found", etc. The alarm relay will still activate in response to all alarms. The next message is:

LCD100:

**ACTIVATE CABLE RELAY ON LEAK ONLY?  
ENTER # FOR YES, \* FOR NO**

The factory default is no. This will cause the relay to activate for all cable problems.

The relays are permanently set to alarm if the system is not in monitor mode. If automatic monitoring is disabled for all installed cards, the relays will activate.

## 2.9.2 Display Special Archives

PAL-AT has a special archive that records the first time the system is enabled for automatic monitoring and the first time each cable card is set for monitoring. To view the special archives, press 2 and # from the special function menu.

## 2.9.3 Set Special Options

There are five options to set with this function: (1) the length of time of the alarm silence, (2) automapping, (3) averaging rate, (4) noise factor and (5) power save delay. PAL-AT goes through these options in sequence.

### 2.9.3.1 Set Alarm Silence Time

PAL-AT is normally shipped with the alarm silence interval set for 12 hours as described in Section 2.4.3. The interval can be set from 1 minute to 96 hours to suit specific applications. To change the alarm silence time press 3 and # from the Special Function Menu. The message is:

LCD101:

**SET ALARM SILENCE TIME  
ENTER HOURS (MAX. 96), THEN #**

Enter the number of hours from 0 to 96 and #. The next message is:

LCD102:

**SET ALARM SILENCE TIME  
?? HOURS. ENTER MINUTES, THEN #**

Enter the number of minutes from 0 to 59 and #. A silence time of 0 hours and 0 minutes defaults to 12 hours. PAL-AT automatically continues to automapping selection.

### 2.9.3.2 Select Automapping

PAL-AT is normally shipped configured for automapping. Typically in the automapping mode, if PAL-AT is monitoring using map 1 and goes into alarm due to a leak, an operator acknowledges the leak and makes a new reference map. Then the system is monitoring using map 2. When the cable dries sufficiently or a probe resets, PAL-AT detects a "drying cable" fault, but does not activate any alarm relays. PAL-AT automatically compares the cable to map 1, and if they match, the system goes back to monitoring using map 1. If the cable does not match map 1 because it is not completely dry, PAL-AT takes a new reference map 3 automatically and monitors using map 3. As the cable continues drying, this process is repeated several times, retaking map 3, until the cable finally matches map 1.

PAL-AT also can be configured to activate alarms and relays when it detects a drying cable or probe reset just as it does when it detects a leak. Select this configuration by entering \* at the next message. The next message is:

LCD103:

**ALLOW AUTOMAP ON DRYING/PROBE RESET  
ENTER # FOR YES, \* FOR NO**

Press # to allow automapping or \* to alarm for drying cable or probe reset.

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If automapping is selected the next message is:

LCD104:

**SELECT ARCHIVING METHOD FOR AUTOMAPPING  
ENTER # FOR FIRST / MAP ONLY, \* FOR ALL**

Each time PAL-AT detects a drying cable and it remaps or selects a different map, it archives these events. If a substantial length of cable is wet, the drying process results in many repetitive archives that do not provide any new information. When the "FIRST/MAP ONLY" option is selected, PAL-AT only archives the first occurrence of drying on a cable and each time it selects a different map number to monitor. Press # or \* to select the archiving method. PAL-AT is normally configured for "FIRST/MAP ONLY".

### 2.9.3.3 Set Averaging Rate

PAL-AT cables are occasionally installed in areas where a high voltage cable (typically at least several thousand volts) is located a few feet away.

If the sensing string has probes, the induced voltage from the AC line may reduce the PAL-AT's ability to locate the end of the string. PAL-AT has provisions for changing the sampling rate of the pulses that are applied to the cable to cancel the effect of the AC voltage. This does slow the system though and it will require approximately 15 seconds to monitor 5,000 feet of cable.

Contact PermAlert for more information if you think the PAL-AT requires the special sampling rate. To change the sampling rate, enter 5 for 50 Hz or 6 for 60 Hz interference at the following message:

LCD105:

**SET SAMPLE AVERAGING, THEN #  
0 = NORMAL, 5 = 50 CYCLE, 6 = 60 CYCLE**

### 2.9.3.4 Set Noise Factor

The default setting for this is 8. It is normally used for diagnostic purposes. Do not change it unless a PermAlert technician request you to change it. Enter # to accept the default entry.

LCD106:

**ENTER NOISE FACTOR (4-60): 8  
\* TO CLEAR, # TO ACCEPT ENTRY**

### 2.9.3.5 Power Save Delay

The cable cards take advantage of a low power feature available in the PAL-AT firmware. The cable cards are powered up and checked one at a time in sequence until the last card is checked. There may be 1 to 8 cable cards depending on the system configuration. After the last card is checked, a selectable delay from 0 to 9999 seconds is started and all cards remain on low power until the delay is completed. Then the cards are checked again.

This is especially useful in high temperature applications (above 90° F). A delay of 1 minute allows the system to run without a cooling fan, in ambient temperatures up to 120°F. Contact PermAlert for applications involving higher ambient temperatures.

The next message is:

LCD107:

**SET POWER SAVE DELAY (0-9999 SEC)  
\* TO RE ENTER, # TO ACCEPT**

Enter the desired delay. The default delay is 0 seconds.

## 2.9.4 Communications Options

The PAL-AT can communicate with an external computer via RS-232 port B. Refer to the "Communications Options for PAL-AT" data sheet for details. PermAlert also offers Windows-based PALCOM Communication software packages that can monitor 254 PAL-AT systems.

In addition, software can be written by the customer to read the display and enter keypad data from a remote computer.

First, an address command must be sent to the system so it will respond (see Section 2.9.4.2). The address command is "AD,XX" where "XX" is the address of the system in hexadecimal format. Allowable values are 01 to FE (1 to 254). The "ESCAPE" key character clears the PAL-AT input buffer. It is recommended to send "ESC" before the address string at the beginning of each communication session. The corresponding system will respond with a prompt "MON 15M>" (15 may vary).

Now the PAL-AT system will respond to the display command (DI) and keypad command (KP). When the PALAT receives the ASCII string "DI" it will transmit 2-lines, 40 characters each, plus CR, that echoes the LCD display. When the PAL-AT receives the ASCII string "KP," followed by any combination of numerals "0" to "9", "\*" or "#" and finally ended with a ".", it responds in the same manner as if the numbers were entered at the keypad.

### Data format should be:

- 8 data bits
- 1 stop bit
- No parity
- 110 to 9600 baud

A 1/10 second delay between sending each character is recommended.

### CS Command

An additional communication command is available. The command is "CS", or "cable status". When PAL-AT receives "CS", it answers with 8 lines of data. Each line gives the status of each cable card and is 8 bytes long plus a carriage return. The ASCII code answer is decoded as follows:

-----+CR

1 2 3 4 5 6 7 8

#### Byte # Description

- |   |                              |
|---|------------------------------|
| 1 | Cable # (1-8)                |
| 2 | Cable Status (defined below) |
|   | 0=not installed              |
|   | 1=off-line                   |
|   | 2=normal                     |
|   | 3=leak                       |
|   | 4=break                      |
|   | 5=short                      |
|   | 6=probe active               |
|   | 7=probe reset                |
|   | 8=drying                     |
|   | 9=no end/fault in 50 ft.     |

#### Byte # Description

- |   |                            |
|---|----------------------------|
| 3 | } Distance or probe number |
| 4 |                            |
| 5 |                            |
| 6 |                            |
| 7 |                            |
| 8 | (sum of bytes 1- 7) MOD 10 |

If there is more than a 5 minute delay between commands received by PAL-AT, the communication link is broken and the system address command must be resent. When communication is completed with a specific system, send the address command with system number 255 ("AD,FF") to end the communication link.

### 2.9.4.1 Set Baud Rate

The baud rate can be set from 110 to 9600 baud for RS-232 port B. To set the baud rate press 4 and # from the Special Functions Menu.

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The message is:

LCD108:

MODEM BAUD RATE NOW ????  
ENTER \* FOR NEXT RATE, # WHEN CORRECT

If the displayed rate (???) is correct, press #. If not, press \* for a different rate until the proper rate is displayed. Then press # and the PAL-AT will return to the Special Function Menu.

### 2.9.4.2 Set System Identification

Each PAL-AT must have a unique identification number, or address, from 1 to 254. To set the identification number, press 5 and # from the Special Function Menu.

The display is:

LCD109:

ENTER SYSTEM ID (1-254): ???  
\* TO CLEAR, # TO ACCEPT ENTRY

Enter a number from 1 to 254 (usually in sequence 1, 2, 3...) for the system and then press #.

### 2.9.4.3 Enter Phone Number

Refer to the "PALCOM Communications Software Operating Manual" for details of this function.

### 2.9.5 Display Cable Data

PAL-AT has a feature to display the data points that are compared to the "map" during monitoring. This is intended to be used as a diagnostic tool if PALCOM software is not available, especially during the initial start-up. If you suspect the cable may be wet during the initial setup because PAL-AT says the system length is much longer than expected, you can view the data. A graph of the data for a typical system with a single wet area of cable looks like Figure 2.9.5A

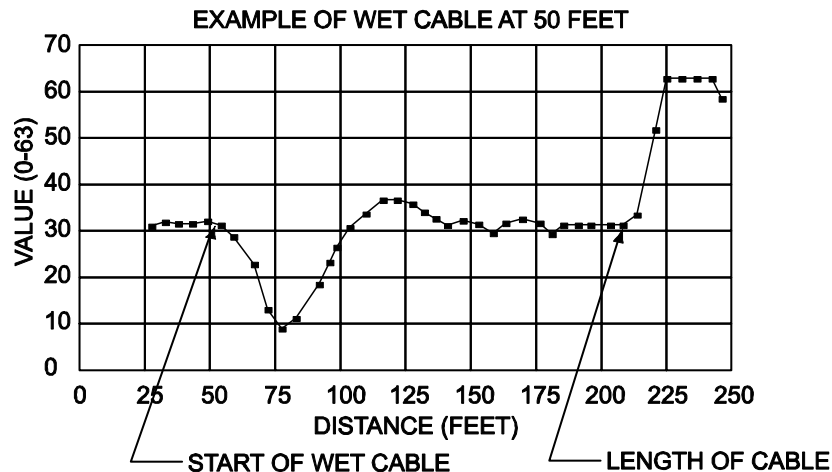


Figure 2.9.5A

A normal dry cable has values between 25 and 35. The dry section of cable data may be a straight horizontal baseline or vary  $\pm 3$  to 4 points vertically as shown. The start of a typical wet area has values drop toward 0 as shown at 50 feet. Following the leak area there is a rise in the values, as shown at 110 feet. This is a typical leak signature. The rise up to a value of 63 at 210 feet is a typical end of cable (or break) signature.

There is wide variation in the values depending on how much cable is wet, length of cable, the types of

cable being used, if probes are installed, etc. For example, a larger leak will go down to 0 at 50 feet, rise to 63 at 110 feet drop back down to 32 and finally rise to 63 at the end. The important point is the leak typically starts where the values start dropping quickly to 20 or less. Contact PermAlert for additional information on data analysis. Select the display cable data function from the Special Function Menu by pressing 7 and #.

## 2.9.5.1 Multiple Cable System

If the system has multiple cable cards, the first message is:

LCD110:

**ENTER CABLE NUMBER (1-?), THEN # :  
FOR DIAGNOSTICS \* TO RETURN TO MENU**

Next PAL-AT will automatically verify the selected cable to get the current data of the cable.

## 2.9.5.2 Select Function

The display cable data function has 2 features that can be selected from the next menu.

LCD111:

**1 # LOW / HIGH LOCATIONS, 2 # DATA POINTS  
\* TO RETURN TO SPECIAL FUNCTION MENU**

## 2.9.5.3 Low / High Locations

This feature locates the areas where the data is below a low limit (wet cable or short) or above a high limit (bad connector or end of cable). This feature is useful in long cable systems (over 1000 feet). Feature 2, Data Points may be simpler for short systems. Select feature 1 by pressing 1 and then #.

LCD112:

**CABLE ?, ENTER LOW LIMIT (0-63), THEN #  
\* TO RETURN TO MENU**

Next enter a low limit and then #. A value of 10-15 may be used to find a typical leak. A value of 0 may be used to find only larger leaks.

The next display asks for a high limit. A value of 63 is usually found at the end of the cable or break. Also, a poorly installed "Gold" cable connector may have a value above 50. Enter the value and # at the following display.

LCD113:

**CABLE ?, ENTER HIGH LIMIT (0-63), THEN #  
\* TO RETURN TO MENU**

PAL-AT displays the following 2 messages showing where the data exceeds the low and high limits throughout the length of the cable. After all locations are displayed, PAL-AT will return to message LCD111.

LCD114:

**UNDER LOW LIMIT OF ?? AT ???? TO ????  
\* TO RETURN TO MENU # FOR NEXT**

LCD115:

**OVER HIGH LIMIT OF ?? AT ???? TO ????  
\* TO RETURN TO MENU # FOR NEXT**

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### 2.9.5.4 Data Points

The Data Points feature displays each data point from the selected starting distance. The starting distance may be a trouble area located with Low / High Locations. When 2 # is entered at display LCD111, the following message is displayed:

LCD116:

<b>CABLE ?, ENTER STARTING DISTANCE, THEN # * TO RETURN TO MENU</b>
---

Any non-zero distance may be entered and then #. The following display shows typical data for a cable 180 feet long.

LCD117:

<b>161 166 170 175 179 184 189 194 199</b>
<b>33 33 33 33 36 61 63 63 33</b>

The top row displays distance, in feet or meters, and the second line has a value for that location. Enter # to display the next set of data or enter 9 to get the preceding length of cable. The "\*" key can be pressed to return to the menu at any time.

## **3 Response to Alarms**

### **3.1 Decisions**

There are several alarm conditions: Leak, drying, short, break, probe activate/reset and fault. In addition, location information is given. PAL-AT tells you about changes in the system from the baseline established when you made the reference map. It requires an intelligent decision by you to decide if the alarm condition is a serious problem or an acceptable deviation from the baseline.

#### **3.1.1 Locations**

PAL-AT sensor locations fall into two broad categories: Accessible locations and inaccessible location. Accessible locations are areas monitored because the facility personnel do not often visit them. Inaccessible areas are areas monitored because they are too expensive, too difficult or remote for regular inspection.

Computer room subfloors and pipe tunnels are good examples of accessible locations. The simplest course of action for accessible locations is to check the location. Checking the location means seeing the sensor at the location, not just being in the vicinity. Repair the problem in these cases.

Secondary contained piping is an example of an inaccessible location. PAL-AT can be used as a tool to gather data about the conditions in these areas. The type of sensor in the leak area is important. All sensor cables change electrical properties as the fluid covers more of the sensor. Leaks are characterized by a constantly increasing amount of wet sensor. The installed sensor cables allow PAL-AT to provide information about how serious a leak is in inaccessible spaces. Probe sensors do not change properties as more liquid covers the sensor. Instead, they act as a switch, either wet or dry.

### **3.2 Alarm Conditions**

#### **3.2.1 Fault**

Fault is displayed only if the alarm condition occurs in the first 50 feet of the sensor string. Since the first 50 feet of sensor string is always jumper cable, there is no leak sensing capabilities in the first 50 feet.

The common causes of the "FAULT" condition are a loose connection of the jumper cable to the PAL-AT, an improperly soldered connector, damage to the cable or the jumper cable is less than 50 feet long. First, make sure the connectors are properly installed and tightened. If there is damaged cable, replace it with the same length and type of cable.

#### **3.2.2 Break Alarm**

When PAL-AT enters break alarm mode, either there is serious damage to the sensor string or a connector is improperly installed. The break message shows the distance to the break, so it can be located on the system drawing.

#### **3.2.3 Leak Alarm**

Once PAL-AT locates a leak, the key is to decide if there is a true leak or a puddle in an inaccessible location. Leaks get larger, puddles do not. A puddle may be condensation from moisture that entered the system during installation. A condensation puddle must be dried eventually to prevent damage to the pipe system. First, locate the system drawing that was made during installation. Low points and drainage slopes should be shown on the drawing. Compare the location of the leak on the PAL-AT display with the system drawing to find the physical location of the leak. Once the slope is determined, you are ready to analyze the data.

### **3.3 Leak Analysis**

Menu function 6, History, is used during the analysis to determine where a leak exists. Step through the history archive and record the appropriate data (time, distance and map number) for entries referring to a leak and new reference map. Also note the password of the individual who took the new reference

## 3 Response to Alarms

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maps. Do this for all entries that were made since the first alarm was recorded in the same general area as the present leak.

### 3.3.1 First Leak

The alarm message shows which map is used for monitoring. If this is the first leak in a particular area, you should take a new map and continue monitoring to see if there is another alarm. Again, a leak typically continues to change, but a condensation puddle does not. Repeat this process a second time if PAL-AT finds another leak. If it is already monitoring using map 5 (or 8 for AT20K, AT80K), then make a new map 5 (or 8).

### 3.3.2 Repeated Leaks

If a leak is found several successive times in the same general location, you have reasonable confidence that there is an actual leak and not just condensation. The first “leak” entry in the history, at the same general distance, shows the location where the leak is first detected. If the system slopes away from PAL-AT at the leak, the pattern of archive records should show a series of leaks at the same spot in the system. If the system slopes toward PAL-AT, the pattern should show the leaks getting closer. PAL-AT displays the distance to the closest point of the fluid in the sensor string.

If the alarms are mixed “leak” and “drying” then there is a wetting and drying cycle that could be due to several causes. For example, in buried piping systems it is probably a containment problem that is allowing ground water in intermittently. This could be related to weather or cycles in the ground water level.

Try to isolate the cause of the alarm. An air test of the secondary containment or a pressure test of the product pipe helps determine if the containment is intact or if the product pipe is leaking.

## 4 Recommended Inspection

### 4.1 Alarm Test

Every six months or more frequently, depending on the application, test PAL-AT to insure that the alarm circuitry is functioning properly. The simplest method is to disconnect the sensor cable. PAL-AT should show a fault in the cable and activate the alarm. Reconnect the cable and the alarm resets after several seconds. Repeat this process for each cable for an AT20K, AT40K, or AT80K.

### 4.2 Cable Test

If AGW-Gold sensor cable is accessible and can be dried easily, wet a short length of cable to activate an alarm. The cable should be dried after the test.

### 4.3 Processor Card and Battery Test

There are 2 different series of processor cards. They can be identified by their serial numbers according to the following table.

Serial Number	Revision Designation	PAL-AT System	Figure
78-XXXXXXX	F,G	AT20C	4.3A
79-XXXXXXX	F,G	AT50C/AT40K	4.3A
7A-XXXXXXX	F,G	AT20K/AT80K	4.3A
7B-XXXXXXX	H	AT20C	4.3B
7C-XXXXXXX	H	AT50C/AT40K	4.3B
7D-XXXXXXX	H	AT20K/AT80K	4.3B

A ribbon cable connects to a connector on the processor card to power the front panel green LED, red LED and 12V audible alarm (optional). In this configuration, the alarm relay dry contacts can be used for control at the user's option without interfering with the 12VDC audible alarm.

The green LED will flash slowly whenever the system is not monitoring. In monitoring mode, it will be on continuously, after the initial 3 sweeps of the cable. The red LED is illuminated whenever any cable is in alarm, whether the alarm has been silenced or not.

There are also 2 "Language Select" jumpers to select the language version for PAL-AT. There are 4 positions for the 2 jumpers as shown in the following table.

Left Jumper Position	Right Jumper Position	Language/Units
1 - 2 Left Pins	4 - 2 Right Pins	English / Feet
2 - 2 <sup>nd</sup> & 3 <sup>rd</sup> Pins From Left	4 - 2 Right Pins	English / Meters
1 - 2 Left Pins	3 - 2 <sup>nd</sup> & 3 <sup>rd</sup> Pins From Right	German / Meters
2 - 2 <sup>nd</sup> & 3 <sup>rd</sup> Pins From Left	3 - 2 <sup>nd</sup> & 3 <sup>rd</sup> Pins From Right	Spanish / Meters

PAL-AT requires no maintenance other than replacing the battery for the clock. The battery runs the clock up to one (1) year when the power fails. To check the condition of the battery on the processor card, turn off the power to the PAL-AT for at least 60 seconds. Turn the power back on and check the clock. If it has re-set to 0000:00 01/01/00 then the battery should be replaced. Processor card revisions G or H do not have a replaceable battery. If the clock resets after a power loss, send the card to PermAlert for repair. It is the user's responsibility to contact PermAlert ESP for instructions to return the processor card for battery replacement.

## 4 Recommended Inspection

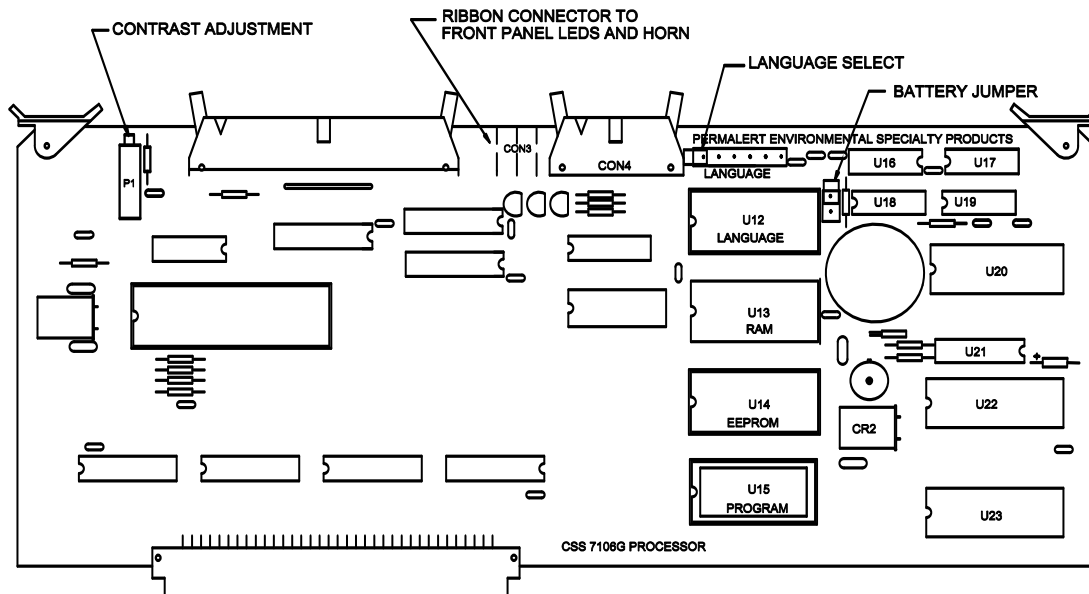


Figure 4.3A: Processor Card Details, Revision G

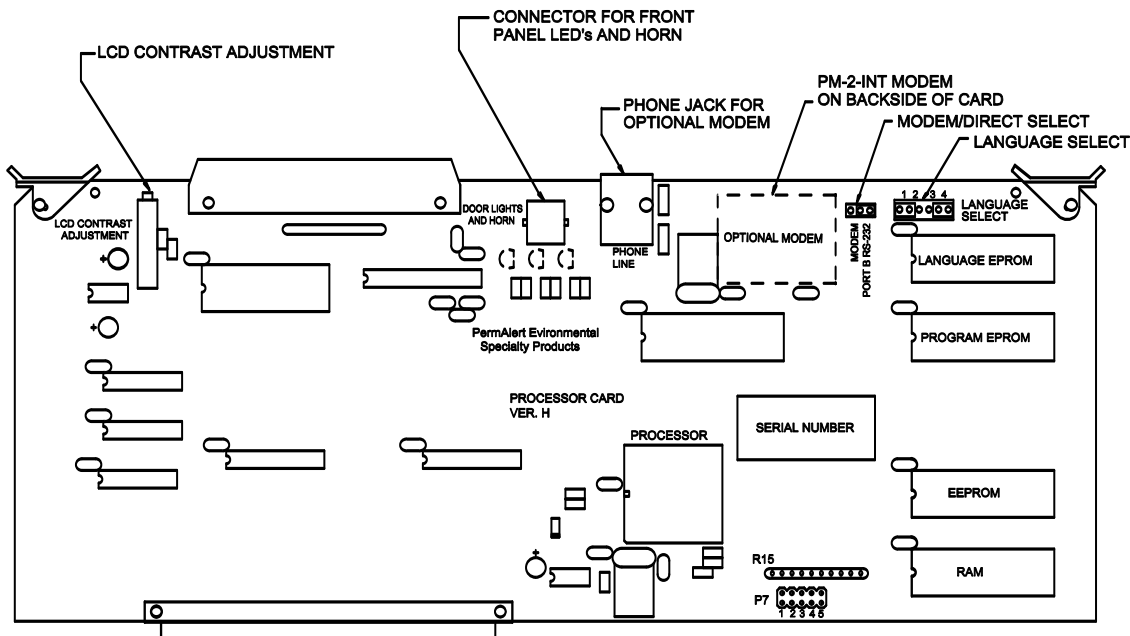


Figure 4.3B: Processor Card Details, Revision H

### 4.3.1 Optional Internal Modem

An optional internal modem is available for the version H processor card (see Figure 4.3B). The modem is usually factory installed but can be installed in the field. First turn off the PAL-AT and remove the processor card. The modem plugs into 2 terminal strips on the back of the card. The pins are keyed and only fit one way. Next move the "Modem/Direct Select" jumper to the left 2 pins or "Modem" position. This redirects the RS-232 B port to the modem instead of to the terminal strip on the motherboard. Reinstall the processor card and install the analog phone line plug into the jack at the top of the card. Refer to the "PALCOM Communications Software Operating Manual" for additional information about PALCOM.

## 5 Installation & Troubleshooting

### 5.1 Initial Power-Up Checks

Observe the following procedures during the installation of a PAL-AT system.

**MAKE SURE ALL CARDS ARE SEATED PROPERLY AND ALL WIRES TO THE TERMINAL STRIPS ARE SECURELY FASTENED BEFORE APPLYING POWER.**

If the cable card is not seated properly, inspect the coaxial cable connector on the cable card(s) and the mating connector on the motherboard. Make sure the center pin of the connector is straight and centered in the socket.

If the cable card does not slide in easily, carefully apply gentle sideways pressure on the card until the connector is lined up properly and then insert the card.

### 5.2 Cable Connector Tests

The following tests should be performed on each length of cable after both connectors are installed. Figure 5.2A illustrates the tests. Any overbraid or outer jacket is not shown. Install the connectors according to the instructions in the "PAL-AT Installation Manual".

#### Insulation Test

The insulation test checks for a short between the center conductor and outer braid shield.

1. Remove the jumper wire used in the continuity test, as shown in Figure 18 and connect one ohmmeter test lead to the connector's center contact and the other lead to the connector body.
2. A good cable will give a full-scale reading (at least 10 megohms). Test readings below full scale indicate damaged cable or an improperly installed connector. If you cannot resolve the problem, contact PermAlert's Field Service Department for assistance.

#### Continuity Test

The continuity test checks for broken cable, open connectors, and poor solder connections.

1. Connect a short jumper wire with alligator clips between the UHF connector's center contact and the body of the connector at one end of the cable, as shown in Figure 18.  
**Note: Do not clip onto the threaded coupling ring because it is not tightly secured and will give intermittent readings.**
2. Connect the ohmmeter's test leads to the connector's center contact and connector body on the other end of the cable.
3. The ohmmeter reading should be less than 10 ohms/1000' of cable. If it is not, check the jumper wire, test lead connections, and repeat the test. If the problem persists, contact the PermAlert Field Service Department for assistance.

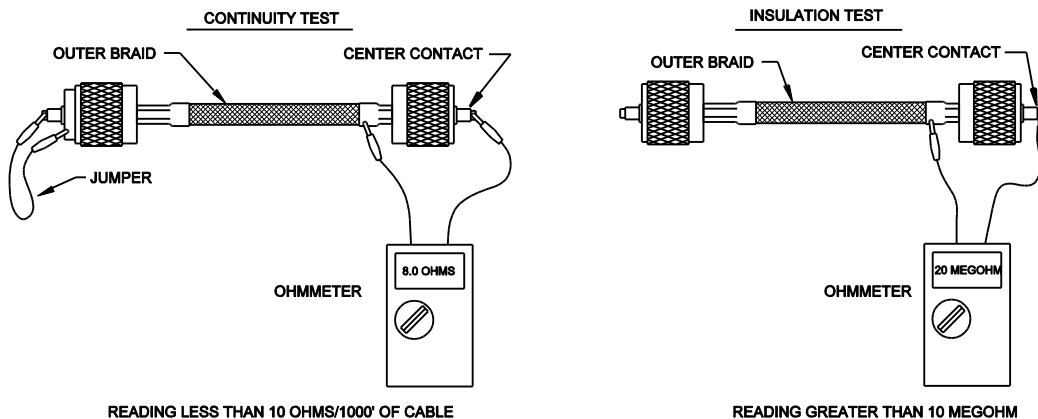


Figure 5.2A: Cable Tests

## 5 Installation and Troubleshooting

### 5.3 Cable Card Sensitivity Adjustment

Cable cards can be identified by the serial number printed on a label on the card and the revision number printed on the board. There are 6 diagnostic LED's along the top edge of the card to aid in troubleshooting (refer to Figure 5.3A).

The LEDs indicate:

<u>LED</u>	<u>Status</u>
Red - (Alarm)	On if cable is in alarm
Green - (Scan)	On when cable is scanned
Green - (-5)	
Green - (+5)	On when respective voltage is on
Green - (+24)	
Red - (Drive Pulse)	On if no signal received from pulse card or pulse card improperly installed

The operating mode of the cable relay for each card is controlled by a jumper on the card (see Section 2.9.1). The system is shipped with the jumper in the "NC" position. This means the cable relay is normally energized and the "C" and "NC" contacts will close in the event of an alarm or relay failure. To change the configuration to "NO", simply move the jumper to the 2 right most pins of the 3-pin jumper header.

There is a sensitivity adjustment on the cable card that can be set for high, medium or low sensitivity (see Figure 5.3A). The sensitivity is normally set to M (medium) for water-based liquid detection and H (high) for hydrocarbon detection to meet or exceed the values published on the "Product Data Sheet for PAL-AT Sensor Cable Options". **If the sensor cable is monitoring for hydrocarbons, PAL-AT should always be set on high sensitivity.** A lower sensitivity requires more wet cable to activate an alarm. **The risk of damage to the environment and equipment in the monitored area should be considered before selecting a lower sensitivity.** Changing from high to medium sensitivity approximately doubles the amount of wet cable needed for an alarm. Changing from medium to low sensitivity doubles the amount again. The sensitivity header has 5 pins, with the left pin number 1. To change the sensitivity for a specific application, install the jumper on pins 1-2 for high sensitivity, pins 2-3 for medium, and 4-5 for low.

If the sensitivity is changed a new reference map must be taken. Refer to Section 2.5.4 to set a system for a new map 1.

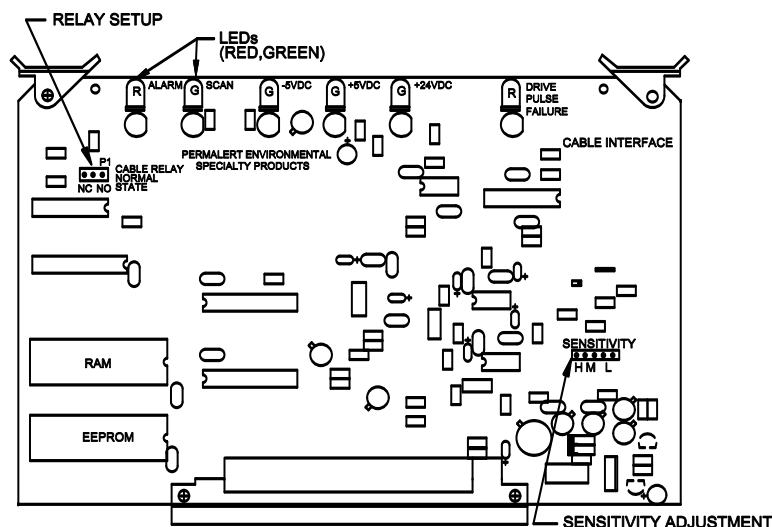


Figure 5.3A: Cable Card

## 5.4 Cable Card Connector Tests

PAL-AT has an Intrinsically Safe Cable Card Connector Assembly that connects the cable interface card to the sensor string (see Figure 5.4A). If the fuse in the assembly fails, PAL-AT gives the message "NO END FOUND" or "FAULT IN FIRST 50 FEET". A shorted BNC connector or coaxial connector on the motherboard also gives these messages.

There are several checks to help isolate the problem. Turn the power off and disconnect the jumper cable. Check the resistance from the center pin of the BNC cable connector to the base of the connector. It should be 50-60 ohms with the cable card installed. If the reading is outside this range, replace the cable card connector assembly. *A special tool is needed to remove the coaxial connector from the motherboard (Part# 8068400). Contact PermAlert ESP Field Service for details.*

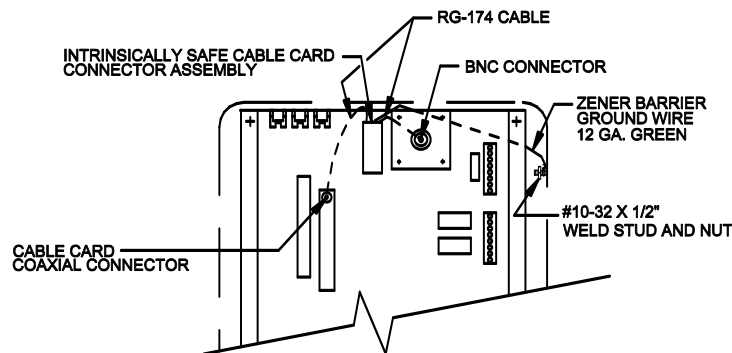


Figure 5.4A Cable Card Connector Assembly

## 5.5 Cable Expansion Module

Additional cables can be monitored by an AT20K, AT40K or AT80K with the installation of Cable Expansion Modules. Each module can monitor 1 cable and includes: (1) an intrinsically safe cable card connector assembly, (2) a cable interface card, and (3) a BNC/UHF adapter for connection to the jumper cable connector.

To install a Cable Expansion Module, first turn off the AC power and carefully remove the motherboard and white mounting plate from the enclosure. **Do not support the board on the BNC cable receptacles that extend through the mounting plate.**

The cable card connector assembly has a BNC connector on one end and a cable card coaxial connector on the other (see Figure 5.4A). Refer to Figure 2.1.3A or 2.1.3C to locate the BNC connector in the correct cable receptacle mounting hole. Next, slide the cable card coaxial connector into the correct cable card socket on the motherboard. **Caution: a special tool is required to remove a cable connector from the socket.** The connector should snap firmly into place. The green ground wire from the cable card connector assembly must be connected to the green ground screw. Carefully reinstall the motherboard making sure the wires are not pinched.

If one of the original cable cards is monitoring a cable, it may go into alarm when the number of cable cards is changed. If this happens, take a new reference map 1 (see Section 2.5.4).

## 5.6 FCC

The user is cautioned that any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This

## 5 Installation and Troubleshooting

equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

### 5.7 U.L., C-U.L. & FMRC

The PAL-AT monitoring system is listed by Underwriter's Laboratories, Inc. and approved by Factory Mutual Research Company. PAL-AT provides intrinsically safe output circuits of sensor cables and probes for use in Class 1, Division 1, Groups C and D locations. The PAL-AT can be supplied with a C-UL listing mark for Canadian applications.

### 5.8 Troubleshooting Guide

The following guide lists the most-frequently encountered problems. If you are unable to resolve a problem, contact PermaAlert ESP Field Technical Assistance at, 847-966-2190 or e-mail at, [service@permalert.com](mailto:service@permalert.com).

SYMPTOM	POSSIBLE PROBLEM	ACTION
NO LCD - screen blank	No power to the PAL-AT.  Ribbon cable is connected wrong to LCD  Contrast is adjusted incorrectly on the processor card.  LCD is defective	Connect power to PAL-AT.  Check that all cards are properly seated.  Turn on the power switch.  Check the 120/240 VAC at the input terminal strip.  Check the green LED on the door. If it is on, the power supply is operating. If not, check that the 6-pin output connector of the power supply is secure.  Check for +12 VDC on the terminal strip. If the +12 V is not found, the power supply is defective.  Turn off the power to the PAL-AT. Reconnect the ribbon cable. The edge of the ribbon next to the contrast adjustment on the processor card goes to the bottom edge of the connector on the LCD.  Adjust the contrast (see Figure 4.3A or 4.3B).  Replace the LCD.
LCD DISTORTED - top row dark blocks, bottom row blank.	Firmware EPROM is installed incorrectly.	Replace program EPROM on the processor card (see Figure 4.3A or 4.3B). The notched end of the EPROM should be to the left.
PARTIAL LCD OPERATION 1/2 line	The resistor pack on the back of the LCD near the connector is cracked because the cards were not fully seated when the door was closed.	Replace the LCD.

<b>SYMPTOM</b>	<b>POSSIBLE PROBLEM</b>	<b>ACTION</b>
NO END FOUND	Jumper cable is disconnected at the BNC connector.	Check that the center pin of the BNC is fully seated.
FAULT IN 1 <sup>st</sup> 50 FEET	Connector in the first 50 feet of the system is faulty. Bent/broken pin in the cable card connector assembly. Fuse is blown in the cable connector assembly.	Perform insulation and continuity tests (see Section 5.2). Replace the cable card connector (a special tool is needed) Test cable card connector assembly (see Section 5.4).
NO INTERFACE CARD INSTALLED	Cable or pulse card not seated properly in the motherboard.	Turn off the power and reset all cards.
BASELINE = 0 or not 25 to 35	A/D module on the cable card is not installed properly. Pulse card is defective.	Check that module #3 is properly inserted in the socket and no pins are bent (see Figure 5.3A). Replace the pulse card.
DATE and TIME PROBLEMS	Battery jumper not installed Battery lost charge during power failure	Install jumper on 2 pins on processor card (see Figure 4.3A). Replace processor card (replace battery) (see Section 4.3).
NO COMMUNICATION - PALCOM cannot communicate with PAL-AT.	Baud rate of PAL-AT does not match PALCOM rate. Loose wire on RS-232 connection or leads reversed. PAL-AT address set to wrong number.	Change baud rate with Special Function Menu item 4. Redo connection: pins 2, 3 and 7. Change address with Special Function Menu item 5.

## 5.9 Restrictions & Limitations

For proper operation of the PAL-AT Leak Detection and Location system the following restrictions and limitations apply.

### 5.9.1 Alarm Panels

1. The PAL-AT panel is designed to be located inside a temperature-controlled building. For outdoor locations is must be mounted inside either a NEMA 3R (ventilated) or NEMA 4X (non-ventilated) enclosure.
2. Outdoor enclosures must be shielded from direct sunlight, and the inside temperature must be regulated to maintain temperature specifications of the PAL-AT. A fan is required to circulate air inside the outer enclosure if the ambient temperature can reach 120°F. In high temperature applications, the power save delay should be at least one minute (see Section 2.9.3.5).

## **5 Installation and Troubleshooting**

### **5.9.2 Sensor Cables**

1. Sensor cables and jumper cables should not be installed in locations that are subject to frequent moisture intrusion or wetness. The only exceptions are JMP-U and JPP jumper cable and TFH sensor cable.
2. Electrical conduit for jumper cables must be sealed against moisture intrusion.
3. **Cable connectors should be located in accessible areas.** They must be electrically tested for integrity and then encapsulated with shrink tubing and sealant.

**The ability of the PAL-AT to sense and locate leaks can be affected by the following occurrences:**

1. An improperly installed connector can limit the ability of the system to see beyond this point. Pinching or cutting the cable can have the same effect.
2. Contamination such as dirt or mud filling a portion of the cable may make it insensitive to leaks in this portion.
3. A large amount of wet cable may decrease the sensitivity and accuracy of the system beyond the wet area. Several probes that are activated simultaneously will have the same effect.
4. While the cables are made of durable and corrosion resistant materials, caution must be exercised in cable handling to avoid excessive abrasion or damage. This damage may have a detrimental effect on the operation of the system. *Pulling the cable around sharp edges, or pulling cable through secondary contained piping that has not been properly designed to accept leak detection cables may cause abrasion to the cable.*

**The following precautions must be observed for TFH hydrocarbon cables.**

1. The maximum burial depth is 20 feet.
2. The cable must be air dried after exposure to gasoline and other highly volatile hydrocarbons. The cable must be completely dried or ground water can enter the cable jacket.
3. The cable cannot be reused after exposure to jet fuel, motor oil, diesel fuel or other non-volatile hydrocarbons.
4. Soap or detergent must not be used to clean the cable. Contact of the jacket with soap will allow water into the cable.
5. Refer to Section 5 "Installation of Direct Buried Sensor Cables" in the "PAL-AT Installation Manual" for more details.

### **5.9.3 Probes**

1. The maximum number of probes that can be connected to the PAL-AT is normally 10 for each cable card. Consult PermAlert for exceptions to this limit.
2. The operating temperature range of the PHL probe is 0°F to 90°F. All other probes have a range of 0°F to 180°F.
3. The PHL probe is resettable after exposure to gasoline, solvents and highly volatile hydrocarbons. It will not reset after exposure to diesel fuel or heavy oils.
4. The PHLR probe is resettable after exposure to all fuels, including non-volatile diesel and jet fuel and is recommended for those applications. The sensor elements can be cleaned and reused or replaced.
5. The PHLR-P probe is designed for pressurized containment applications. The vent hole on the probe must not be submerged in any liquid when the containment is being pressurized or the probe may be damaged.

## **6 Output Relay System**

The PAL-AT Output Relay System consists of an electronic microprocessor-based interface and control panel that monitors a PAL-AT Leak Detection/Location System and controls from 4 to 60, 10-amp 250-volt rated relays. The output relays are available in groups of 4. There are four PAL-AT Output Relay System components available:

<b>Model</b>	<b>Description</b>
AT-ORC	Output Relay Controller Panel with 1 Relay Module (expandable to 2)
AT-RM	Relay Module with 4 relays
AT-ORx1	Output Relay Panel with 1 Relay Module
AT-ORx4	Output Relay Panel with 1 Relay Module (expandable to 4)

### **6.1 Installation of Output Relay System**

1. The standard AT-ORC Output Relay Controller Panel must be permanently mounted within 25 feet of the PALAT Leak Detection/Location Panel.
2. The optional AT-ORx1/AT-ORx4 Output Relay Panel(s) must be permanently mounted adjacent to the AT-ORC Output Relay Controller Panel or other Output Relay Panels. The maximum distance between panels is 2 feet.
3. All panels must be located in an area with an ambient temperature of not less than 0°F and not exceeding 120°F. If a panel is located outside, watertight conduit fittings and associated hardware must be used in order to keep the NEMA 4X rating of the enclosure. The enclosure must not be located in direct sunlight to prevent excessive heat buildup.
4. Connect the AT-ORC to an isolated (circuit breaker protected) 120/240 VAC 50/60 Hz circuit (see Figure 6.1A).
5. Each AT-ORx4/AT-ORx1 Output Relay Panel includes a 48" power cable. The power cable should be connected between the connector on the +5VDC pigtail on the main controller board and connector on the "Y" pigtail on the AT-RM in the first AT-ORx4/AT-ORx1 panel (see Figures 6.1A, 6.1B and 6.1C). If more than 1 AT-ORx4/ AT-ORx1 is installed, the power cable is installed from the "Y" of the first panel to the "Y" of the next one, etc.
6. Each AT-ORx4 Output Relay Panel also includes 4 ribbon cables. All ribbons will only be used if 4 AT-RMs are installed (save extra ribbons for later expansion in the panels). There are two #1 ribbons that are each 2" long and connect plug P2 to plug P3 on adjacent AT-RMs. A 10" ribbon, ribbon #2, is used inside the panel to connect P2 and P3 as shown. The 36" ribbon, ribbon #3, runs from P4 on the AT-ORC to P2 on the first Output Relay Module in the first AT-ORx1/AT-ORx4. If additional AT-ORx1/AT-ORx4 Output Relay Panels are installed, the 36" ribbon connects from P3 on the previous panel to P2 on the first AT-RM in the present panel (see Figures 6.1A, 6.1B and 6.1C).
7. Each AT-ORx1 Output Relay Panel includes a 36" ribbon. It runs from P3 on the previous panel to P2 on the AT-RM in the present panel.
8. Three additional AT-RM Relay Modules may be added to each AT-ORx4 panel. 4 plastic mounting standoffs are installed in the AT-ORx4 for each module. Carefully align the holes in the module with the standoffs and press the AT-RM into position. Then connect the ribbon cables as described above.
9. It is recommended that all external wiring be run in conduit.

## 6 Output Relay System

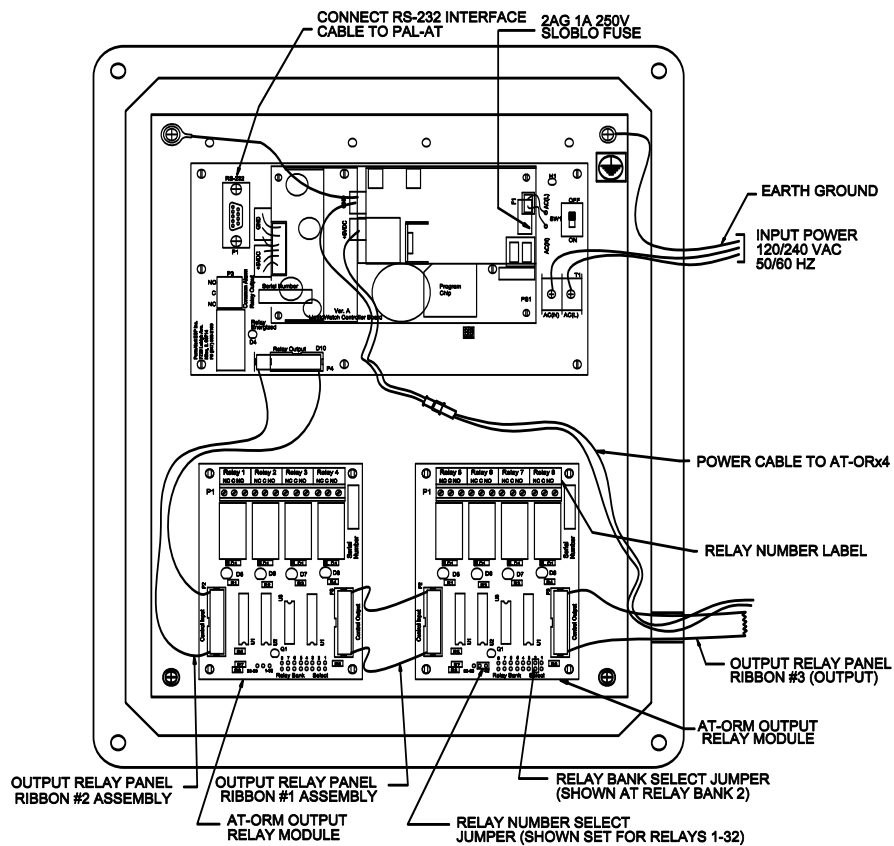


Figure 6.1A - AT-ORC Output Relay Controller Wiring Diagram

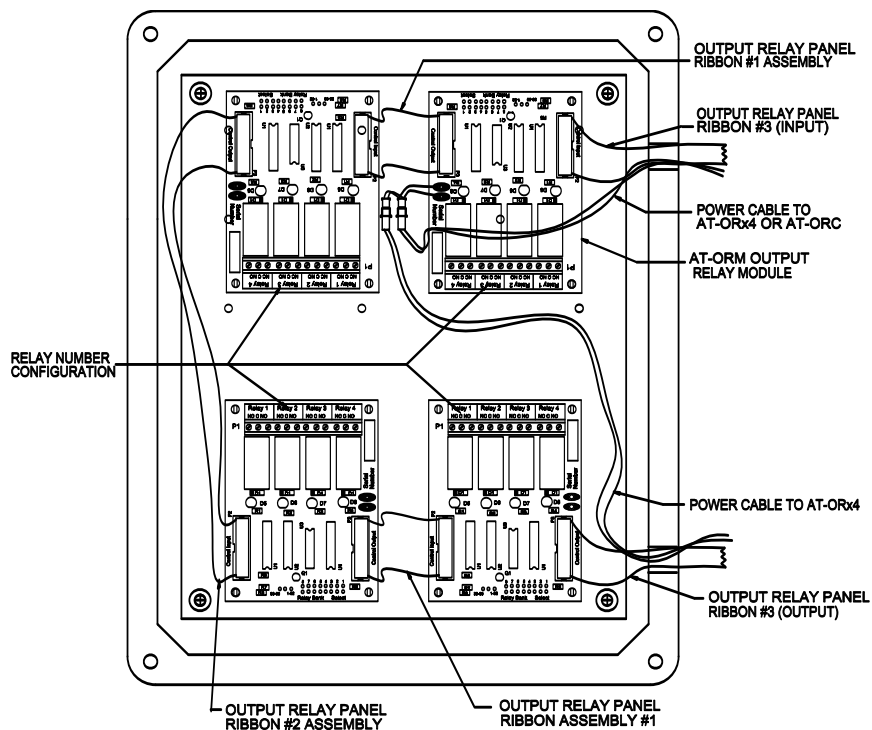


Figure 6.1B - AT-ORx4 Output Relay Panel Wiring Diagram

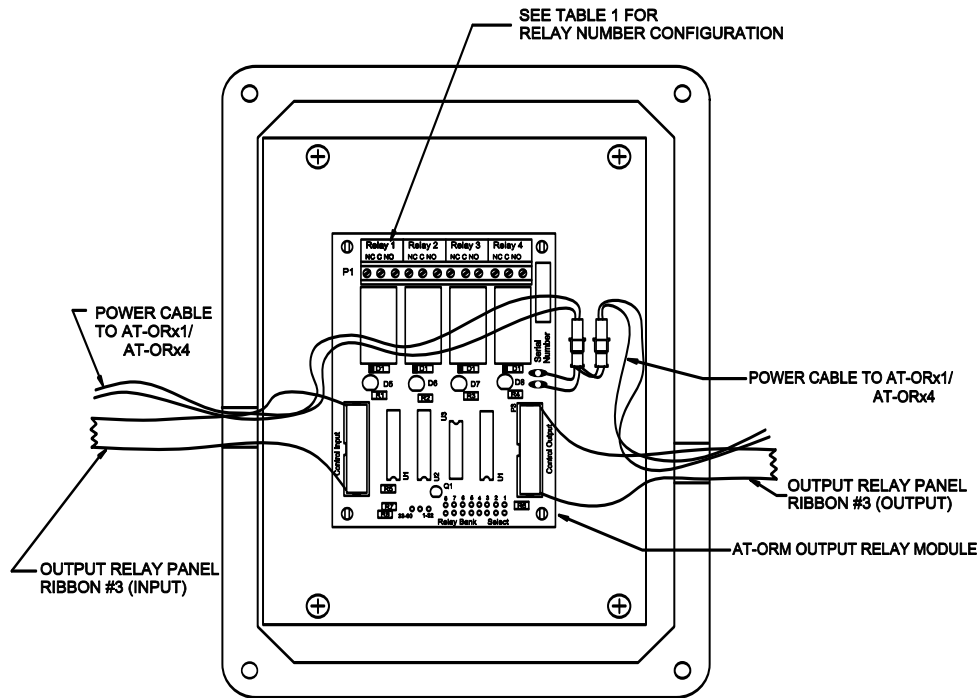


Figure 6.1C: AT-ORx1 Output Relay Panel Wiring Diagram

## 6.2 Relay Module Configuration

Each added AT-RM relay module must be configured before operating the system. Two jumpers are set to select the numbers assigned to the 4 relays (1-4, 5-8, etc.). Refer to Figure 6.1A and locate the jumpers in the lower right corner. The 60 relays are organized in 15 banks of 4. The first AT-RM is set to bank 1 and addresses relays 1 to 4. The Relay Number Select Jumper sets the module to address relays from 1-32 or 33-60. The Relay Bank Select Jumper selects which group of 4 numbers to assign (5-8, 9-12, etc.). Labels are supplied to renumber the relays. They are applied over the relay label that is printed on the Relay Module circuit board (see Figures 6.1A, 6.1B or 6.1C). Refer to Table 6.1 for jumper settings.

## 6 Output Relay System

Jumper Setting vs. Relay Number Assignment					
33-60 / 1-32	Relay Bank Select	Relay Number Assignment			
1-32	2	Relay 5	Relay 6	Relay 7	Relay 8
1-32	3	Relay 9	Relay 10	Relay 11	Relay 12
1-32	4	Relay 13	Relay 14	Relay 15	Relay 16
1-32	5	Relay 17	Relay 18	Relay 19	Relay 20
1-32	6	Relay 21	Relay 22	Relay 23	Relay 24
1-32	7	Relay 25	Relay 26	Relay 27	Relay 28
1-32	8	Relay 29	Relay 30	Relay 31	Relay 32
33-60	1	Relay 33	Relay 34	Relay 35	Relay 36
33-60	2	Relay 37	Relay 38	Relay 39	Relay 40
33-60	3	Relay 41	Relay 42	Relay 43	Relay 44
33-60	4	Relay 45	Relay 46	Relay 47	Relay 48
33-60	5	Relay 49	Relay 50	Relay 51	Relay 52
33-60	6	Relay 53	Relay 54	Relay 55	Relay 56
33-60	7	Relay 57	Relay 58	Relay 59	Relay 60

Table 6.1

### 6.3 Internal Diagnostic Indicators

The AT-ORC Output Relay Controller has a yellow LED (D4), which indicates, when lit, that the common alarm relay is energized and communication has been established with the PAL-AT Leak Detection/Location Panel. If communication is lost, the relay will deenergize. Each control relay on an AT-RM also has a yellow LED that indicates the relay is energized.

### 6.4 Control Relays

When PAL-AT detects a leak or probe activation in a section of sensing cable that has a control relay assigned, it will communicate to the AT-ORC Output Relay Controller which switches the SPDT output relay rated for 250VAC, 10A. **The AT-ORC Output Relay System is shipped with the relays configured to operate in a normally energized mode, so they de-energize in the alarm state.** The assigned control relay remains switched until the leak or probe activation is cleared or a new reference map is taken and PALAT is monitoring the cable again.

## 6.5 RS-232 Port Interface Cable Installation

The AT-ORC Output Relay Controller is provided with an RS-232 communications port and an interface cable. The 9 pin male D connector on the interface cable connects to the Output Relay Controller RS-232 port (see Figure 6.1A). The other end of the cable connects to the terminal strip in the PAL-AT as follows:

<u>Wire Color</u>	<u>PAL-AT Terminal</u>
Red	RA
White	TA
Black	G

## 6.6 PAL-AT Control of Output Relay System

When the PAL-AT Leak Detection/Location system detects a leak or probe activation in a section of sensing cable and that section has a control relay assigned to it, the PAL-AT communicates to the AT-ORC Output Relay Controller and switches the SPDT output relay. The assigned control relay remains switched until the leak or probe activation is cleared or a new reference map is taken and the PAL-AT monitors the cable again.

### 6.6.1 Sensing Cable and Probe Requirements

If sequential sections of sensing cable will control different relays, then the ends of the sensing cables should be separated slightly from each other. This is required since there is a +/- 5 feet tolerance in locating the leak. In this case, when assigning an output relay to a section of sensing cable, **both the start and end of the sensing cable should incorporate a 10-foot section of jumper cable (JMP-U) to isolate the section.** The two sections of JMP-U and the sensing cable will then be setup as one section of sensing cable during the PAL-AT setup process. Probes will not need extra jumper cable.

### 6.6.2 Assign Output Relays

Follow the setup procedure detailed in Section 2.1. If the PAL-AT detects that an AT-ORC Output Relay Controller is connected and powered, the setup function will include the following step. After the end is accepted for the section being setup, the PAL-AT displays:

LCD118:

**ENTER RELAY NUMBER FOR SECTION ??:  
\* TO REENTER, # TO ACCEPT**

Enter the number for the control relay that is assigned to the section that was just setup, and then press the # key to accept the entered relay number. If no control relay is assigned to the section being setup then just press #. After the # key is pressed, the PAL-AT will repeat message LCD07 for the next section until the end of setup is reached.

### 6.6.3 Display Output Relay Assignments

The control relay assignments can be viewed in the Display Setup Data function of the PAL-AT. Follow the display setup procedure detailed in Section 2.5. If the PAL-AT detects an AT-ORC Output Relay Controller is connected and powered, after the end is displayed for the last section, the PAL-AT displays the following or similar message:

LCD119:

**CABLE ? SET FOR AUTOMATIC MONITORING  
CRI ? \*FOR MENU, # TO CONTINUE**

## 6 Output Relay System

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When # is pressed, the relay data can be viewed for the first section:

LCD120:

**CABLE ?, SECTION ?? ACTIVATES RELAY ??  
\* FOR MENU, # FOR NEXT SECTION**

In a similar manner, the data for each section is displayed. The PAL-AT returns to the Main Menu after all sections are displayed. Enter \* at any time to return to the Main Menu.

### 6.6.4 Change Output Relay Assignments

At the message LCD119 above, if # is pressed and a password with level 250 or higher has been entered, the relay data can be changed and the next message is:

LCD121:

**CABLE ?, SECTION ?? ACTIVATES RELAY ??  
\* CHANGE DATA/MENU, # FOR NEXT SECTION**

Enter # to view the data as in the message above. To change the relay assignment, press \* and the next message is:

LCD122:

**CABLE ?, SECTION ?? ACTIVATES RELAY ??  
\* RETURN TO MENU, # CHANGE RELAY NUMBER**

Enter # and the next message is:

LCD123:

**CABLE ?, SECTION ?? ACTIVATES RELAY ??  
ENTER NEW RELAY NUMBER, THEN #**

Enter a relay number from 1 to 60, depending on how many relay are installed, and then #. Continue to the next relay.

## 7 PAL-AT Setup Record

DATE: \_\_\_\_\_

**MODEL #:** \_\_\_\_\_

**SERIAL #:** \_\_\_\_\_

**LOCATION:** \_\_\_\_\_

[illegible]

## 7 PAL-AT Setup Record

[illegible]

## **8 Warranty Registration**

The PAL-AT® warranty must be registered before the master password will be issued. The master password is required by PAL-AT before it will automatically monitor a system. Contact the PermAlert ESP Warranty Department at 847/966-2190 to register your warranty. The warranty personnel will require model number and serial number of the PAL-AT. The numbers are located on the inside of the cabinet door.

### **WARRANTY**

Seller warrants that the PAL-AT Leak Detection System (the "System") will be free from defects in materials and workmanship for a period of one year from the date of shipment by Seller to Buyer. Seller is not responsible for damage to the System occurring in transit or arising from the installation, alteration or repair of the System by persons other than Seller's employees, or from any abnormal or improper use of, negligence with respect to or accident affecting the System. Expendable service parts, such as probes, are not warranted by Seller. Seller's sole obligation and liability, and Buyer's sole remedy, under this warranty shall be the repair or replacement, at Seller's election, by Seller of any defective materials or workmanship covered by this warranty, without the charge to Buyer. Repaired or replacement materials shall be delivered to Buyer f.o.b. Seller's plant or f.o.b. such other location as Seller shall designate. Seller shall not be responsible for any product returned to Seller without Seller's prior express consent. No claim shall be permitted under the warranty contained in this Section unless Buyer notifies Seller in writing within ten (10) days after Buyer first hears of facts giving rise to any such claim and unless notice is given within the one year term of this warranty. In order to be valid, any notice sent to Seller in connection with said claim under this warranty must reasonably specify the defect which is the subject of such claim. Buyer shall be responsible for testing and inspecting the System promptly after receipt and thereafter at such intervals as are reasonably prudent so as to inform Seller of any defects which exist in the System. Notwithstanding the filing of a claim hereunder, this warranty shall expire after one year from the original date of shipment of the System in respect to materials and workmanship which are not then the subject of a proper claim.

To the maximum extent permitted by law, Buyer irrevocably waives all claims against Seller for money damages relating to the condition, use and performance of the goods sold pursuant hereto, including claims based upon tort, strict liability, negligence and product liability. Notwithstanding the provisions of the preceding sentence, if money damages are assessed against Seller, in no event shall Seller's liability for such damages exceed the purchase price of products sold by Seller.

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## Notes



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