PST3/PST8
PUMP AND SLUG TEST PACKAGE

REVISION: 3/94

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SECTION 1. HARDWARE

The PST is a complete datalogging system for pump and slug tests. The PST3 can measure up to 3 wells and the PST8 up to 8 wells. This manual consists of 2 major parts. The first part, consisting of Sections 1, 2, and 3, contains the basic information required to operate the PST. Section 3 is a prompt sheet to be carried into the field. It leads a user step by step through the procedure for running a test. The second major part, Sections 4 and 5, is a reference section containing more detailed information.

> **NOTE**: This is the ONLY manual you'll need if you use the PST for pump and slug tests. For other applications the CR10 and PC208 manuals will apply.

The PST is a complete system including both hardware and software. The heart of the system is the datalogger, the CR10 Measurement and Control Module (CR10).

The system is pre-wired, contains a rechargeable power supply and is mounted in a sealed case. The following pages depict and explain the PST hardware. Please review the following diagrams to familiarize yourself with the system.

Figure 1.1 shows a field setup with a "cutaway" view of the well with a pressure transducer installed. See Figure 1-3 for details on the pressure transducer installation.

The vent tube in the pressure transducer cable terminates in the DES1 junction where the air is dry and vented to atmosphere. Unvented cable continues to the circular connector on the PST case. Figure 1-2 shows case details while Figure 1-4 shows cabling options to bring 12 volts DC to the PST to back up or change the battery.

FIGURE 1-1. Field Setup

PRESSURE RELIEF VALVE. OPEN THE VALVE BY TURNING COUNTERCLOCKWISE TO EQUALIZE PRESSURE INSIDE AND OUTSIDE THE CASE. AFTER OPENING THE CASE, CLOSE THE VALVE BY ROTATING CLOCKWISE TO MAINTAIN A GOOD SEAL.

CONNECTOR FOR 12VDC POWER. SEE FIG 1-4

LATCHES FLIP UP FROM THE BOTTOM OF THE LATCH. (CAN BE USED TO "PRY UP" THE TOP HALF OF THE CASE IF SEALED.)

CONNECTOR FOR EXTERNAL CONNECTION OF THE CR10KD. (USING THE OPTIONAL KDCBL REMOTE CABLE).

GROUND LUG: ATTACH A 12GA COPPER WIRE FROM THIS LUG TO A GROUND ROD OR STEEL WELL CASING. (DO NOT USE A TRUCK OR CAR BODY)

CONNECTORS FOR THE PRESSURE TRANSDUCERS. ATTACHED CAPS ARE NUMBERED.

FIGURE 1-2. External Details of the PST Case
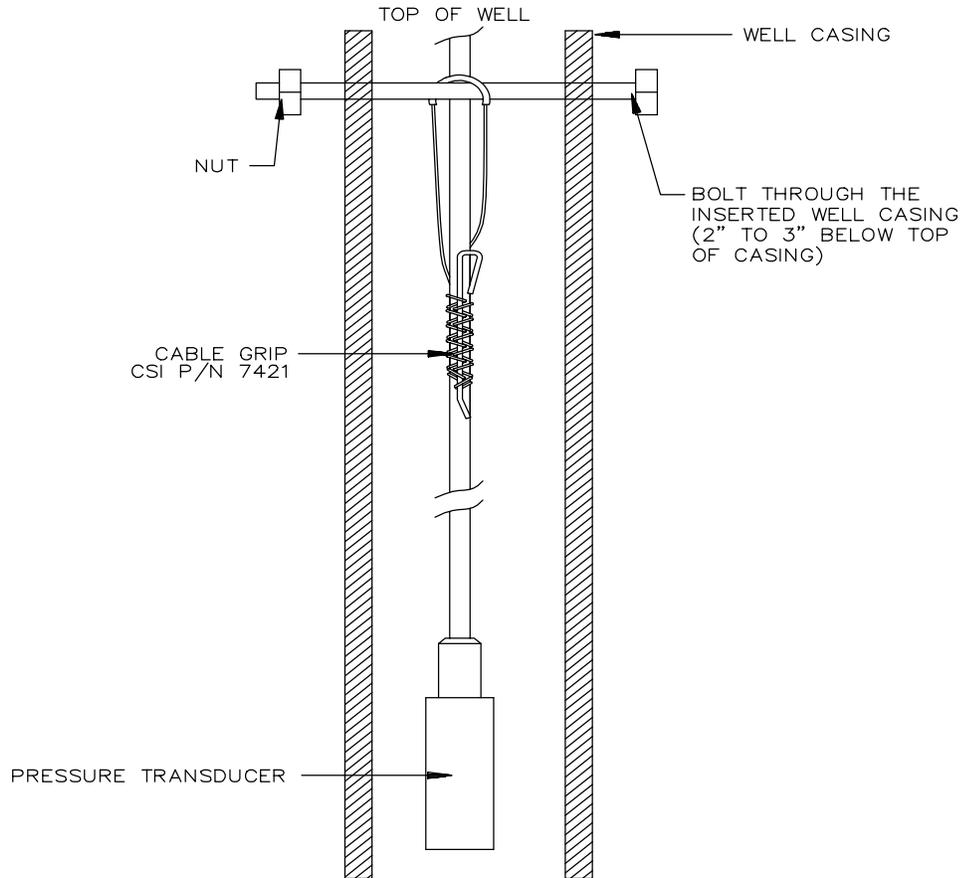
FIGURE 1-3. Using the Cable Grip to Mount the Transducer
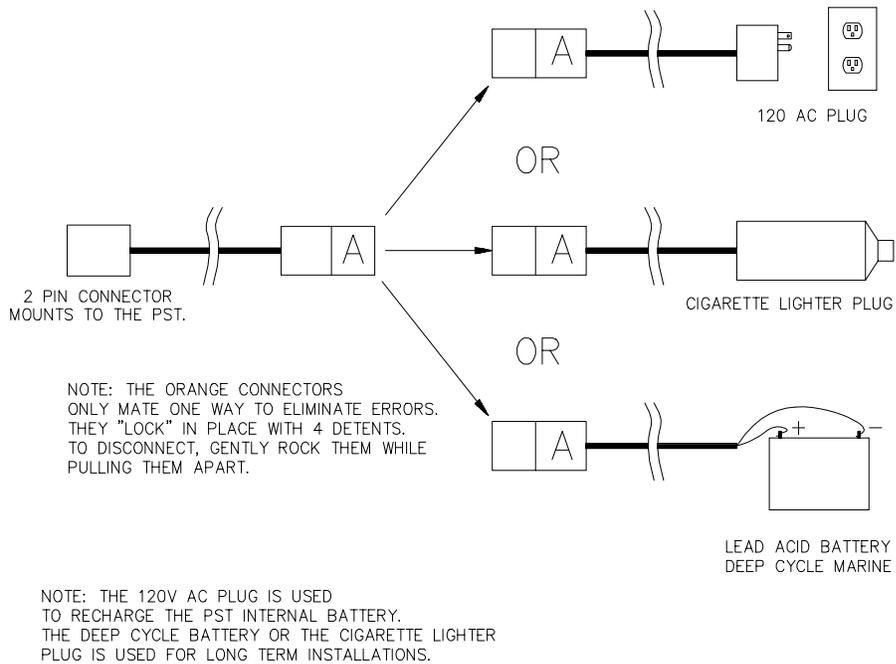
FIGURE 1-4. 12 VDC Power Options
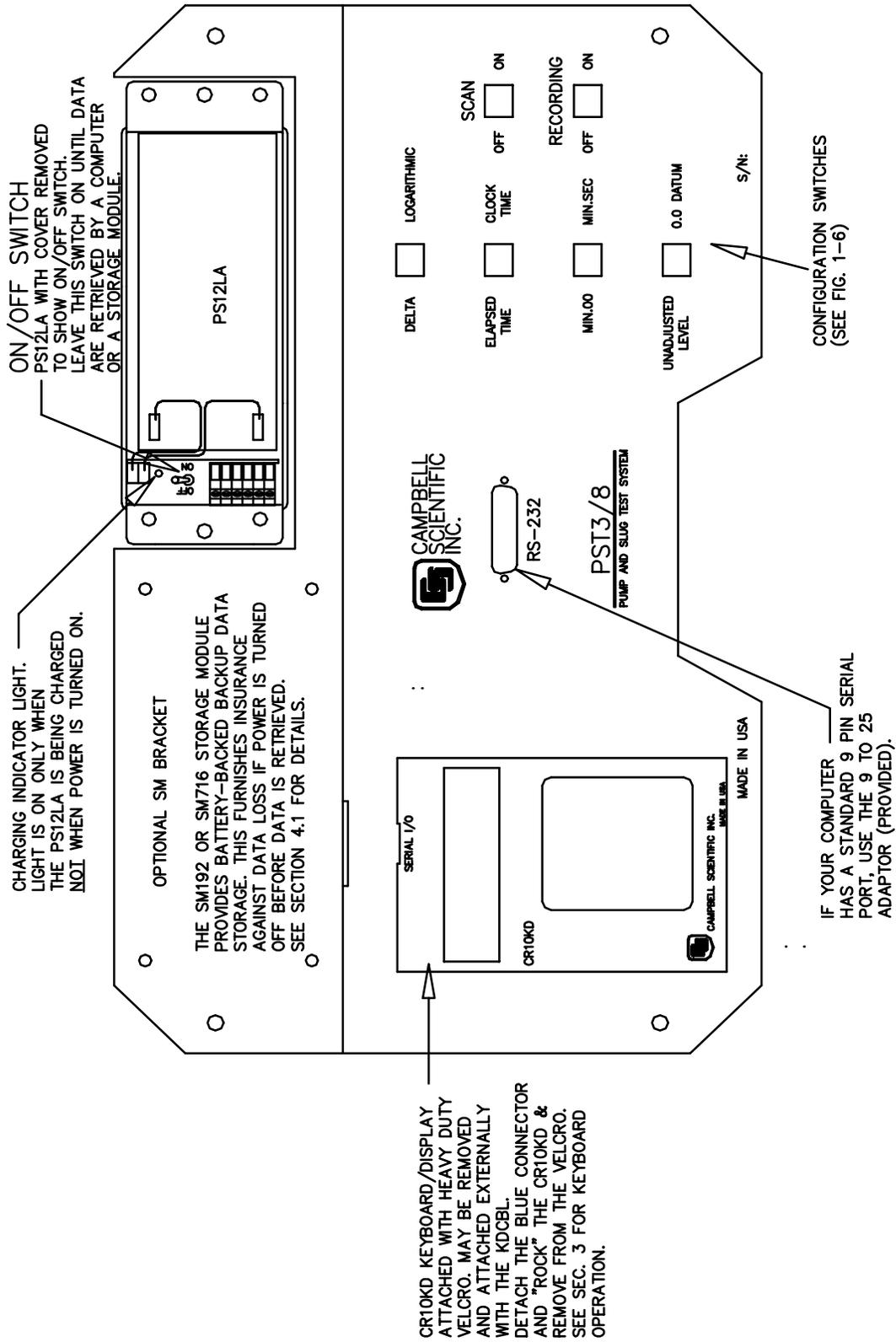
FIGURE 1-5. Control Panel Detail

FIGURE 1-6. Test Configuration Switches

Method of Recording Data

DELTA

Time and water level are recorded whenever the level changes by a specified delta value. The USER selects the delta value. Default is 0.25 (feet or meters). See Sec. 4 for details.
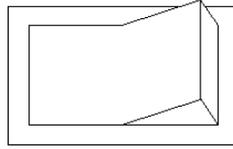
LOGARITHMIC

The sensors are scanned and data are recorded on a logarithmic time sequence. See Sec. 4 for details.

Recording Time

ELAPSED TIME

Time is recorded as the time ELAPSED since the beginning of the test.
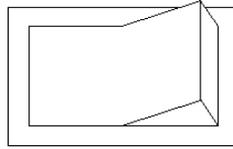
CLOCK TIME

Time is recorded as clock time (day, hour, minute, second).

NOTE: The PST clock must be set after the unit is turned on. See Sec. 3.2.

If Elapsed Time has been selected it can be recorded as:

MIN.00

.XX is the fractional portion (base 10) of a minute. Useful for importing into analysis programs like Interpex Aquix or Slugix or Gerraghty and Miller's Aqtesolv.
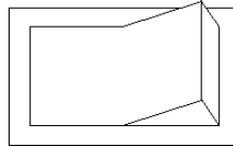
MIN.SEC

Minutes and seconds.

Water Level Reference

UNADJUSTED LEVEL

The water level measured by the transducer in each well based on the multiplier <u>AND</u> offset set in *4 mode. An example would be the water level referenced to mean sea level.
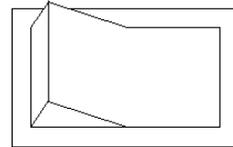
0.0 DATUM

The pre-test measured water level is recorded and used as a 0.0 datum. Subsequent readings are recorded as a change from that point. A decreasing water level is recorded as a positive change. Example: With a 0.0 datum a water level which has been lowered by 10.4 feet, the level is recorded as +10.4 ft. The 0.0 datum requires a correct multiplier for each pressure transducer, but the offset is **NOT** used.

After Sensor Installation

SCAN

OFF   **ON**
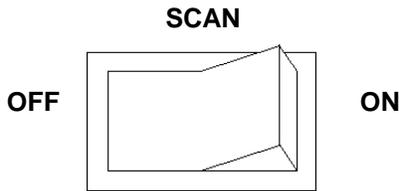
The sensors can be scanned before the test is started. No data are recorded when scanning. Set the switch to OFF when scanning is completed; scanning sensors uses battery power. During a test, this switch is inoperative.

Running a Test

Recording

OFF   **ON**
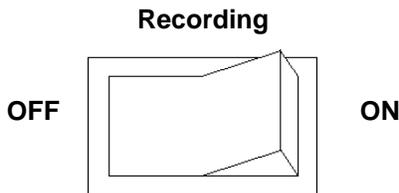
Starts and stops a test.

Begin the test by setting the recording switch to the "ON" position. In a **Delta** test this can be done before the slug is introduced or the pump is turned on because data is recorded only when water level changes occur. However, the elapsed time starts at the time the switch is set. Data collection is started in Logarithmic tests at the time the recording switch is set to the on position.

Stop the test by setting the recording switch to the "OFF" position. At this point, the PST records time, all sensor readings, test number and the battery voltage.

SECTION 2. SOFTWARE

There are 2 major software items in the PST system:

- *Datalogger software to operate the CR10, make the measurements and store data in the Final Storage in the CR10 (and the Storage Module if one is being used).*

- *PC software (PC208 and PCPST) to aid in setup and data retrieval to an ASCII file in a PC.*

Once the file is stored in the PC, analysis can begin. Commercial analysis software is a separate item which must be purchased by the user. PCPST can convert the data files to formats compatible with three commonly used commercial analysis programs.

2.1 DATALOGGER SOFTWARE

The CR10 in the PST has a Power-Up PROM. When the power is turned on, the CR10 goes through a memory check and loads the PST program into RAM. The user then sets the datalogger clock and the configuration switches and enters key information such as the calibration figures for each pressure transducer and begins the test.

> **NOTE:** The user can write other CR10 programs and "load them over the top" of the PST program. If you wish to do this, refer to the CR10 and PC208 manuals.

2.2 PC SOFTWARE

2.2.1 PC208 DATALOGGER SUPPORT SOFTWARE

PC208 is Campbell Scientific's Datalogger Support Software. It is a package of programs that make computer/datalogger operations easier. In the PST, PC208 is invisible to the user. It is the primary tool that PCPST uses to accomplish its tasks. For the PST user, a knowledge of PC208 is not needed. PC208 is shipped on either three 5¼" floppies or two 3.5" diskettes.

2.2.2 PCPST - PST SUPPORT SOFTWARE

PCPST simplifies all interactions between the PST and a PC, including data retrieval and data handling. PCPST uses PC208 to accomplish many of the tasks it performs. PCPST requires PST Version 3. You can determine the version of your PST by pressing the following on the keyboard display: *BA (repeat A's until you reach the seventh location) i.e. 07:version number.

Computer requirements for running PCPST are:

- IBM PC, XT, AT (IBM trademarks) or compatible.

- PC/MS-DOS Version 2.0 equivalent or higher. Multitasking operating system NOT recommended.

- At least 450 Kbytes available system memory.

- CGA/EGA/VGA video with 80 x 25 character display.

2.2.3 STANDARD INSTALLATION OF PCPST AND PC208 ON YOUR COMPUTER

You will need both the PCPST diskette and the set of PC208 diskettes. Make working copies of these diskettes and place the originals in a safe place. Additional information can be found in Section 5.

You will also need approximately one megabyte of free hard disk space to install these programs.

> **NOTE**: If you do not have a hard disk or if you choose to use different directories, subdirectories, etc. additional information can be found in Section 5.

Run PCPST batch program INSTALL.BAT to install this software on your computer. For example, to install the software in a subdirectory named PST on your hard drive C:, insert your PCPST work diskette in floppy drive A: and enter:

```
a:
install c: pst
```

Next, install PC208 into the same subdirectory, named "PST." To do this, insert the PC208

SECTION 2. SOFTWARE

diskette 1 in floppy drive A: and enter the following:

```
install
```

Follow the directions provided on the screen as the installation proceeds. Remember to install the programs into subdirectory "PST." Remove and insert subsequent diskettes as requested. The first time you run PCPST after installing it on your hard drive, you may need to set the communications port (default is COM1). The option for changing your communications port is in the utility menu.

2.2.4 QUICK START-UP PROCEDURE

Change to the drive and subdirectory where you installed PCPST and start the program. Continuing the previous installation example, enter the following:

```
c:
cd\pst
pst3  (or PST8, if you have the
8 channel PST system)
```

When you choose the appropriate options in PCPST, you can monitor well tests and retrieve test data from the PST into your computer. Data will be stored in a subdirectory on your disk named DATA. You can see a list of your data files by entering the following command at the DOS prompt from the PST subdirectory:

```
dir data
```

2.2.5 PCPST OPERATIONS

PCPST is a menu-driven program for the Campbell Scientific PST3/PST8 system. Computer tasks and some PST operations are reduced to one or two keystrokes, with the most common operations provided on the main menu, and less common ones on the utilities submenu. The following describes PCPST start up and the details of each menu option.

Start PCPST by going to the subdirectory containing the program and then entering "PST" at the DOS prompt.

PCPST first tries to communicate with the PST over the computer's serial communications port. This may take a few seconds. The purpose of this communication is to identify whether a

model PST3 or PST8 is being used. Model information is needed for monitoring wells in real time, checking the PST battery voltage, and for some data conversion steps. If PCPST cannot communicate with a PST, it will prompt you to enter a "3" or an "8".

To avoid the delay associated with this communication, start PCPST by entering "PST3" or "PST8" at the DOS prompt.

If you change to another PST model after starting PCPST, exit and restart PCPST with the other PST attached, or with the correct command, PST3 or PST8.

2.2.6 MAIN MENU OPTIONS

A. Monitor well(s) in real time

PCPST uses PC208/GraphTerm (or TERM) to display current well levels. As indicated by PCPST, well levels are updated only when the SCAN or RECORDING switches on the PST are in the ON position. PCPST displays three input locations for a PST3, and eight for a PST8.

You may change to a graphical monitoring mode by typing "G" while monitoring well levels. See the PC208/GraphTerm manual for more details on GraphTerm operation.

B. Collect WELL.DAT data from PST and convert to .RPT/.PRN files

1. PCPST collects raw data from the PST into a file named WELL.DAT, placing it in the DATA subdirectory. PC208/TELCOM is used for the data transfer.

2. PCPST checks WELL.DAT to make sure it contains valid PST data. If the data looks good, PCPST segregates it into separate test data files, based on the start and stop "headers" that the PST automatically places in its data.

3. PCPST calls SPLIT to convert the data to .RPT files suitable for printing or incorporating into a test report, and into .PRN files suitable for importing into spreadsheet programs. Files are placed in the DATA subdirectory and are named as follows:

TSTxxWLy.DAT   Where xx is a sequential test number in the order the test data is found in WELL.DAT, and y is

	the PST well number (y = S means all wells)
TSTxxWLy.RPT	Printable file with page and column headings, page numbers and printer form feed characters
TSTxxWLy.PRN	File ready to import into spreadsheet or database programs

C. Select and view .RPT data files

This menu item allows the user to select and view converted data. Directions are provided on the computer display.

2.2.7 UTILITIES MENU OPTIONS

A. Select communications port

PCPST supports communications ports COM1, COM2, COM3, and COM4. Follow directions on the computer display.

B. Back up WELL.DAT and converted data to another drive

This menu item permits the user to make a copy of the data to another drive and/or subdirectory. It is recommended that the user make this backup immediately after collecting the data.

Copying the data to another drive, such as a floppy drive, is safer than copying it to another subdirectory on the same drive.

C. Set PST date and time using computer date and time

This menu item uses PC208/GraphTerm and the computer's clock to set the PST's clock.

D. Check PST battery voltage

PCPST uses PC208/GraphTerm in communication with the PST3/8 to display the PST battery voltage. The SCAN or RECORDING switches on the PST must be in the ON position for a current voltage reading. See the PC208/GraphTerm manual if more GraphTerm operation instructions are needed.

E. Convert WELL.DAT elapsed time data to .PRN analysis software format

When the user selects this menu item, PCPST will convert the raw data file named WELL.DAT into individual well test .PRN files that can be imported into aquifer analysis programs such as AQTESOLV (by Gerraghty and Miller) and AQUIX/SLUGIX (by Interpex). The required time format for these software packages is elapsed time. Therefore, the data must be collected with the PST switch set to ELAPSED TIME and MIN.00. Under this menu item, PCPST will not convert data collected with the PST switch set to CLOCK TIME.

F. Convert WELL.DAT to .RPT and .PRN files

This menu item converts data exactly the same way the main menu option A does. The difference is that instead of gathering WELL.DAT from the PST, PCPST simply uses the copy of WELL.DAT located in the DATA subdirectory. This allows the user to convert storage module data or archived copies of WELL.DAT, or to only keep WELL.DAT files and discard unneeded .RPT/.PRN files, knowing they can be regenerated.

G. Erase all data from storage module

By selecting this menu item, the user can erase an SM192 or SM716 storage module contained in the attached PST or connected to the computer through an SC532 interface. PCPST uses PC208/SMCOM to erase the storage module. Because of the dangerous nature of this item, the user will be prompted to confirm the action before it is actually taken.

H. Erase all data from PST

By selecting this menu item, the user can erase all data contained in the attached PST. PC208/GraphTerm is used by PCPST to erase the PST. Because of the dangerous nature of this item, the user will be prompted to confirm the action before it is actually taken.

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I. Get data from storage module to WELL.DAT

1. This item allows the user to collect data from an SM192 or SM716 storage module. First, PCPST uses PC208/GraphTerm to ensure that the PST has finished transferring data to the storage module. Then, PCPST uses PC208/TELCOM to collect the data from the storage module. The storage module must be connected to a PST for this operation. Data can be converted using utilities menu option E or F.

2. If the storage module is removed from the PST, or the PST is powered down before data has been retrieved from the storage module, please refer to the PC208/SMCOM manual for data retrieval instructions. An SC532 interface will be required to retrieve data from a separated storage module.

    > **NOTE:** Powering down the PST erases any data which has not been transferred to a storage module or the computer.

PCPST NOTES:

A. To prevent inadvertent data loss by copying new data over existing data, PCPST options which overwrite existing data will pause and warn you if you have not performed a data backup. PCPST will ask if you want to overwrite the existing WELL.DAT file. If you need to back up the data, respond with an "N" for no, and then perform a data backup. If you respond with a "Y" for yes, WELL.DAT will be overwritten.

B. Whenever WELL.DAT is overwritten, PCPST first appends the old data to a backup file in subdirectory DATA named WELL.BAK. Over time, as more data is collected from the PST, this file will grow in size. When necessary, you can delete the data using a DOS command such as:

```
del data\well.bak
```

C. To erase ALL data from your computer disks, you must exit to DOS and enter the following DOS command:

```
del data
```

D. PCPST is provided with a data viewer named VIEW.COM. This viewer enables you to confirm that collected data looks reasonable and your testing was successful. If you prefer to use a different file viewer, such as a familiar text editor, you can tell PCPST to use your viewer by running the batch program PSTPAR\VIEWER.BAT from the subdirectory containing PCPST. Then simply follow the instructions provided by the program. For example, at the DOS prompt enter:

```
pstpar\viewer
```

E. In the event that the default screen colors for PCPST are unacceptable, you can select different colors by running batch program PSTPAR\COLORS.BAT from the subdirectory containing PCPST. Please follow the instructions provided by the program. For example, at the DOS prompt, enter:

```
pstpar\colors
```

3.0 STEP BY STEP PROCEDURE FOR A PUMP OR SLUG TEST.

3.1 The day before a test

Connect the PST to 115 VAC via the AC adapter to "top off" the battery. After several hours or overnight, disconnect.

Connect the pressure transducer(s), enter the multiplier(s) - see *4 Table, below. Verify reasonable readings.

Check desiccant box. Verify tight connections in terminal strip. Confirm the presence of desiccant (this should be changed every 3-6 months) and porous plastic filter (see Figure 1-1, Section 1).

3.2 PST setup the day of the test

Power

Turn the PST power switch on (Figure 1-5, Section 1). The CR10 will go through a memory check. When ":96" appears on the screen, go on to the next step (some PST versions will display a meaningless 71 and E99 before the :96 appears).

Set datalogger clock

Set the datalogger clock: year, day-of-year (see the table at the back of this prompt sheet), and military time.

Two methods:

Using the CR10

If using a computer, escape from the program PST to the DOS prompt before using the keyboard display.

Key in	ID:data	Explanation
*5	:HH:MM:SS	Displays current time
A	05:xx	Displays year
year (last 2 digits)		
A	05:xxxx	Enters the correct year and then displays the day of the year.
day of year (see table, page 3-9)		
A	05:HH:MM:SS	Enters the correct day-of-year and displays hours/minutes.
hours & minutes (military time)		
A	:HH:MM:SS	Enters the corrected time in military time (0-2400).

Or using a laptop

Run the program PST. Select option C in the Utilities menu.

Measure the water level manually

Measure and note the water level in each well using a chalked tape, beeper, etc.

Install the PRESSURE TRANSDUCERS in the wells

In each well to be monitored:
- Measure the length of the pressure transducer cable to be installed down the well.
- Install the pressure transducer in the well. Suggested method of mounting in Figure 1-3, Section 1.
- The transducer should be placed below the maximum draw down, but should not exceed the pressure range of the transducer.

5 psi	11.5 ft
10 psi	23 ft
15 psi	35 ft
20 psi	46 ft
30 psi	70 ft

} Maximum depths for transducers

- The caps on the external connectors on the PST are stamped with a well number. Attach each transducer to the appropriate external connector, starting with #1.

Set the switches

Set the switches to match the test configuration you have selected (see Figure 1-6, Section 1).

Enter the setup information into the *4 table

The *4 table can be thought of as a look up table containing specific information for the test, e.g. site I.D. number (to be chosen by the user), the number of wells, sensor multiplier(s) and offset(s), etc.

Using the CR10

If you are using a computer, escape from the program PST menu to the DOS prompt before using the keyboard display.

CR10KD Key Definition Summary
- A Advance or "enter"
- B Back up
- C Change sign
- D Enter a decimal point

To view a value in the *4 table, key in:
>   *4 [location number] A

>   OR

To enter a new value into the *4 table, key in:
>   *4 [location number] A [new value]   A if positive, CA if negative

Examples:

To change the # of wells to 3, key the following:

Keystrokes	Explanation
*4	enter mode 4
1A	go to location 1
3A	enter 3 ("A" to enter or advance)

To change the location ID # to 237:

Keystrokes	Explanation
*4	enter mode 4
A	go to location 0
237A	to 237

To change Delta for well #1 to 0.1:

Keystrokes	Explanation
*4	enter mode 4
4A	go to location 4
D1A	to 0.1 (the "D" is for decimal)

To change the offset for well #3 to -1.012

Keystrokes	Explanation
*4	enter mode 4
12A	go to location 12 in the *4 table
1D012CA	enter -1.012 into the table

**PST3
*4 Table**

*4 Location	Parameters
0	Location ID #
1	Number of wells to be monitored
2	Execution interval in seconds (.25, .5, or 1)
3	Logarithmic base interval in seconds (.25, .5, or 1)
4	Delta threshold, well #1 (Engr. units; ft, meters)
5	Multiplier, well #1 (Engr. units/mV @ 0.5 mA)

6 . . . . Offset, well #1 (Engr. units)

7 . . . . Delta threshold, well #2

8 . . . . Multiplier, well #2

9 . . . . Offset, well #2

10 . . . . Delta threshold, well #3

11 . . . . Multiplier, well #3

12 . . . . Offset, well #3

13 . . . . Final logarithmic interval in seconds

14 . . . . Exc. code, transducer #1

15 . . . . Exc. code, transducer #2

16 . . . . Exc. code, transducer #3

Excitation Code
0 for sensors from 5-20 psi
1 for sensors over 20 psi

PST8
***4 Table**

<u>*4 Location</u>   <u>Parameters</u>

0 . . . . Location ID #

1 . . . . Number of wells to be monitored

2 . . . . Execution interval

3 . . . . Logarithmic base interval

4 . . . . Delta threshold, well #1 (Engr. units; ft, meters)

5 . . . . Multiplier, well #1 (Engr. units/mV @ 0.5 mA)

6 . . . . Offset, well #1 (Engr. units)

7 . . . . Delta threshold, well #2

8 . . . . Multiplier, well #2

9 . . . . Offset, well #2

10 . . . . Delta threshold, well #3

11 . . . . Multiplier, well #3

12 . . . . Offset, well #3

13 . . . . Delta threshold well #4

14 . . . . Multiplier, well #4

15 . . . . Offset, well #4

16 . . . . Delta threshold, well #5

17 . . . . Multiplier, well #5

18 . . . . Offset, well #5

19 . . . . Delta threshold, well #6

20 . . . . Multiplier, well #6

21 . . . . Offset, well #6

22 . . . . Delta threshold, well #7

23 . . . . Multiplier, well #7

24 . . . . Offset, well #7

25 . . . . Delta threshold, well #8

26 . . . . Multiplier, well #8

27 . . . . Offset, well #8

28 . . . . Final logarithmic interval in seconds
29 . . . . Exc. code, transducer #1
30 . . . . Exc. code, transducer #2
31 . . . . Exc. code, transducer #3
32 . . . . Exc. code, transducer #4
33 . . . . Exc. code, transducer #5
34 . . . . Exc. code, transducer #6
35 . . . . Exc. code, transducer #7
36 . . . . Exc. code, transducer #8

Excitation Code
0 for sensors from 5-20 psi
1 for sensors over 20 psi

Note: For the final logarithmic interval (13,28) to be in seconds, the logarithmic base interval (3) must be the default 0.25 seconds.

Scan the sensors

Flip the scan switch on and note the water level reading in each well. Also check the battery voltage. See Viewing the measurements below.

If the battery voltage is below 11.0 volts (at the start of the test) use the charger cable to provide power to the battery.

Viewing the measurements

Scanning or during a test, the measurements can be viewed as they are made.

Two methods:

NOTE: Readings are current ONLY if the scan or record switch is ON.

Using the CR10

Key in: *6 [Location #] A

Other keys:
A - advance
B - backup

PST3 *6 Location

1 . . . . .Level well #1

2 . . . . .Level well #2

3 . . . . .Level well #3

4 . . . . .Location ID #

5 . . . . .Number of wells

6 . . . . .Battery voltage

35 . . . . .Elapsed time

NOTE: These values are updated only if the SCAN or RECORDING switch is on.

PST8 *6 Location

1 . . . . .Level well #1

2 . . . . .Level well #2

3 . . . . .Level well #3

4 . . . . .Level well #4

5 . . . . .Level well #5

6 . . . . .Level well #6

7 . . . . .Level well #7

8 . . . . .Level well #8

9 . . . . .Location ID #

10 . . . . .Number of wells

11 . . . . .Battery voltage

35 . . . . .Elapsed time

NOTE: These values are updated only if the SCAN or RECORDING switch is on.

Or using a laptop

Run PST. Select Option A.

The Offset

NOTE: The 0.0 datum option does not require an offset.

calculate the offset

(Manual reading) - (PST reading) = offset

Enter the offset(s) in the *4 table

See the *4 table, above.

Scan the sensors again to verify the offset	Correct the offset if necessary.
Turn off the scan switch	Ready to begin the test.

3.3 Begin the test

Turn the recording switch to the "ON" position at the same time the pumps are turned on or the slug is inserted.

Logarithmic

Logarithmic - data collection begins when the switch is turned to "ON".

Delta

Delta - the elapsed time starts when the switch is turned to "ON". In a slug test the switch can be turned to "ON" just before the slug is introduced. Data will be recorded as the water level changes.

3.4 Stopping the test

Set the Recording switch to the "OFF" position.

At the end of the test the following will be recorded:
- the sensors' current readings
- the header line including location ID # and battery voltage.

DO NOT turn the power switch off until all data is collected into a PC or the optional storage module. ALL DATA IN THE PST WILL BE LOST WHEN POWER IS TURNED OFF.

3.5 *7 Mode Displaying Final Readings

Recorded data can be verified from the keyboard/display in *7 mode. Data retrieval should be done with a PC running PCPST.

07:XXXX   where XXXX is the next location in the ring memory where data will be stored.

Commands Specific to *7 Mode:

#	Display Final Storage location number:enter location to advance to, or C to display data
#A	Advance to same element in next array with the same ID
#B	Back up to same element in previous array with the same ID

Example:

Only one data point at a time can be viewed. The data will look something like this for the first 0.3 seconds of a Delta interval, 0.0 datum, elapsed time test with 3 wells:

01:99	Indicates that the following is a header. This header contains the startup information when a test is stopped.
02:1106	Start time (military time)
03:74.5	Starting depth of water
04:0003	Number of wells
05:0097	Location ID number (chosen by the user in *4 table)
06:0217	Day of year
07:12:29	Battery voltage at start of test

Then proceeding into the data

01:0001	Well number
02:.0075	Time in decimal minutes
03:.423	Water level
04:0002	Well number
05:00.875	Time
06:0.366	Water level
07:0003	Well number
ETC.	

DAY OF YEAR (JULIAN) CALENDAR

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JAN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
FEB	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60		
MAR	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
APR	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	
MAY	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
JUN	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	
JUL	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212
AUG	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243
SEP	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	
OCT	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
NOV	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	
DEC	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365

Add 1 to unshaded values during leap years.

SECTION 4. TECHNICAL DETAILS - HARDWARE

4.1 STORAGE MODULE

An optional SM192 or SM716 storage module can be used to collect data from the PST or to provide additional memory capacity. A bracket is available (PST-BKT) for mounting the storage module to the PST.

To collect data, simply plug the storage module into the connector for the CR10KD keyboard/display. An SC90 line monitor can be used to monitor when the data collection is complete.

The PST will not transfer any data to the storage module during the first 20 minutes of a Delta test, or the first 20 seconds of a logarithmic test. All data will be transferred at the end of a test (when recording is turned off). To avoid possible data loss, wait at least 60 seconds after ending a test before changing setup information in the *4 table.

> **NOTE:** Do not turn the power off until you have retrieved data from the Storage Module. Otherwise, automated data retrieval using PCPST will not be possible.

4.2 PRESSURE TRANSDUCERS

4.2.1 FACTORY CALIBRATION

Table 4.2-1 is an example of a calibration sheet furnished with a Keller PSI Series 169/173 pressure transducer. The column labelled "BFSL" is a best fit straight line calculated using factory test data for this sensor. Please note that each calibration is unique. Your data will be different.

To obtain the multiplier in feet for each sensor:

$$M = \frac{\text{(full scale pressure in psi) x (2.31 ft/psi)}}{\text{(BFSL value at full scale - BFSL value at 0.0 psi)}}$$

The offset is set in the field. See Section 3.2.

4.2.2 TWO-POINT CALIBRATION

A two-point or multi-point calibration can be calculated by using an initial multiplier of 1 and offset of 0.0. Scan the sensors by setting the scan switch to the ON position. Use *6 Mode to monitor the appropriate input location. Record on a sheet of paper the observed level and the corresponding voltage for two or more points. For a two point calibration:

Multiplier (m) = (depth 2 - depth 1)/
                       (voltage 2 - voltage 1).

Offset (b) = depth 1 - m X voltage 1.

For a multi-point calibration, use the desired method to fit a straight line to your data.

4.2.3 OVERRANGE

The PST measures the output of the transducer on a 0 to +25 millivolt input range. If the psi range of the transducer is exceeded, the output voltage of the transducer potentially could exceed 25 mV. An overrange occurs if the sensor outputs more than 25 mV. A -6999 in the data file represents an over-range. In the monitor mode of PC208 program GraphTerm, an overrange is represented by a -99999.

Two excitation codes can be specified in *4 mode to match the full scale output of the transducer to the +25 mV input range. Select the default of "0" for transducers in the range of 5 to 20 psi. If the transducer is 30 psi or greater, the corresponding excitation code should be set to "1" in *4 mode.

> **NOTE:** Unexpected overrange readings may indicate a sensor problem, such as poor connection.

4.3 LOGARITHMIC SAMPLING INTERVALS

Logarithmic sampling is based on the execution interval set in *4 mode. The default interval is 0.25 seconds which results in the following intervals:

Elapsed Time	Interval	Points per Interval
0 - 20 sec.	0.25 sec.	80
20 - 120 sec.	5 sec.	20
2 - 10 min.	30 sec.	16
10 - 100 min.	2 min.	45
100 - 1000 min.	10 min.	90
1000 min. plus	60 min.	

# of seconds in *4 location 13 (PST3) or 28 (PST8)

TABLE 4.2-1. Keller-PSI Calibration Report

Customer:	Campbell Scientific			Test Date:	07-06-92		
Model No:	169-110-0051			Text Excitation	.5 mA		
Serial No:	93907			Test Temperatures:	Room = 27ºC		
Pressure Range:	0 to 15 PSIG				Cold = 0ºC		
Excitation:	.5 mA						
Output:	0-60 mV						

Test Pressure PSIG	BFSL Rm Temp Outputs	------- Run #1 -------		------- Run #2 -------		------- Run #3 -------	
		Rm Temp Outputs	Error %FSO	Rm Temp Outputs	Error %FSO	Cd Temp Outputs	Error %FSO
0.00	0.14	0.176	0.076	0.188	0.101	0.066	-0.006
3.00	9.55	9.519	-0.066	9.522	-0.060	9.449	-0.008
6.00	18.96	18.921	-0.083	18.916	-0.094	18.885	-0.006
9.00	28.37	28.358	-0.025	28.352	-0.038	28.350	-0.002
12.00	37.78	37.801	0.045	37.789	0.020	37.821	0.003
15.00	47.19	47.222	0.069	47.212	0.048	47.265	0.006
12.00	37.78	37.806	0.056	37.796	0.035	37.826	0.004
9.00	28.37	28.361	-0.019	28.356	-0.030	28.352	-0.001
6.00	18.96	18.926	-0.072	18.925	-0.074	18.888	-0.006
3.00	9.55	9.528	-0.047	9.528	-0.047	9.454	-0.008
0.00	0.14	0.189	0.103	0.189	0.103	0.073	-0.005

Maximum Static Error: 0.103 %FSO   Maximum Thermal Error @ Cold: -.008 %FSO/C

Maximum Non-Repeatability: -0.26 %FSO

Electrical Termination:		
	Black	+Input
	Red	+Output
	Green	-Output
	White	-Input

With 3 wells or more on one PST, the first step interval will be greater than 0.25 seconds (see Section 4.4). The elapsed time will be offset by the increased time required to execute the first step interval. A change of the execution interval to 0.5 seconds would result in the following:

Elapsed Time	Interval	Points per Interval
0 - 40 sec.	0.5 sec.	80
40 - 240 sec.	10 sec.	20
4 - 20 min.	1 min.	16
20 - 200 min.	4 min.	45
200 - 2000 min.	20 min.	90
2000 min. plus	120 min.	

2 times the value in *4 location 13 (PST3) or 28 (PST8)

If the interval is changed, it must be a multiple of 0.125 (1/8) seconds. If the execution interval were changed to 1 second, the following rate of data collection would result:

Elapsed Time	Interval	Points per Interval
0 - 80 sec.	1 sec.	80
80 - 480 sec.	20 sec.	20
8 - 40 min.	2 min.	16
40 - 400 min.	8 min.	45
400 - 4000 min.	40 min.	90
4000 min. plus	240 min.	

> **NOTE**: Never set the base interval greater than 1 second.

4 times the value in *4 location 13 (PST3) or 28 (PST8)

4.4 DELTA SAMPLING

Time and water level are recorded only when the water level changes by a user-specified Delta threshold. When using Delta sampling, each well in the test must have its own Delta threshold value set in the *4 Table. The default

threshold is 0.25. The units are determined by the multiplier used for the pressure transducer.

In Delta sampling, measurements are made at regular intervals. The default sampling interval is 0.25 seconds. It can be changed in the *4 Table to 0.5 seconds or 1.0 seconds. The default value gives the greatest resolution.

Example: If the Delta threshold is set to 0.1 feet and the water level drops 1 foot, 10 data records would be stored. Each record would have a time and water level. Each water level would be approximately 0.1 foot apart and the time values would correspond to the times when the water level reached each recorded point.

4.5 MAXIMUM SAMPLING RATES

The maximum recording rate depends on the number of wells monitored. For Delta tests, well #1 should be the pumping well; it is scanned at a faster rate than the monitoring wells. The following tables show the maximum rate as a function of the number of wells monitored for Delta and logarithmic tests.

Number of Wells	Well #1 Maximum Times/sec.	Remaining Wells Maximum Times/sec.
1	4	1
2	4	1
3	3.7	0.9
4	3.5	0.9
5	3	0.9
6	3	0.9
7	2.8	0.7
8	2.8	0.7

Number of Wells	Maximum Times/sec.
1	4
2	4
3	2
4	2
5	2
6	2
7	1.5
8	1.5

4.5.1 OVERRUN

A table overrun occurs when the program is not completed within the time of the execution interval. In the Delta mode table overruns occur, so don't be concerned. The four times

per second execution interval is set up to optimize speed of data collection. If an overrun occurs the program executes at the next 0.25 second interval.

4.6. DATA STORAGE CAPACITY

Water level values less than 69 use one data point per well while values over 69 use two data points. The examples found in Sections 4.6.1 and 4.6.3 assume level values less than 69 using only one data point.

4.6.1 DELTA WITH ELAPSED TIME

Delta files with elapsed time use three data points (well #, time, and level < 69) in Final Storage each time a recording is made. With 29,900 available data points in Final Storage, 9967 recordings (29,900/3) can be made before data are overwritten. The time it takes before the oldest data are overwritten with new data is dependent on the Delta interval and the total change in depth of all the wells.

Example: If there is one well, a Delta value of 0.05 feet, and the well level changes 100 feet during the test, then there will be a total of 2000 (100 ft / 0.05 ft/record = 2000 records) recordings of time and the corresponding level out of the 9967 possible. There would still be 7967 recordings remaining before the oldest data is overwritten. If there are six wells and the total water level change of all wells combined is 100 feet, with the same Delta value of 0.05 feet, 2000 of the possible 9967 recordings would still be used.

4.6.2 DELTA WITH CLOCK TIME

Delta files with clock time use five data points in Final Storage each time a recording is made. With 29,900 available data points in Final Storage, 5980 recordings can be made before data are overwritten. The previous example for lapsed time holds except that total number of recordings is 5980.

4.6.3 LOGARITHMIC WITH ELAPSED TIME

Memory overwriting is dependent on the time and the number of wells. One well uses three data points each time a recording is made; two wells use four data points; eight wells use 10 data points. Figure the total number of recordings that can be stored by dividing 29,900

by the number of data points used each recording.

Number of Wells	Data Points	Total # of Records
1	3	9966
2	4	7475
3	5	5980
4	6	4983
5	7	4271
6	8	3737
7	9	3322
8	10	2990

To calculate the total time to fill the memory, the execution interval must be considered. Six different time intervals between samples are used during the course of the test. During the first 1000 minutes, 251 recordings are made. The sixth interval (from the *4 table) is then used until the test is stopped.

Example: How long will it take to fill the memory with six wells? A total of 3322 records can be recorded. The first 251 recordings take 1000 minutes. Assume the remaining recordings (3322 - 251 = 3021) are all at a 60 minute interval (*4 table). 3021 X 60 = 181,260 minutes = 125 days before memory is filled.

4.6.4 LOGARITHMIC WITH CLOCK TIME

Memory considerations are the same as with logarithmic elapsed time with the following exceptions.

Number of Wells	Data Points	Total # of Records
1	5	5980
2	6	4983
3	7	4271
4	8	3737
5	9	3322
6	10	2990
7	11	2718
8	12	2491

4.7 SYNCHRONIZED START FOR MULTIPLE PST'S

Tests on multiple PST units can be started at the same time in a synchronized start configuration. To do this, a two wire conductor must be connected to the C1 and G terminals of the CR10 wiring panels. To access the wiring panel, the PST cover plate must be removed by loosening the thumb screws. Multiple PST units are linked by attaching C1 to C1 and G to G between any number of units.

No connectors have been provided in the PST case for this purpose. In this situation the external power connectors on each unit could be rewired to C1 and G rather than the PS12 power supply. Special cables would have to be built to connect the various PST units.

When **ANY** PST "recording" switch is switched to ON, all the PST units will start recording. The data collection will be according to the individual switch configuration and *4 mode settings of each PST unit.

Call the Water Resources Group at Campbell Scientific for further details.

SECTION 5. TECHNICAL DETAILS - SOFTWARE

5.1 README FILE

This file contains the full text of the users manual for PCPST menu software. It briefly describes the contents of the Campbell Scientific PCPST diskette and how to install the software on a computer. This file may also be viewed on the computer screen after installing PCPST by entering "readme" at the DOS prompt.

5.2 INSTALLATION

5.2.1 WORKING COPY

An example of a DOS command to make a working copy of the diskette in drive A: follows:

1. Make sure that the distribution diskette is write protected. Have a blank formatted diskette labeled "PCPST--working copy" ready for step 2.

2. Insert the distribution diskette in floppy drive A: and enter:

```
diskcopy a: a
```

Then press "Enter".

3. Follow the directions provided by DOS as it guides you through the diskcopy procedure. When this step is completed, you may use the new working copy of PCPST.

5.3 INSTALLATION AND OPERATION WITHOUT A HARD DISK

5.3.1 DOS PATH

Before beginning PST operations, you must install PC208 Datalogger Support Software so that PC208 program files are available to PCPST. If PC208 was installed previously, you may want to install PCPST into the same directory as PC208. If you install them into separate subdirectories, you should add the subdirectory containing PC208 to your DOS

PATH. For example, if you installed PC208 in a subdirectory named PC208 on drive C:, the following line in your AUTOEXEC.BAT file would make PC208 accessible to PCPST:

```
set path=c:\;c:\dos;c:\pc208
```

5.3.2 PC208 INSTALLATION

To install the PC208 Software, insert diskette 1 (marked 1 of 3) in a floppy disk drive. After logging onto the disk drive, type "INSTALL". The INSTALL program will prompt:

```
PC208 Datalogger Support
Software Install Program ver.
X.X
```

To abort the installation, type "Ctrl-C" or "Break" at any time.

The Monochrome display mode should be specified when installing for a computer which uses a Monochrome Display Adapter (MDA). The Black & White display mode is for computers which have a Color Graphics Adapter (CGA) with a monochrome monitor. With other adapter/monitor combinations, specify the default display mode.

Select a display mode (B = Black & White, M = Monochrome, D = Default). Select the appropriate option, and Install will prompt:

```
Enter name of drive containing
PC208 disk:
```

Enter the appropriate drive letter for your computer (A: or B:). This is the drive that has the PC208 diskette in it. Install will prompt:

```
Enter destination drive and path
name:
```

Enter the drive and path in which the PC208 software is to be installed. The installation program for PCPST has already created a subdirectory \PST. Next, Install will prompt:

```
1=      EDLOG Datalogger Program
        Editor
2=      GRAPHTERM Terminal
        Emulator
3=      TELCOM Data Collection
        Program
4=      SPLIT Data Split/Merge
        Program
5=      SMCOM Storage Module
        Communications
        (SM192/716)
6=      All of the above

        Enter a list of digits
        corresponding to what you
        want installed:
```

HARD DISK

If installing the PC208 software on a hard disk or a diskette with 1.2 megabytes or greater, then select 6 to install all the programs on the specific drive.

FLOPPIES

If installing the PC208 software on 360 K floppies, then run the Install program two separate times. It will require two formatted floppies, and the floppies should be blank (without the system on them). The first time, select 2 and 3 for GraphTerm and TELCOM. Next, select 4 for SPLIT.

5.3.3 RUNNING PCPST FROM A FLOPPY DISK

PC208 should be in the root directory of the work diskette, or in drive B: with "B:\" in your DOS PATH. See your DOS reference for more information on the DOS PATH.

5.3.4 INSTALLATION WITHOUT A HARD DISK

1. Insert the work PCPST diskette into the desired floppy drive. Then, change to that drive and start the program. For example, to run PCPST from drive A:, you should insert the work diskette into drive A: and type the following:

```
a:
PST
```

2. Data will be collected into a subdirectory named "DATA" on your work diskette. Continuing the above example, you can see a list of your data files by typing the following:

```
dir data (if you are in the root
directory of A:)
OR
dir a:\data
(if you are in some other drive
or directory)
```

3. For floppy disk operations, available data space may be small. For example, if PCPST and the necessary PC208 program files were copied onto a 720 Kbyte diskette, there would be only about 70 Kbytes available for data storage on the diskette.

5.3.5 PROGRAM FILES:

PCPST program files:

COLORS.BAT	INSTALL.BAT	PST.EXE
PST3.BAT	PST8.BAT	README.BAT
VIEWER.BAT		

Auxiliary files used by PCPST are kept in subdirectory PSTPAR. Normally, you will not need to be concerned with the auxiliary files. Most of the files in subdirectory PSTPAR are parameter files used by PC208/SPLIT to convert data. The following is a listing of subdirectory PSTPAR:

[.]	[..]	AQSDEL1.PAR
AQSDEL2.PAR	AQSDEL3.PAR	AQSDEL4.PAR
AQSDEL5.PAR	AQSDEL6.PAR	AQSDEL7.PAR
AQSDEL8.PAR	AQSLOG1.PAR	AQSLOG2.PAR
AQSLOG3.PAR	AQSLOG4.PAR	AQSLOG5.PAR
AQSLOG6.PAR	AQSLOG7.PAR	AQSLOG8.PAR
COLORS	COLORS.BAT	COMPORT
DELCLK1.PAR	DELCLK2.PAR	DELCLK3.PAR
DELCLK4.PAR	DELCLK5.PAR	DELCLK6.PAR
DELCLK7.PAR	DELCLK8.PAR	DELLAP1.PAR
DELLAP2.PAR	DELLAP3.PAR	DELLAP4.PAR
DELLAP5.PAR	DELLAP6.PAR	DELLAP7.PAR
DELLAP8.PAR	LOGCLK3.PAR	LOGCLK8.PAR
LOGLAP3.PAR	LOGLAP8.PAR	PST33.DLD
PST83.DLD	README.DOC	SM.STN
SM1.STN	SM2.STN	SM3.STN
SM4.STN	VIEW.COM	VIEWER.BAT
VIEWER	WELL.STN	WELL1.STN
WELL2.STN	WELL3.STN	WELL4.STN

PC208 program files installed and used by PCPST are:

GT.EXE	For some communications
SMCOM.COM	For erasing a storage module
SPLIT.COM	For data conversion
SPLIT.001	For data conversion
SPLIT.002	For data conversion
SPLIT.003	For data conversion
SPLIT.004	For data conversion
TELCOM.EXE	For data retrieval