TDS

Surveying Card User's Manual

Tripod Data Systems, Inc.

TDS-48

Surveying Card

User's Manual

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1. INTRODUCTION

In this chapter you will become familiar with the TDS-48 Surveying Card; you will install the card in your HP-48SX Handheld Computer; you will learn about its general features and capabilities; and you will be introduced to the organization and content of this manual.

WELCOME TO THE TDS-48

The TDS-48 is an IC (Integrated Circuit) Card for the HP-48SX Scientific Expandable Handheld Calculator.

With the introduction of the HP-48SX, Hewlett-Packard has provided a handheld computer that can have the impact for the land surveying market in the '90s similar to the impact of the HP-41CX in the '80s. The HP-48SX is the "spiritual" successor of the HP-41CX in that it is designed in the vertical format; it accepts ROM and RAM plug in cards; and, it allows for data exchange with other computing devices. However, the 48SX is the "logical" successor to the HP-28S, in that its programming language is a superset of the 28S version of object-oriented RPN. Programs written to run on the 28S, once keyed into the 48SX, will run compatibly. Programs written to run on the 41 will *not* run on the 48SX directly.

The HP-48SX has significantly more computational capability than previous HP scientific calculator products. Indeed, it is unlikely that any single user will require or need to learn all of the features of the machine. This is certainly true for the typical land surveyor. By using the TDS-48 Surveying Card in

conjunction with your HP-48SX, you will be able to take advantage of all of the hardware features of the 48SX in your day-to-day surveying work without having to open the 48SX manuals. This TDS-48 Manual contains all of the information you need to experience the productivity improvements in your work afforded by this technology. The TDS-48 converts your HP-48SX into a powerful field computer that provides four basic functions needed by the professional land surveyor:

1) The TDS-48 may be used to collect raw data observations in the field either manually by keying them in or automatically by connecting the product to an electronic total station that uses an RS232 interface. These observations are converted to three dimensional coordinates as they are obtained.

2) Since the coordinates of your observed points are available in the field, you may apply a wide variety of built-in CO-GO functions to the coordinates to analyze and adjust your job, as well as to add design points to your data file.

3) You may use the TDS-48 to stake out your design points in any of several modes. Points may be staked by point number, by station and offset from a center line of a right-of-way, or by slope staking.

4) In the office, and you can use TDS's companion TFR software to upload and/or download your coordinates and raw data to or from an office PC.

SYSTEM CONFIGURATION

The minimum configuration required for the TDS-48 is the following:

1) 1 HP-48SX Scientific Expandable Calculator

2) 1 TDS-48 Surveying Card

3) 1 TDS-48 Keyboard Overlay

4) 1 TDS 128k-byte RAM Card *OR* 1 TDS 256k-byte Mult-Memory™ Card *OR* 1 TDS 512k-byte Multi-Memory™ Card *OR* 1 HP-82214A 32k-byte RAM Card *OR* 1 HP-82215A 128k-byte RAM Card

In addition, if you want to connect your TDS-48 to your office PC, you will need:

5) 1 HP-82208A opt.1AW Cable (see note below)

6) 1 TDS TFR PC Program (see note below)

If you want to connect your TDS-48 to your electronic total station, you will need:

7) 1 TDS-48 Total Station Cable Adapter

8) 1 TDS-48 Tripod Bracket

NOTE: The HP-82208A opt.1AW consists of an RS232 cable with a standard DB-9 female connector on the PC end and the HP-48SX mini RS232 connector on the other. If you order an HP-82208A without the option, you will receive, in addition to the cable, a DB-9 to DB-25 connector adapter and a floppy disc for your PC that will provide generic data communication capabilities for your PC and your HP-48SX. The TDS TFR PC Program will provide for data communication between your PC and your TDS-48. It also serves as a file conversion capability to convert your surveying data files into files that are compatible with approximately 20 different brands of PC Surveying and Civil Engineering Software. The TDS TFR PC Program is included as a part of TDS-PC PLUS Surveying Office Software

INSTALLING YOUR TDS-48 SURVEYING CARD

Installation of your TDS-48 Surveying Card and the associated RAM Card is simple and straight forward. However, you should follow these installation instructions exactly as they are presented here:

Be certain that you have three AAA alkaline battery cells properly installed in your HP-48SX before you begin the card installation process. If you have no cards plugged into your HP-48SX, you may go to step 3.

1) Turn your HP-48SX OFF: **[➡] [ON]**

2) Remove any IC cards you may have plugged into your 48. (This will cause a system memory loss if your plug-in RAM is configured as part of the main system RAM.)

3) Turn your HP-48SX **[ON]**.

4) Turn your HP-48SX OFF: **[➡] [ON]**.

5) Insert your TDS-48 Surveying Card into Port 1 of your HP-48SX. (Port 1 may be identified by the graphic on the back of the unit.) Cards are installed with the card graphics facing up when the 48 is inverted (keyboard down).

6) Turn your HP-48SX **[ON]**.

7) Turn your HP-48SX OFF: **[➡] [ON]**.

8) Insert your RAM Card into Port 2 of your HP-48SX. (Port 2 may be identified by the graphic on the back of the unit.)

9) Place the TDS-48 Keyboard Overlay ont eh HP-48SX's keyboard. The small tabs on the edges of the overlay fit into slots on the keyboard.

10) Your HP-48SX is now properly configured.

11) The first time that you install a RAM card which has not been used previously with TDS-48, the unit will prompt you with the message "Can I erase all data in port 2? [Y/N]". Be certain that you do not want to save any information which may have been recorded by other applications before you press **[Y]**.

12) When you turn on your TDS-48 the first time, you *may* get an "Invalid Card Data" error message. This is normal. Ignore this error message and proceed with running your TDS-48. If you have installed the RAM card properly and you get a "No RAM card in port 2" error message, you probably have the write protect switch on you RAM card set. Try adjusting this switch which is located on the top edge of the card.

NOTE: For the remainder of this manual, we will adopt the convention of using the term TDS-48 to refer to the combination of a TDS-48 Surveying Card installed in an HP-48SX with a RAM Card.

USE OF THE TDS-48 SURVEYING CARD WITH TDS MULTI-MEMORY™ RAM CARDS

Hewlett-Packard makes available RAM cards for the 48 in two sizes, 32k-bytes and 128k-bytes. In addition, TDS manufactures a 128k-byte RAM Card. With the version of the TDS-48 that came with this manual, you can also use Multi-Memory™ RAM cards from Tripod Data Systems instead of the smaller capacity cards. Multi-Memory™ Cards come in either one of two sizes, 256k-bytes or 512k-bytes. These cards will

accommodate up to 6000 or 12,000 three dimensional points with descriptors, respectively. You may still use the smaller capacity cards if you wish.

Use of Multi-Memory™ RAM Cards is the same as the use of the other RAM cards. Just install the TDS-48 Card in port 1 and install a Multi-Memory™ RAM Card in port 2 of your HP-48SX. The software will complete the configuration. It is not necessary for you to manipulate the bank switching functions as described in the instructions that come with your Multi-Memory™ Card . *However, be sure to read the note below.*

NOTE: If you intend to use the Multi-Memory™ RAM Card with other software than the TDS-48, or if you want to use any applications software which may have come preloaded in your Multi-Memory™ RAM Card, you should not just install your Multi-Memory™ Card and use it as described above. If you do, the TDS-48 will clear software from the card that you will need later. You should first make a backup copy of the software in your card on your PC. Instructions for doing this are given in the manuals that accompanied your Multi-Memory™ Card and any associated applications software.

SPECIAL NOTICE FOR USERS OF TDS-48 SURVEYING CARDS AND EARLIER VERSION OF THE TDS-48

The TDS-48 Surveying Card that came with this manual is Version 3.0 or later. Because of some fundamental differences between ordinary 32k-byte and 128k-byte RAM cards and Multi-Memory™ Cards, the TDS-48 Surveying Card, Version 3.0 stores coordinate data in a slightly different format than earlier versionsof the TDS-48. While Version 3.0 can recognize data files created by any vintage of Surveying Card, TDS-48 Surveying Cards of earlier versions than Version 3.0, cannot

use data files on cards created by Version 3.0. In fact, **if you plug in a RAM card which stores data created by an earlier version into a 48 to use with a Version 3.0 TDS-48 Card, the card will first convert all of the data on the card to the new format. And thus, you will not be able to move it back.**

This will only cause a potential problem for survey firms which use a mix of older version and new version cards, and want to interchange data among them. This data interchange by card can only go one way, from older cards to newer cards. However, the file transfer format used by these various versions is the same. **Existing versions of the TDS-TFR PC software will accommodate data from all versions of the TDS-48 or the TDS-48.** Thus, if you want to move coordinate data collected by a Version 3.0 Card back to a machine containing a earlier version card, you should complete this transfer using the file transfer capability of the two products rather than doing a card swap between machines. (This may be done wirelessly by using the infrared data transfer capability of the HP-48SX.)

NOTE: Remember, if you try to use a card created by or used by a TDS-48 Version 3.0; upon start-up, the software will first prompt you to see if it can erase all of the data in port 2. Thus, you should be very careful in swapping data cards among cards of mixed vintage.

RUNNING THE TDS-48

Turn the TDS-48 **[ON]**. When you first turn on your TDS-48, you are presented with the standard HP-48SX operational stack in the display. The keyboard will respond as a standard HP-48SX. It is beyond the scope of this manual to describe the operations of the standard HP-48SX. To learn how to use your system as a standard HP-48SX, consult the HP-48SX Operator's Manuals that came with your unit.

INTRODUCTION

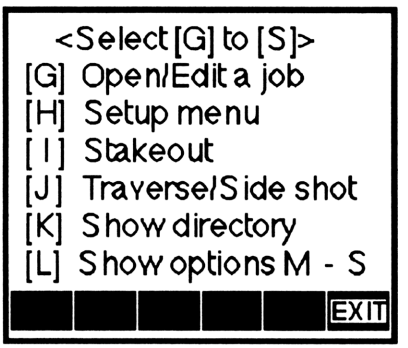
When the TDS-48 Surveying Card software is running, the Card takes over the control of the operation of the unit and the machine will *not* behave as a standard 48. To use the unit as an HP-48SX it is necessary for you to EXIT the program (see below).

To run the Surveying Card Software, first press the alpha key [α] [α] twice.

> **NOTE:** This manual uses the convention of showing keystrokes in **[BOLDFACE]** enclosed in square brackets **[]**. This convention is used whether the key is primary, shifted or a "soft" key. The alpha key is the one directly above the *gold* left shift key and is depicted in this manual as it is on the keyboard as **[α]**. In the standard HP-48SX, pressing **[α]** once will enable the alpha key definitions for the next keystroke. Pressing **[α]** twice will lock the system in alpha mode. You will learn more about the keyboard and display of the TDS-48 in the next chapter: Getting Started.

Now, in alpha mode, type **[F] [C] [4] [8] [ENTER]**. (Use of the **[ENTER]** key will clear alpha mode.)

You should now see the Main Menu of the TDS-48.



Once you have activated the TDS-48 software, the TDS-48 will remain in control of the system until you intentionally return to the standard HP-48SX operating system. Turning the unit OFF and then ON again should return you to the same screen that was active when the unit was turned OFF.

EXITING THE TDS-48

If you wish to exit from the TDS-48 and return control of the system to the standard HP-48SX operating system, press the **[EXIT]** softkey **[F]** from the Main Menu (screen above). You may now return to the TDS-48 by repeating the instructions given in the previous section.

NOTE: For a more detailed description of "soft" keys and their use, see Chapter 2 - Getting Started.

HOW TO LEARN THE SYSTEM AND HOW TO USE THIS MANUAL

The best way to learn the TDS-48 System is just to sit down and use it. You will find the user interface to be very intuitive and easy to master. This is due primarily to the consistency within the TDS-48 which has been widely accepted within the surveying community. The TDS-48 utilizes a combined "Menu"-and-"Screen" user interface. Screens make appropriate use of the HP-48SX's "softkeys". These six keys across the top of the keyboard are defined as is appropriate to each job. The definitions of these keys is always shown in the bottom row of the 48's screen. After you've learned a few "rules of the road" (Chapter 2), the most effective way to master any feature of the TDS-48 is to go ahead and press some keys. See what happens. You can't hurt the TDS-48.

This User's Manual is organized into two major sections. The

first consists of introductory material and a series of examples which teach the various features of the TDS-48 system in tutorial fashion. The second section consists of a detailed Reference Manual which describes all of the functions of the TDS-48. It is organized by class of function. Having mastered the basic operation of the TDS-48 by learning the "rules of the road" and by following the example problems, you should then need to use the Reference Manual only to answer specific questions about detailed operations of a particular function.

2. GETTING STARTED

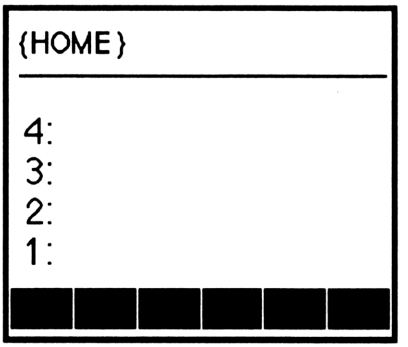
In this chapter you will start to use your TDS-48. You will initialize the unit by setting the correct time and date and by selecting the various devices with which your TDS-48 will communicate. You will learn how the features and functions in the TDS-48 are organized and how the various kinds of data are stored. Finally, you will set up your first job.

BEFORE YOU START

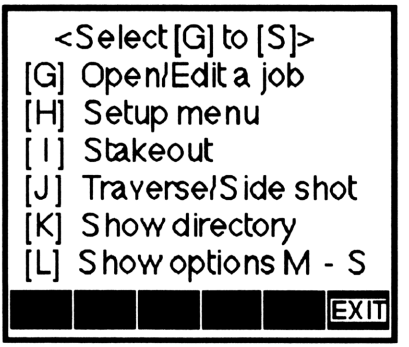
Before you start, you should be certain that you have installed in your HP-48SX your batteries; your TDS-48 Surveying Card; and, *either* an HP-82214A 32k-byte RAM Card *or* an HP-82215A 128k-byte RAM Card. For installation instruction see Chapter 1 - Introduction.

THE RULES OF THE ROAD

Now press the **[ON]** key. You will see the operational stack of the standard HP-48SX operating system displayed as:



Now press **[α] [α] [T] [D] [S] [4] [8] [ENTER]**. The TDS-48 Surveying Card has now taken over control of the machine. You will see the MAIN MENU of the system which looks like:



Now press the **[➡]** and **[ON]** keys. As you probably already know, you access the functions printed in *gold* above the keys by pressing the gold shift key **[⬅]** *before* the appropriate key. Likewise, you access the functions printed in *blue* above the keys by pressing the blue shift key **[➡]** *before* the appropriate key. In this case, pressing **[➡]** prior to pressing **[ON]** will execute **[OFF]**.

Now press **[ON]** again. Notice that you return to the Main

Menu. This is where you were when you turned the unit OFF. This is the *first Rule of the Road:* **When you turn the TDS-48 ON, you will return to the screen or menu location occupied when you turned the machine OFF.**

The six boxes at the bottom of the display screen are called *"soft"* key labels. They identify the functions of the six keys in the top row of the keyboard. Pressing any one of these keys will activate the function shown in the box above that key in the bottom row of the screen. The functions will change depending on the particular screen that you are using and the problem that you are solving.

MENUS VS. SCREENS - WHAT'S THE DIFFERENCE?

The TDS-48 is an intuitive use machine. Much progress can be made in mastering its system by pressing keys and seeing what happens in response. However, full understanding of the machine requires that a few simple concepts be well understood. One of these is the difference between a MENU and a SCREEN. A MENU is a display that is characterized by a list of functions or operations which may be selected by choosing one of the alphabetic keys listed down the left hand column of the display. Except for the **[EXIT]** key, MENUS do not use active "soft" keys. The **[EXIT]** key is always labeled above the **[F]** key on the right. Pressing one of the alpha keys shown in the MENU display will present you with either another MENU (with more alpha choices and an **[EXIT]** key) or a SCREEN.

The **[EXIT]** key will always return to the SCREEN or MENU location occupied prior to a current SCREEN or MENU. Thus, MENUS in the TDS-48 are arranged like a "tree". By selecting a sequence of alpha keys, you make progress from the MAIN MENU (the trunk of the tree) to the large branches (additional menus) to the small branches (sub-menus or screens) and then to the twigs and leaves (screens). By pressing **[EXIT]**

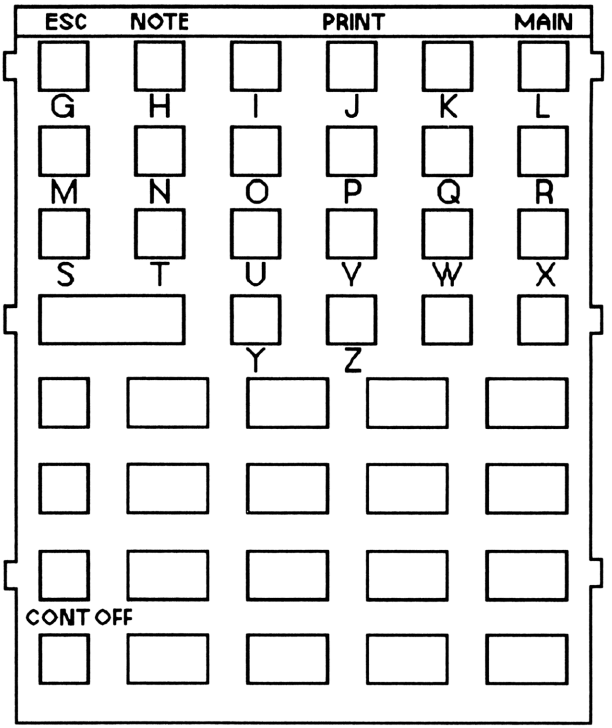
successively, you can progress back through the branches to the trunk (the MAIN MENU).

As an example of how this works, consider the Curve Menu. The MAIN MENU is large enough to require two displays. You may access the second display by pressing **[L]** in the MAIN MENU and viewing the choices M through S. (As you become familiar with the TDS-48, you will learn the frequently used letters in the MAIN MENU. You will be able to access the choices in the second screen from the first screen by pressing the appropriate letter directly.) The Curve Menu is choice **[Q]**. Press **[Q]** and see the Curve Menu. Arbitrarily choose **[G]:** Horizontal Curve. This presents you with the Solving Horiz Curve Screen in the display. This is the screen where you will solve your horizontal curve problems. You will practice with this screen in the next section. Now press the **[EXIT]** softkey three times. Pause each time to notice how the TDS-48 returns to the previous MENU in the MENU "tree". Finally, you arrive back at the first display of the MAIN MENU.

NOTE: In the HP-48SX, the top row of keys are used for the alpha keys A - F, as well as for the softkeys. For this reason, all Menu labels in the TDS-48 will begin with the letter **[G]**. Since there is no ambiguity in *MENUS* between menu selection keys and softkeys, it is *not* necessary to press the [α] key prior to making a menu screen selection.

THE KEYBOARD OVERLAY

Your TDS-48 Surveying Card comes with an overlay which you may install on your HP-48SX's keyboard to help you locate the alpha keys more easily and to mask the shifted function on the 48 which are not used by the TDS-48. The overlay appears as shown:



Note that the alpha keys, printed in black, are positioned below the associated key. The **[CONT]** and **[OFF]** functions, printed in orange and blue respectively, are positioned above the **[ON]** key with which they are associated. The Global Top-Row Keyboard Functions (see below) are printed in orange at the top of the overlay, but each is associated with the key just above it in the top row.

GLOBAL TOP-ROW KEYBOARD FUNCTIONS

In addition to the six softkeys whose functions change depending on the screen that is active, there are four *Global*

Keys that you access with the *gold* shift key and three of the keys in the top row. They are the keystrokes **[←] [A]** **[←] [B]**, **[←] [D]**, and **[←] [F]**, and the functions they perform are **[ESC]**, **[NOTE]**, **[PRINT]**, and **[MAIN]** respectively. These functions are described briefly below:

[ESC] - **[←] [A]** The **[ESC]**, Escape, function allows you to escape temporarily from the TDS-48 program and return to the main operating system of the HP-48SX. This function will also "bring with it" the contents of the current screen at the current cursor location and load this value into the HP-48SX operational stack at level 1. Then you can perform any calculation that you want on this value, including running your own software. When you return to the TDS-48, the system will return to the screen that you were in prior to the escape; and whatever is in level 1 of the stack when you return will be loaded at the cursor location in the screen that you wire in prior to the escape. The keystrokes required to execute the Escape function are **[←] [A]**. The details of the operation at the function are given below.

The **[ESC]** (Escape) functions may only be executed from a SCREEN. When you are in a screen and you press **[ESC]** - (**[←] [A]**), control of the system is passed temporarily from the TDS-48 to the operating system of the 48SX. In addition, the numerical value in the screen at the screen cursor location is loaded in the operational stack of the 48 at level 1. The word "HALT" appears in the annunciator line at the top of the screen to indicate that a running program has been halted. Thus, it is now possible for you to perform any calculations that you want in the stack, including calculations on the value that has been returned. This can be done either manually from the keyboard or via other software routines which you may have written and loaded into the system memory. When you are finished and wish to return to the TDS-48, press **[←] [CONT]**. (**[CONT]** is the orange shifted function above the **[ON]** key.) You will return to the screen you were in before executing **[ESC]**. When you return, the value at the cursor location is replaced by the

value from level 1 of the 48's stack.

[NOTE] - [←] [B] The **[NOTE]** function will allow you to key in arbitrary text information into the raw data file of the active job. At any time during your work, if you would like to record a note, such as the names of your crew or any other pertinent information, press **[←] [B]**. You will then be able to key in random text information which will be stored in the raw data file as a note.

[PRINT] - [←] [D] The **[PRINT]** function will allow you to print the current contents of the screen onto the HP-82240B Infrared Printer. This function may be accessed from any screen or menu in the TDS-48 at any time that you want a hard copy of your work.

[MAIN] - [←] [F] The **[MAIN]** function will allow you to return to the MAIN MENU from any other menu or screen in the TDS-48. It is a shortcut method of returning to the Main Menu "home base" without pressing **[EXIT]** repeatedly as described above.

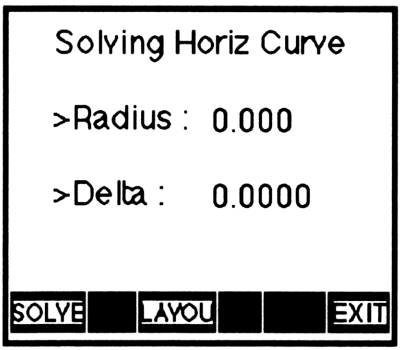
If you would like to see the complete MENU "tree" for the TDS-48 and identify the kinds of surveying problems that can be solved with the TDS-48, turn to pages R-8 to R-10 in the Reference Manual. Just to be sure that you understand this concept, practice moving around the various MENUS and SCREENS using the alpha and **[EXIT]** keys. Use the Menu "tree" in the Reference Manual as a guide.

SCREENS

From the MAIN MENU, return to the Solving Horiz Curve Screen. As you recall, the key-strokes are **[Q] [G]**. As you can now see, a SCREEN is characterized by labels and data on each of the lines of the display separated by colons and by a variety of "soft" key labels at the bottom. These "soft" keys

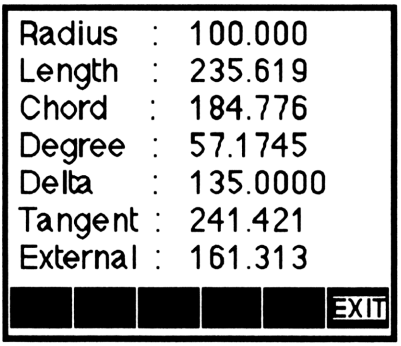
give you several options of functions to perform. It is in the SCREENS where you will *enter your data* and *solve your surveying problems.* While the user interface among the various SCREENS is consistent, each SCREEN solves a different kind of problem. Each SCREEN is explained in detail in the Reference Manual. *You don't solve problems* in the MENUS. The MENUS are just an aid to help you navigate the various TDS-48 SCREENS.

The Solving Horiz Curve Screen appears as:



You will use this screen to solve your first surveying problem and, at the same time, learn some very important concepts or *Rules of the Road.* The first has to do with the uses of the vertical cursor keys [∧] and [v]. When you first enter this screen, the value of the radius is highlighted by a *scroll bar.* By pressing one of these vertical cursor keys, you will move the scroll bar to the next data entry field. The [∧] key moves the scroll bar up in the screen. The [v] key moves the scroll bar down in the screen. (Since this particular screen has only two data entry fields, the action of the two vertical cursor keys is the same.) Thus, the procedure for solving a horizontal curve is to place the scroll bar at each data entry field as defined in the screen; key in the appropriate value; and press the proper solution softkey. In this case, suppose you want to know all of the curve parameters (solve the curve) for a horizontal curve of

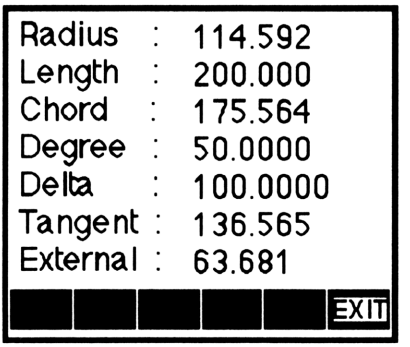
100 ft radius and a delta angle of 135°. With the scroll bar at the radius line, key in 100. Then press **[v]**. (The **[ENTER]** key will also move the scroll bar to the "next" data entry line.) Now key in 135 and press **[SOLVE]** (softkey **[A]**). The screen will now display the solution curve parameters for the curve you have solved.



NOTE: All angles in the TDS-48 are entered and displayed in degree-minutes-and-seconds format and are resolved to the nearest second. The format is DDD.MMSS, where DDD indicates degrees; MM is the minutes; SS the seconds.

Now, pressing **[EXIT]** will show you the last computed curve parameter, the mid-ordinate. Press **[EXIT]** again to return to the Solving Horizontal Curve Screen. This time you will solve a horizontal curve with different known curve parameters and, at the same time, learn the special function of the horizontal cursor keys **[<]** and **[>]**. Suppose that instead of the radius and delta angle of the curve, you know the degree of curvature and the arc length. In this case, it is a curve of 50 degrees of curvature and an arc length of 200 ft. Notice that both data input labels in this screen have a ">" symbol on the screen in front of the label. This symbol is called the *scrolling prompt* symbol. It indicates that you may change the input label prompt by use of the

horizontal cursor keys **[<]** and **[>]**. With the scroll bar on the Radius input line, press the **[>]** key. The prompt will change to "Degree". Key in 50 and press **[v]** (or **[ENTER]**). Now press **[>]** multiple times to see the selections for the second curve parameter. With the label on "Length", key in 200 and press **[SOLVE]**. The solution screen will display the parameters of this new curve.



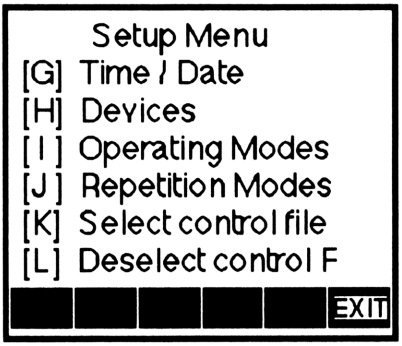
NOTE: A ">" character in front of any prompt in a TDS-48 screen allows you to change the prompt to another option by scrolling through those options with the horizontal cursor keys.

INTERACTIVE USE OF THE MENUS AND SCREENS - THE SETUP MENU

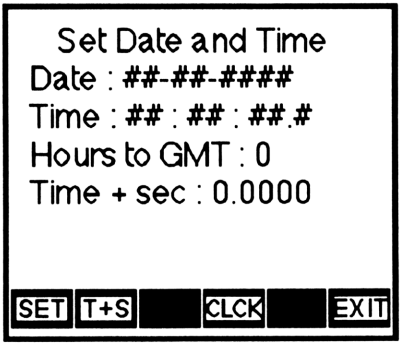
One of the first things that you will want to do after you get familiar with your TDS-48 is to set up the unit for the kinds of jobs and surveys that you do. In addition, you need to become familiar with the interactive nature of the various menus and screens of the TDS-48 as soon as possible. The present section of the manual will illustrate the use of the menus and screens by taking you through a typical setup routine. At the end of this section, you should have the unit set up for your particular

equipment and application. Just as importantly, you should be very familiar with the way menus and screens in the TDS-48 interact.

From the Main Menu, press **[H]** to access the Setup Menu. You should now see the Setup Menu which appears as:



Sooner or later you will need to set the time and date in the machine. So press **[G]** and see the Time and Date Screen:



NOTE: Throughout this manual we will use the convention of displaying the "#" character in any field on the screen where it is not possible to predict what your particular unit will show. In the screen above, your unit will "wake up" with some time and date shown in the top two lines, but not the #s that are used in this example.

Like all of the other screens, the time and date screen is discussed in detail in the Reference Manual. However, this screen is included here to reinforce your understanding of the format of screens in general, and, in particular, how they work in conjunction with the four cursor keys and the five "soft" keys.

Notice in this screen that you cannot move the scroll bar to either of the top two rows. These rows display the *results of computations* . They are not fields that may be modified *directly* from keyboard entries. In the screen above, the other two data entry fields will accept numeric input from the keyboard. With the vertical cursor keys, move the scroll bar to the appropriate field and key in the desired numeric data from the keyboard. These particular fields will accept numeric data only. If you attempt to key in alpha data, the TDS-48 will reject it. This is another important feature of the unit. Only acceptable data types are permitted in any data field in the machine.

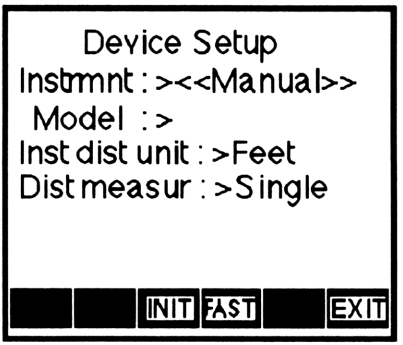
Now, explore the "SOFT" keys. The "SOFT" keys are actually commands to tell the TDS-48 to perform some calculation or function and report the results in the answer-field in the screen. EXAMPLE: to set the date and time, press **[SET]** and follow the prompts in the screen. First key in the current date. Then press **[ENTER].** Next, key in the time in 24-hour format. Press **[ENTER].** The TDS-48 will display the new date and time in the top two rows of the screen. Now press **[CLCK].** The time is updated continuously. You should check this time against a precise time standard and note how many seconds and fraction of seconds to add to bring the machine's time in

synchronization with precise actual time. Then, press a key to break the continuous display. Move the scroll bar to the Time + sec : data line. Key in the time to be added. If you need to subtract time, key in a negative number by using the **[-]** key. Press the **[T+S]** "soft" key. Repeat this process until you have an accurate time being displayed in the screen. Finally, move the scroll bar to the Hours to GMT data field. Key in the number of hours that would have to be added to the time in your time zone to equal Greenwich Meridian Time. Press **[ENTER]**. This parameter is required if you plan on using your TDS-48 for doing sunshots in the field.

NOTE: Dates are entered in the format MM.DDYYYY where MM is the month, DD is the day, and YYYY is the year. Time is entered in the format HH.MMSS where HH is hours, MM is minutes, and SS is seconds.

Now you have set the proper time and date into your TDS-48. When you are finished, press **[EXIT]** to return to the Setup Menu.

Next you'll use the Device Setup Menu. From the Setup Menu, press **[H]** and you'll see:



This is the menu from which you will establish the brand and

model number of the gun to which the TDS-48 will be connected. You can also establish the measurement mode of the gun (single shot or averaging mode).

In this particular screen, notice that all of the data fields have the ">" symbol in the actual data field itself. This indicates that these particular input fields allow only a limited number of input values, and that, rather than keying them in, you may review and select the proper one by using the horizontal cursor keys. Note that the Instrument name and Model lines of the screen are interactive. With the scroll bar on the Instrument line, pressing the **[>]** key will scroll through the instrument name choices. Also, the list of model number options in a particular Model line will be restricted to those that go with the particular brand of instrument.

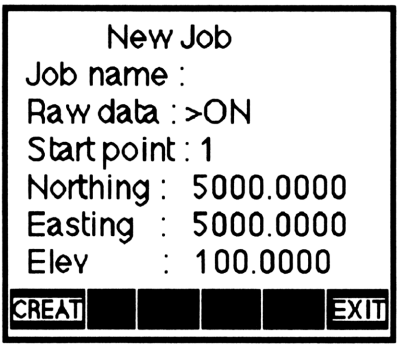
With the scroll bar at the instrument line, press **[>]** repeatedly to see the selections. When you have the proper brand name of total station in the display press **[v]** or **[ENTER]** to move to the Model line. You may now scroll and select the proper model of your brand of total station.
After you have completed the Device Setup Screen, press **[EXIT]** to return to the Setup Menu.

You should now be able to complete the setup procedure for Operating modes and Repetition modes. If you have any trouble understanding the prompts or what the choices mean, consult the screen in question in the Reference Manual. Once your TDS-48 has been set up, it is not necessary to set it up again unless you want to change one or more of the settings. You may change any of the settings at any time, even in the middle of a surveying job. TO RESET: locate the proper Setup Screen. Change the appropriate setup options. Proceed with the job in progress.

CREATING YOUR FIRST JOB

The TDS-48 is now set up so that it is compatible with your equipment. You are ready to do your FIRST JOB. Return to

the Main menu. Press **[G]** to see the Open/Edit a Job Menu. Since you don't have a job established in the machine, you will have to begin by pressing **[G]**. This will present the New Job screen:



The scroll bar is highlighting the Job name field. You may now key in the name of your job. The name may be any combination of up to *eight* alpha, numeric or special characters. You should also realize that you may key in alpha characters in either upper or lower case. The TDS-48 will maintain a distinction between them. For example, name this job **SMITH**. The TDS-48 will treat it as distinct from a job named **Smith**.

NOTE: Unlike *Menus* where you may key in the alpha menu selections without using the [α] key, alpha data fields in *Screens* require you to press the [α] key in order to put the TDS-48 into alpha mode. Pressing [α] once will lock the keyboard into alpha mode and pressing the gold shift key while in alpha mode will lock in lower case characters. Since the cursor keys are used to input alpha characters in alpha mode, you must press [α] again to take the unit out of alpha mode. However, pressing **[ENTER]** will clear alpha mode as well as cause the scroll bar to move to the next data input line in the screen.

As you work in the field, the TDS-48 will collect your field measurements and compute the coordinates (northing, easting, and elevation) of each of the points that you survey. These coordinates are computed automatically from the raw field data. The coordinates are then stored in the TDS-48 under the job name you have set up; in this case, SMITH. However, you also have the option of having your TDS-48 record your raw data. If you would like the TDS-48 to record your raw data, just move the scroll bar past the the raw data line of the display. If you do not want the raw data to be stored, move the scroll bar to the raw data line and press **[>]**. This will set the raw data field to OFF.

NOTE: The coordinates and the raw data are actually stored in different parts of the FC-48's memory. The coordinates may be viewed, modified, adjusted, overwritten, erased, used in CO-GO calculations, etc. On the other hand, the *raw data* may only be viewed, printed out, or transferred to an office computer. They may not be erased or modified in the field. Once a field measurement is taken, the raw data record is updated with the measurement. It may not be altered in the TDS-48.

Because of this, it is highly recommended that you always have the raw data feature ON every time that you survey. With access to the raw data in the office, it will always be possible for you to recreate the original survey without returning to the field. This will be true no matter how altered the *coordinates* may have become.

In the next field in the New Job Screen, you will key in the *starting point number*. Most often this number will be 1. However, it may be any number. This number will also become the smallest point number that the TDS-48 will accept for this particular job. If your starting point is not the smallest point number that you plan to use in a job, you should key in the (correct) smallest point number in this field. Next, provide the

coordinates of the starting point: northing, easting, and elevation. The default values are shown in the display as 5000.0000 ft. for both northing and easting and 100.0000 ft. for elevation.

NOTE: As you will learn when you examine a coordinate file, each point also may have a point descriptor or annotation of up to sixteen characters. The default descriptor for the staring point is START. If you would like to use something else, you may edit this descriptor. You will learn to do this in the section on editing coordinates.

Once you have the New Job screen properly configured, press **[CREAT]**. This is the command that instructs the TDS-48 to create the SMITH job as you have specified it in the screen.

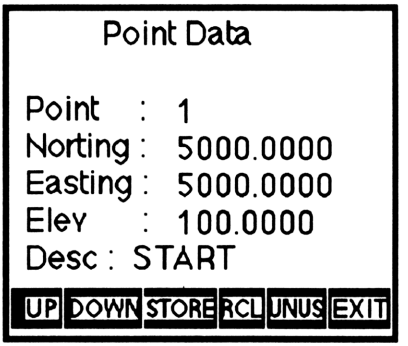
NOTE: This is another general *"rule of the road"*. While you are moving the scroll bar around the screen keying in information in response to prompts, the TDS-48 does not take any direct action. If you make a mistake, you may reposition the scroll bar over the erroneous entry and key in the correct information. The TDS-48 takes its action for any particular screen only in response to a direct command from you. These commands are usually issued by pressing one of the "soft" keys labeled in the bottom row of the display.

After you have pressed **[CREAT]**, the TDS-48 will establish the job SMITH. The TDS-48 will transfer to the Current Job Info Screen so that you may review the status of the current job. Press **[EXIT]** from this screen to return to the Jobs Menu.

The number of jobs that you can store in your TDS-48 at one time is limited only by the total memory of the machine. You can establish any number of jobs exactly as you have established SMITH. To switch between jobs that have already been created,

use the **[H]** key from the Jobs Menu.

You will get practice with the Edit coordinates and View raw data screens when you do the examples in this manual. For the present, press **[J]** from the Jobs Menu. You will see the coordinates for point 1 of the SMITH job that you established earlier.

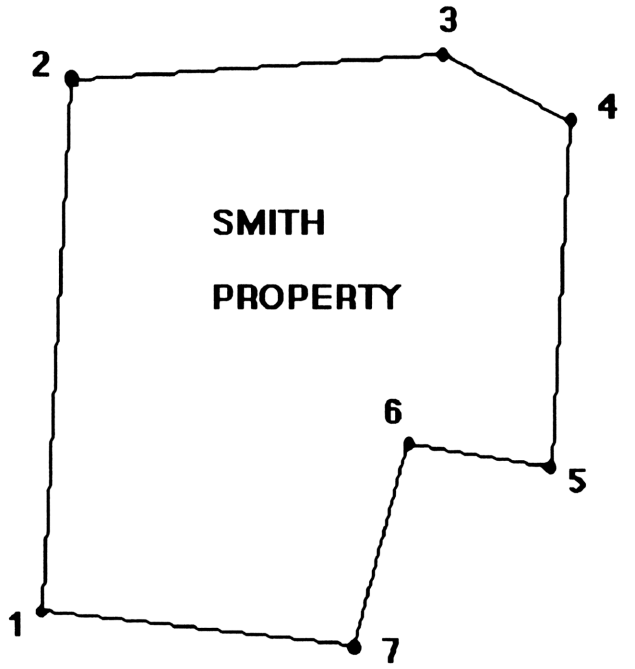


3. YOUR FIRST JOB WITH THE TDS-48

In this chapter, you will begin to do work on the SMITH job which you established in the "Getting Started" Section. You will enter coordinates of the corners of the SMITH property into the TDS-48. You will work with these coordinates using the various Coordinate Geometry (CO-GO) screens. You will create new points for the SMITH job using these CO-GO routines. By the end of this section, you should be familiar with the operation of the screens of the TDS-48 and should have practiced with a variety of CO-GO routines.

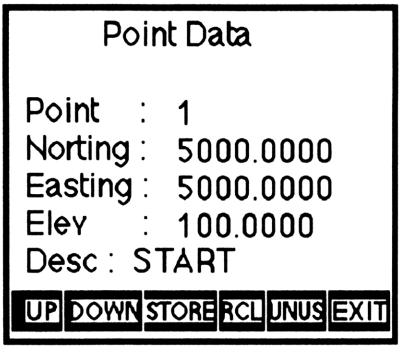
You are now familiar with the TDS-48. You have the unit set up for your equipment and methods of surveying. It's time to put it to work. To get started, work through a sample job called SMITH. It's the one that you created in the Chapter 2: "Getting Started". As you recall, you established the SMITH job with the starting point at 1 using the default coordinates of northing and easting, each equal to 5000.0000 ft. and an elevation of 100 ft. Here is a picture of Mr. Smith's property and a table of coordinate values for the property corners as shown. If you had the raw data from the original survey, you could use it to get these coordinates back into the machine. An alternative method is just to key them in as listed.

FIRST JOB



POINT NUM.	NORTHING	EASTING	ELE.	NOTE
1	5000.0000	5000.0000	100.0000	START
2	5710.2358	5040.8379	103.2864	PT 2
3	5740.5392	5497.5792	106.3649	PT 3
4	5654.9688	5679.7808	108.2213	PT 4
5	5158.3949	5658.6257	117.3596	PT 5
6	5198.2460	5438.2277	114.7919	PT 6
7	4970.3168	5385.8389	112.3029	PT 7

Select the Edit Coordinates screen from the Jobs Menu: From the MAIN MENU, Press **[G]**, then **[J]** (Edit Coordinates) and you will see:



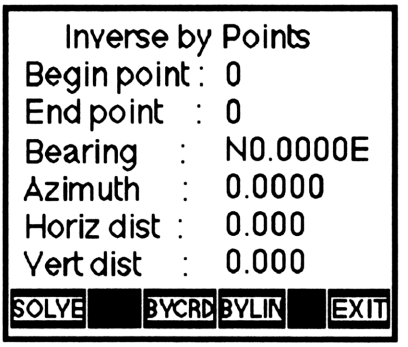
To key in the coordinates, move the scroll bar to each of the data fields and enter the proper values for each one of the points. After you have built a correct screen for each point, press **[STORE]**. Then, move on to the next point. The **[UP]** and **[DOWN]** keys in this screen will help you review the coordinates of points related to the one you are working on. The other commands are equally straightforward. If you are having trouble with this, consult the Point Data Screen in the Reference Manual.

Remember that no matter how the point coordinates get into the TDS-48: whether they were computed from raw data during a field survey; computed by the CO-GO functions in the machine; or keyed in as you have just done, you may always review them in this way: go to the Jobs Menu, and press **[J]** (Edit Coordinates) for the Point Data Screen.

PRACTICE WITH CO-GO - INVERSE BETWEEN POINTS

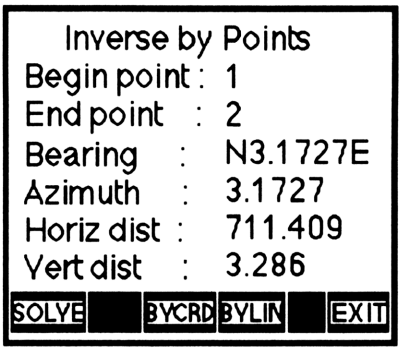
To illustrate this point, take a few minutes now to practice with some of the CO-GO functions on the SMITH job you have just loaded into the machine. From the Main Menu, press **[M]**. The CO-GO Menu is displayed. You'll see ten different coordinate geometry functions in the menu. As an example of

how they all work, assume that the first thing that you want to do is inverse (compute the bearing and distance) between points 1 and 2 in the SMITH job. From the CO-GO Menu, press **[J]** to get the Inverse Screen. That screen should look like:



Like all of the screens in the TDS-48, the use of this one is quite straight forward. Move the scroll bar to the field into which you want to key data; key in the data; move the scroll bar to another field; key in that data, etc. When you have built the screen to be representative of the problem that you are trying to solve, then just press **[SOLVE]**.

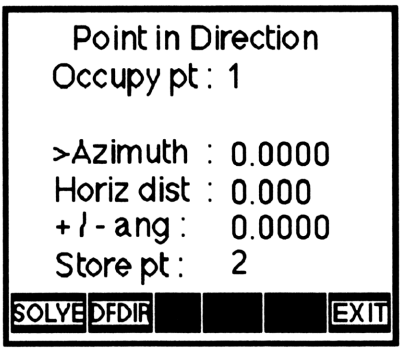
In the case of the *inverse* function, specify 1 as the beginning point; 2 as the ending point; and press **[SOLVE]**. The azimuth, bearing, horizontal distance, and vertical distance between points 1 and 2 will be displayed:



Notice also that, by pressing **[BYCRD]**, you will see a screen that will let you inverse by coordinates rather than by point number; and, by pressing **[BYLIN]**, you will be able to inverse between a point and a line defined by two other points. You may wish to practice with these screens at this time also.

MORE PRACTICE WITH CO-GO - POINT IN DIRECTION

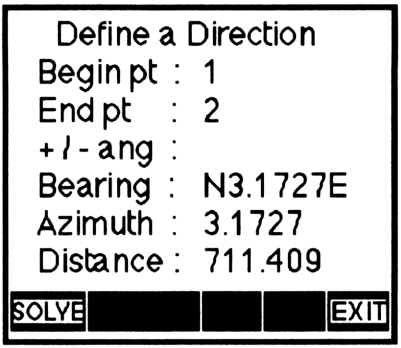
Now you know that the horizontal distance between points 1 and 2 is 711.409 ft. Assume that you want to create 7 new points at 100 ft intervals along the line between points 1 and 2. The function that will do this is the Point-in-Direction function. From the CO-GO Menu, press **[K]** to access it. You should see:



This screen illustrates several important concepts. As in the Inverse Screen, the general procedure to solve this problem is to build the appropriate screen and then press **[SOLVE]**. You should key in 1 as the occupied point and 8 as the first point to be solved for and stored. Also key in 100 as the horizontal distance. The procedure is very similar to the one used to key in coordinates. Build the screen. Then give the machine a command to do something; in this case, **[SOLVE]** for new coordinates and store them in point 8.

Note that the Azimuth line of the display has the ">" scrolling prompt character similar to the Solving Horizontal Curve Screen which you used in Chapter 2. The operation of the horizontal cursor keys in this screen is the same as in the Solving Horizontal Curve Screen. When you move the scroll bar to the azimuth line and press either of the horizontal cursor keys (**[<]** or **[>]**), both the value of the data in that line and the *prompt label* will change. In this case, the Azimuth prompt well change to a Bearing.

In this particular example, assume you don't know either the azimuth or the bearing of the line between points 1 and 2. Invoke the command **[DFDIR]**, *define direction.* Let the TDS-48 compute the azimuth from the point numbers. Press **[DFDIR]**; key in points 1 and 2 to define the line; and press **[SOLVE]**. The TDS-48 will compute the azimuth and bearing of the line and and you'll see:

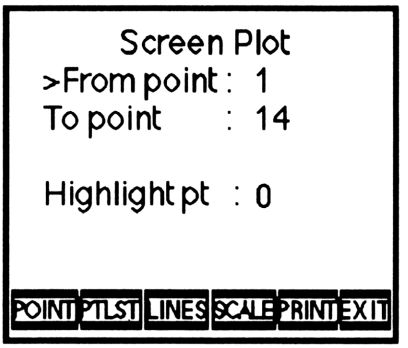


Now, press **[EXIT]** to return to the Point in Direction Screen. Note that the correct azimuth has been filled into the data field for you. Now press **[SOLVE]** to get the coordinates of your first point that is 100 ft from point 1. This will be stored as point 8. A new screen will prompt you for an elevation. Choose an elevation by keying one and pressing **[ENTER]**. Or, you may use the one displayed for you (112.30 ft in this case) by just pressing **[ENTER]**. Next, the TDS-48 will prompt you for a descriptor. Again, key in a descriptor (such as PT 8) and press **[ENTER]**. The machine will return to the Point in Direction screen, set up to solve for the next point, point 9. This procedure may be repeated six more times to obtain the coordinates of the rest of the points at 100 ft intervals along the line from 1 to 2. The last point stored will be point 14. (Note: you do not have to solve for the azimuth each time because it will not change.)

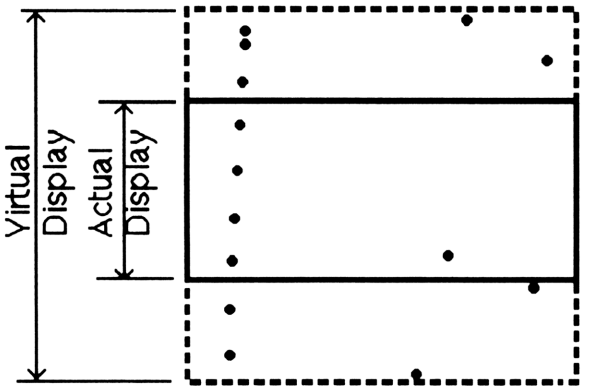
SCREEN GRAPHICS

At this point, you may wonder if those coordinates are indeed along a line between points 1 and 2. One way to tell is to look at these coordinates and try to figure out where they are in relation to the corners of the Smith property. However, there's an easier and faster way. You can use the Screen Plot

capability of the TDS-48 to show the points of the SMITH job graphically in the display. To do this, return to the Main Menu. Press **[P]** for the Screen Plot Screen. As shown below, specify points from point 1 to point 14.



Then press **[POINT]**.



Use the **[∧]** and **[v]** keys to scroll to the "hidden" portions of the plot.

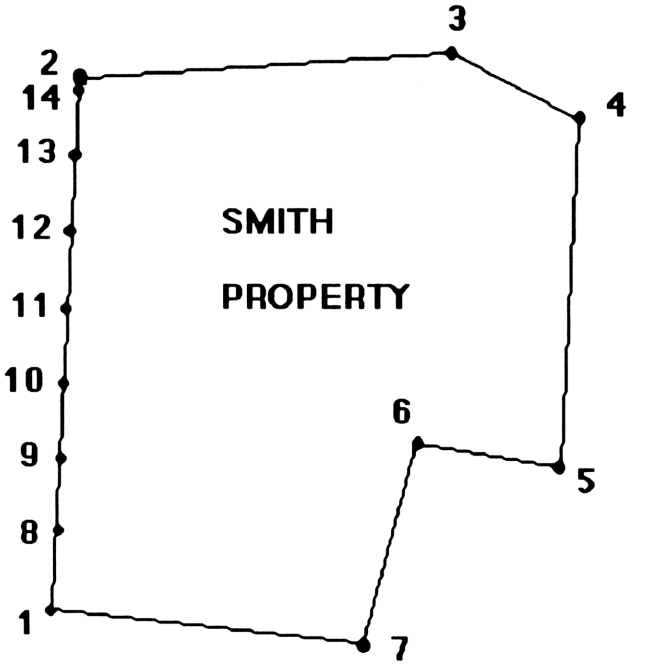
You should now see a partial plot of the points of the SMITH job in the display. Use the **[∧]** and **[v]** keys to view the rest of the plot. Press the **[ON]** key to return to the Screen Plot Screen. See if you can determine what happens if you key one of your point numbers into the "Highlight pt" field. Then press **[POINT]** again. You may also want to see what happens

when you press **[LINES]**.

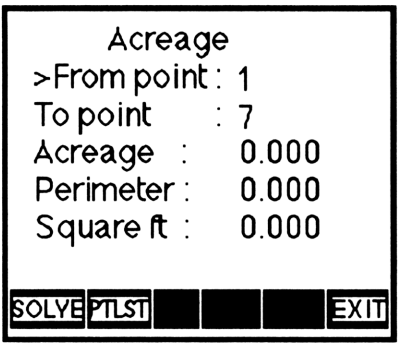
NOTE: The first time that you do a screen plot after you have opened a job, the TDS-48 will automatically set the scale for all screen plots for that job. The TDS-48 will search the coordinate file and select a scale that will plot all of the *specified* points in such a way that they will completely fill the virtual display as shown in the above figure. The scale and location of the points will not change for this job unless you press **[SCALE]**. Pressing **[SCALE]** in the Screen Plot Screen will recompute the scale and location of the plotted points based upon the *new* group of selected points.

MORE CO-GO AND THE POINT LIST - ACREAGE

After you've created points 8 through 14 at 100 ft intervals along the line from point 1 to point 2 in the SMITH job, your picture of the SMITH property should look like: (Point numbers are shown in the manual for reference. Point numbers will *not* appear in a screen plot.)



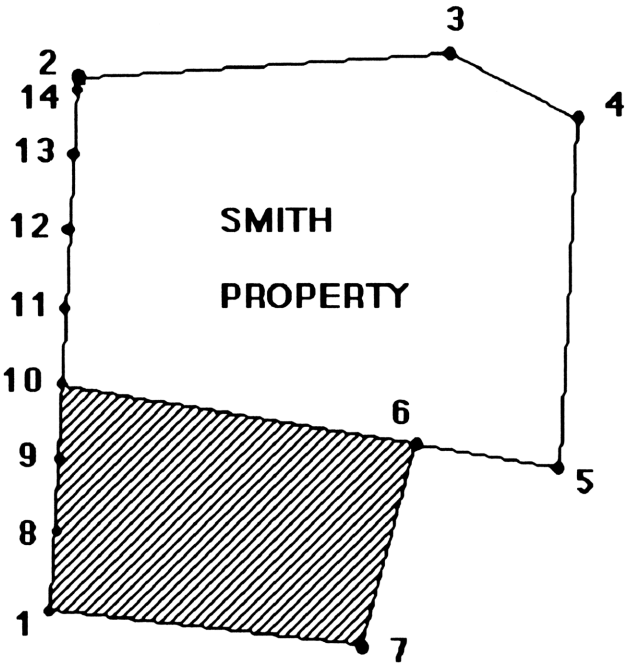
For your next task, you want to find the area of the SMITH property in acres. From the CO-GO Menu, press **[G]** to select the Acreage Screen. The Acreage Screen appears as:



Load the first and last corners of the survey into the "From point" and "To point" fields of the screen. To compute the acreage in acres and square feet and the perimeter in feet, press **[SOLVE].** When you use the "From point" and "To point" fields, the TDS-48 assumes that the acreage that you want to compute is bounded by lines connecting all of the points in sequence from the first point to the last point and then closing back to the first point again. In this case, that means lines connecting from point 1 to 2 to 3 to 4 to 5 to 6 to 7 and back to 1. If you have done this correctly, you should see an area of 9.788 acres, 426354.80 sq ft, and a perimeter of 2712.297 ft.

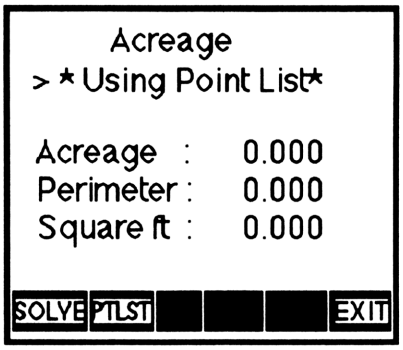
This process works well for those areas that are bounded by lines between points which are numbered *consecutively*. However, suppose you want to compute some other area. Take as an example the area bounded by lines that go from point 1 to 10 to 6 to 7 and back to 1.

NOTE: When the distance units of the TDS-48 are set to feet, the area is reported in both acres and square feet and the perimeter is in feet. When the units are set to meters, the screen is called the Area Screen; the area is in square meters; and, the perimeter is in meters.

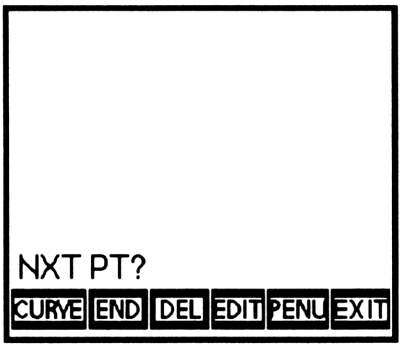


To solve this problem, it is necessary for you to be familiar with the concept of the "**Point List**". In its simplest form, the **Point List** is merely a way to define a sequence of point numbers that are not consecutive. In reality, it is a special kind of file in the machine that consists of the list of point numbers. To solve this particular acreage problem, you must do three things. First, you must specify the sequence of point numbers for the TDS-48 to use. Next, you must set up the Acreage Screen to compute area using that Point List. Finally, you must press **[SOLVE]**.

Note that the "From point" line in the Acreage Screen has the scrolling prompt symbol ">" at the beginning of the line. By pressing one of the horizontal cursor keys, either **[<]** or **[>]**, you will scroll the input format of the points making up the boundary of the area to be computed to:



Next, you must create the proper Point List file. To do this, press **[PTLST].** You will see the Point List Menu. Choose **[G]** to see the Point List Screen:

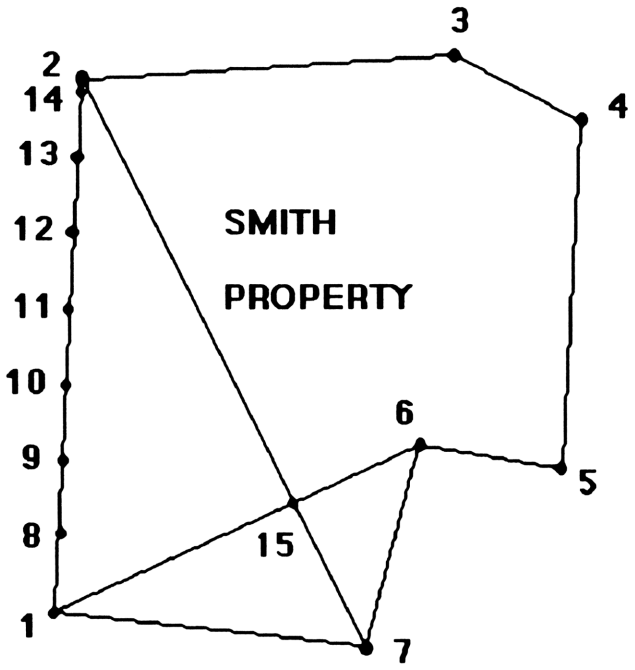


The NXT PT? line is where you key in the first point that you want; in this case, 1. Key in **[1]** and press **[ENTER]**; then **[1] [0] [ENTER]** and so on through points 6, 7 and back to 1. Notice how the point numbers are displayed in the screen as you key them in. You may now exit from the Point List Screen by pressing **[EXIT]**. Press **[EXIT]** again to return to the Acreage Screen. Finally, press **[SOLVE]** to compute the area of this portion of the SMITH property. The correct acreage is 2.495 acres.

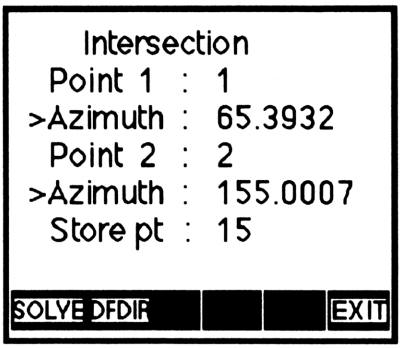
NOTE: The concept of the Point List is used throughout the TDS-48 to specify points to be used in a variety of functions. For example, in the Screen Plot Screen, you may use the point list to select only those points that you want to have shown in the display. To get the most out of your TDS-48, you should be certain that you thoroughly understand the concept of the Point List. It is described in detail beginning in the Reference section. You should take the time to practice with the point list in the context of other functions.

MORE CO-GO PRACTICE - INTERSECTIONS

As a final exercise in this chapter, suppose that you want to find the point that represents the intersection of a line connecting point 1 and point 6 with a line connecting point 2 and point 7. This problem is shown pictorially as:

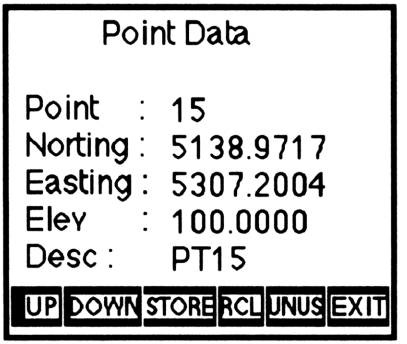


From the CO-GO Menu, select **[I]** for the Intersection Screen. From this screen you may specify the parameters of this problem. The first point is point 1. Rather than specify the azimuth to point 6, the **[DFDIR]** key may be used as in the Point-in -Direction Screen to define the azimuth angle to point 6. This process may be repeated for the line connecting points 2 and 7. Use point 15 as the stored point. When the screen has been properly filled out it should look like:



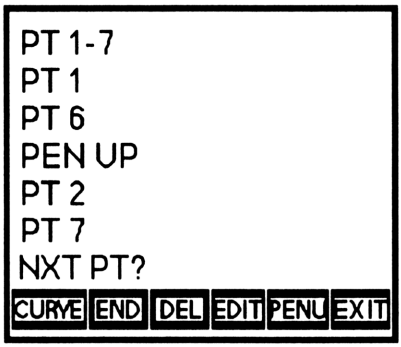
Now press **[SOLVE]**. The TDS-48 will give you an opportunity to specify an elevation and a descriptor before adding point 15 to the job file.

You may review the coordinate values of point 15 by returning to the Main Menu and pressing **[G]** then **[J]**. Now press **[RCL]** and key in 15 for the point number in response to the prompt. The coordinates are shown as:



As a final exercise in this chapter, you will redo the screen plot of the boundary of the SMITH job and show the lines that created point 15 at their intersection. This will illustrate the feature of inserting a **[PENU]** command in the point list that controls the screen plot.

Press **[P]** form the Main Menu and then **[PTLST]**. Press **[H]** to clear the existing list (**[Y]** in response to the "Are you sure?" prompt) and then press **[G]** to edit a new one. You may connect points 1 to 7 in sequence by keying in **[1] [-] [7]** in the first NXT PT? line of the list. Press **[ENTER]** to enter this line. Then key in **[1]** again. Press **[ENTER]** again. This will cause the plot to connect points 1-2-3-4-5-6-7 in sequence and then close back to point 1. Next you want to connect from point 1 to point 6 so key in **[6] [ENTER]**. Now you want to connect point 2 with point 7 but you do *not* want to show a line from 6 to 2. Press **[PENU]** - pen up. This command will "lift the pen" before moving to the next point. Now press **[2] [ENTER] [7] [ENTER]**. Properly filled out your point list should look like:



Press **[EXIT]** twice to return to the Screen Plot Screen; set the scrolling prompt to read *Using point list*; and press **[LINES]**. You should see a portion of the desired plot in the screen. Remember to use the **[∧]** and **[v]** keys to see the rest of the plot.

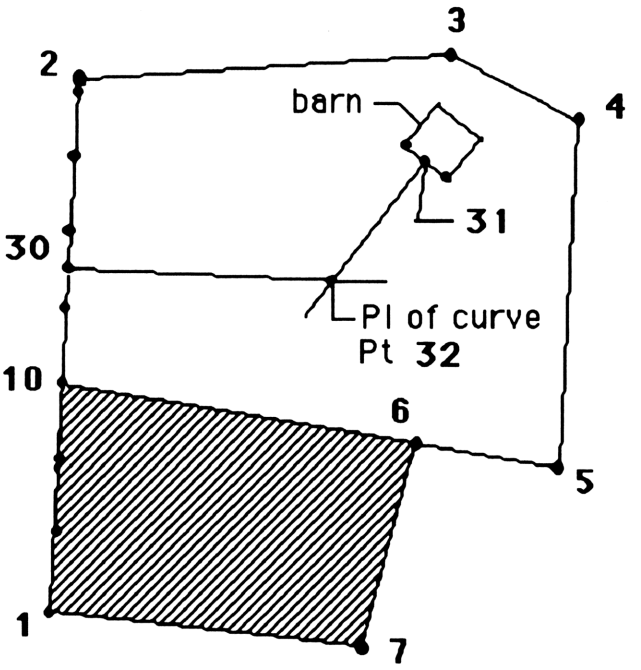
4. CURVES

In this chapter, you will explore the Curve Menu and the various Curve Screens of the TDS-48. You will practice integrating the curve capabilities into the CO-GO routines you have already learned by working on the SMITH job.

HORIZONTAL CURVE SOLUTION

Mr. Smith wants to sell the parcel of land that you previously created with the Acreage Screen. Unfortunately, the existing gravel driveway to his barn runs across this parcel. Mr. Smith would like you to design a new 30 ft wide driveway from his barn to a new access point along the western boundary of his remaining property. He would like you to prepare a map of his property showing the barn and the driveway. In addition, you are to measure the area of the driveway so that he can determine how much gravel he will need for it. To make things interesting, Mr. Smith wants the driveway to meet the road along the western boundary of his property as well as the front of the barn at right angles. He also wants a 150 ft radius curve built into his driveway where these two sections intersect. You have surveyed his property. You have located the center of the driveway in front of the barn (pt. 31) and the desired access point for the center of the driveway at the western boundary of his property (pt. 30). You have also established the bearings of the straight sections of the driveway and the point where they intersect. This is the PI of the curve (pt. 32). These points are shown on the figure below. The coordinates of the relevant points are given in the table.

CURVES



POINT NUM.	NORTHING	EASTING	ELE.	NOTE
30	5449.2580	5025.8319	103.4534	WEST END
31	5557.6343	5483.4702	108.2768	FRT. OF BARN

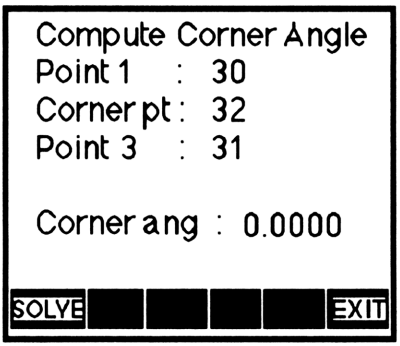
The bearing of line 30 - 32 is S 86 42' 33" E; the bearing of line 31 - 32 is S 44 59' 57" W

With these coordinates and line bearings, you should be able to compute the coordinates of the intersection of the lines (which is also the PI of the curve). Use the Bearing-Bearing option in the Intersection Screen from the CO-GO Menu. The default elevation is 103.4534 ft.

Call this intersection point: point 32. It's coordinates are:

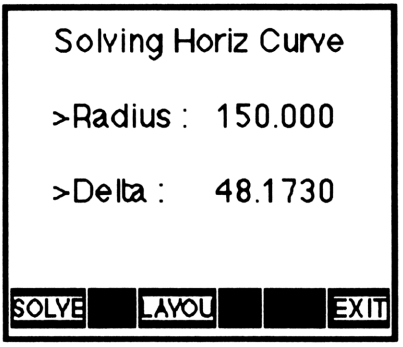
POINT NUM.	NORTHING	EASTING	ELE.	NOTE
32	5430.2675	5356.1071	100.0000	PI OF CURVE

Your next task is to put a 150 ft radius curve on this center line. Select **[Q]** from the Main Menu. Press **[G]** for the Solving Horizontal Curve Screen. To define a curve completely, you need two of its parameters: one that relates to its radius or curvature and one that relates to its length. The Solving Horizontal Curve Screen has two data input lines that relate to these two properties. You may use the horizontal cursor keys (**[<]** or **[>]**) to set the prompt to the quantities you know. In this case, the *radius* is given as 150 ft, and the *delta angle* may be computed from the bearings of the center lines of the driveway which are the tangent lines of the curve. However, the delta angle may be computed quickly by using the Corner Angle Screen in the CO-GO Menu. From the CO-GO Menu press **[N]**. Properly filled out prior to your pressing **[SOLVE]** the Compute Corner Angle Screen appears as:

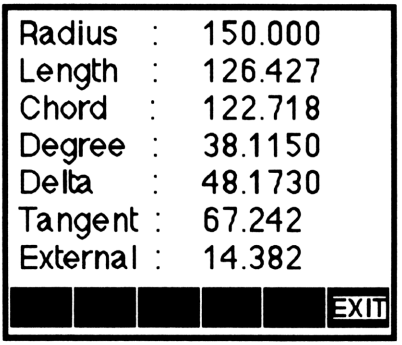


The delta angle may be computed from this screen by using 30 as Point 1, 32 as the Corner pt, and 31 as Point 3. Then press **[SOLVE]**. The corner angle is computed to be 131°42'30", and the delta angle is the difference between this corner angle

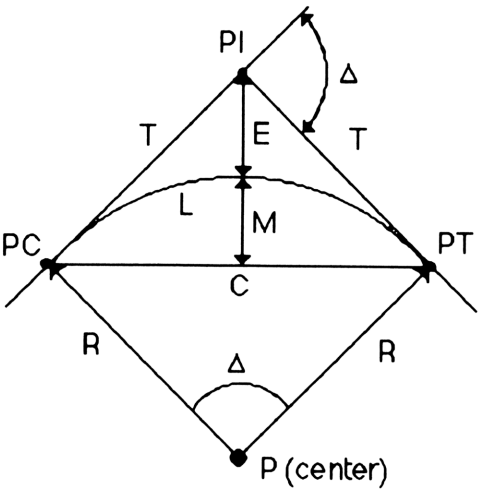
and 180°. Thus, the delta angle is 48°17'30". Key the data into the Solving Horizontal Curve Screen and compute the curve parameters.



The seven computed curve parameters will appear in the solution screen as:



These parameters are defined in the figure below:



PC - Point of Curvature
PT - Point of Tangency
PI - Point of Intersection
P - Radius Point

R - Radius
L - Length (Arc Length)
C - Chord Length
T - Tangent Length
E - External
M - Mid-ordinate
Δ - Internal angle from center to tangent points

Degree of Curvature - Internal angle equivalent to a 100 ft arc length

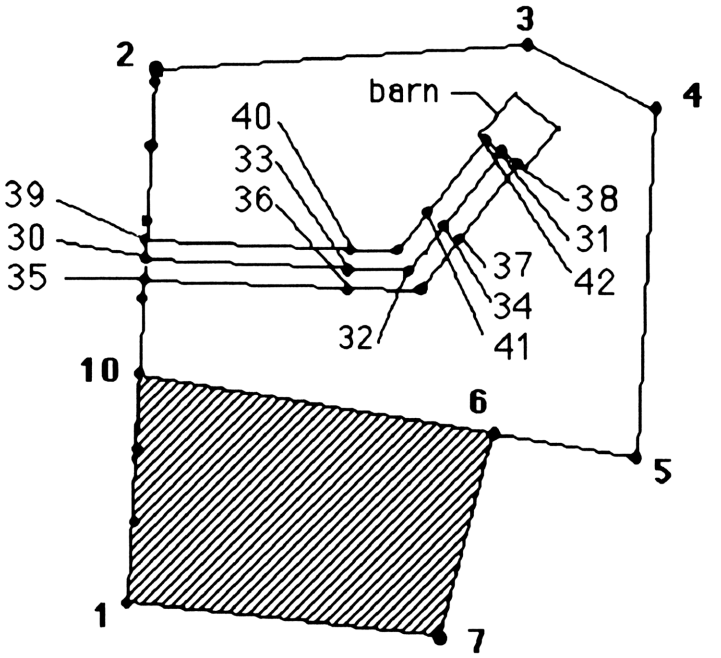
Degree of Curvature = (18,000) / (R x π) Expressed in degrees, minutes, and seconds.

Press **[EXIT]** to see the value of the Mid-ordinate.

FINDING THE PC AND PT

To complete your assignment, you need to compute the coordinates of the PC and PT of the curved portion of the center line of Mr. Smith's driveway. The best way to do this from the solved information is to use the tangent lengths that you just computed and find the points that are exactly one tangent length from the PI (pt 32) along each segment of the center line. This can be quickly accomplished by using the Point-in-Direction Screen which you used in the last chapter. Done properly, you should be able to create points 33 and 34 as shown in the figure

below.



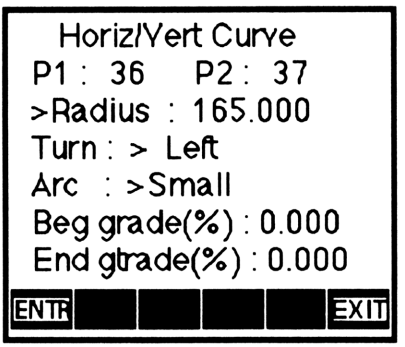
The boundary points of the driveway, points 35 through 42 in the figure above, may be determined from the Point-in-Direction Screen in the CO-GO Menu. Points 35 and 39 may be determined directly since they lie on a line with known end points. The other points may be found by specifying a + or - 90° rotation of the direction line in the Define a Direction Screen. For example, to determine the coordinates of point 36, use the Point-in-Direction screen and the **[DFDIR]** softkey to specify the direction. In this Screen, the beginning point should be point 33; the end point, point 30; and the + / - ang set to -90, since the desired point is rotated 90° counterclockwise from the line specified by the point numbers. Now press **[SOLVE]** and

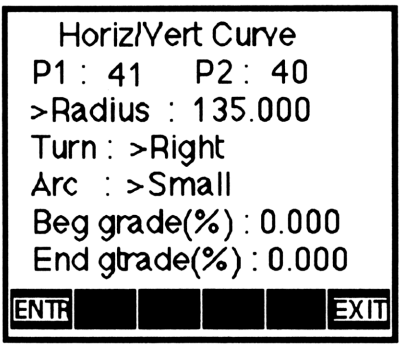
then **[EXIT]** to return to the Point-in-Direction Screen. Specify 15 ft (1/2 the width of the driveway) as the horizontal distance and pt 36 as the point to be stored. Press **[SOLVE]**, and point 36 will be computed and added to the file. In like manner, the other points along the boundary of the driveway may be found.

INSERTING A CURVE IN A POINT LIST

You have now solved for the coordinates of all of the points that will make up the boundary of the driveway. You have the end points of the driveway with 15 ft offsets; the PCs, PIs, and PTs of the center line; and the boundary lines. All that remains is to use the Acreage Screen to compute the area of the driveway. However, to do this properly, you should specify that there is a curve between points 36 and 37 and another one between points 40 and 41. Thereby, the Acreage Screen will compute the area based on the curved sides. The Point List allows you to place a curve rather than a straight line between any two points in the list. The procedure for doing this is: Key in a point on one end of the curve; then press the **[CURVE]** "soft" key. The Screen will prompt for information about the curve which you should fill in.

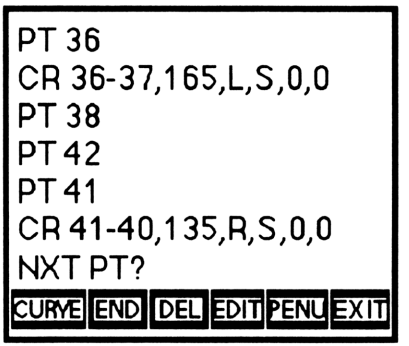
The Point List sequence for this job is: 35, 36, **[CURVE]** (fill out the Horiz/Vert Curve Screen as shown below and press **[ENTER]**), 38, 42, 41, **[CURVE]** (fill out the Horiz/Vert Curve Screen as shown below and press **[ENTER]**), 39. The screens in response to the two curve prompts should look as follows before you press **[ENTER]**:





NOTE: Even though the values of Pt 1 and Pt 2 in this screen are on the same line, you still use the *vertical* cursor keys to move the scroll bar between them. The horizontal cursor keys are reserved for scrolling prompts.

The point List Screen will look a follows before you press **[EXIT]**.



(The first point in the point list, "PT 35" has scrolled off the top of the display.)

By computing the acreage in the Acreage Screen based on this Point List, you may determine the area of the driveway with the curve included. You should compute 0.3264 acres or 15,086.55 sq ft. as the area.

5. FIELD WORK WITH THE TDS-48

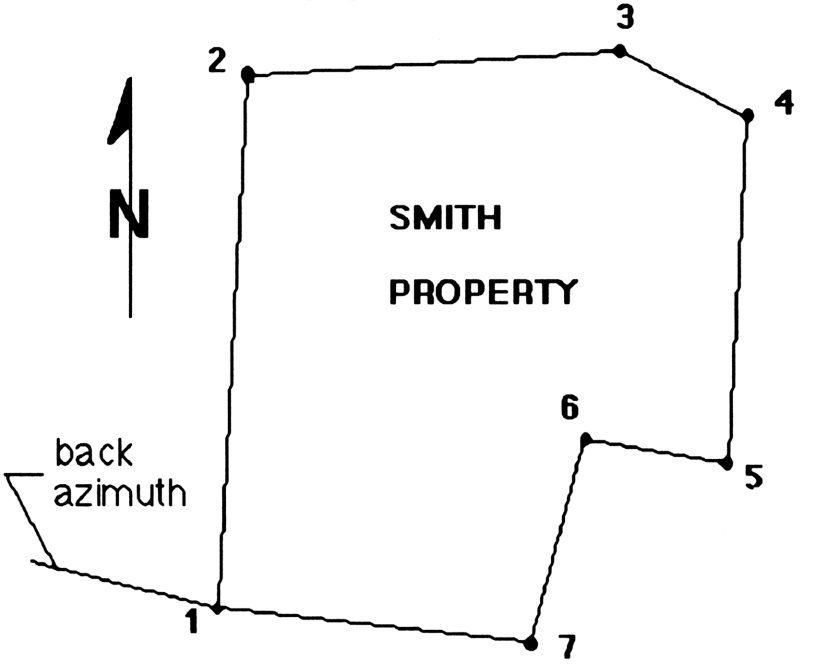
In this chapter, you will learn how to use your TDS-48 in the field. You will survey the SMITH job in several ways. You will perform a boundary survey with both single and multiple observations for each point. You will learn how to do resections in the field. You will see how a topographic survey can be done with the TDS-48. This chapter also covers several techniques for doing stakeouts. The chapter concludes with a description of the field use of the TDS-48 in doing sun shots.

This section of the manual deals with the use of the TDS-48 in the field. As with other sections of this manual, the general approach is cover some basic material and deal with both the theory of the operation of the TDS-48 and its practice. It is assumed that the material contained in this section of the manual will be read and practiced while in an office setting. In order to provide realistic examples, it is assumed that you will be keying in the field data manually from field notes provided in this chapter. During use of the TDS-48 in the field, you will collect angle and distance data automatically from your electronic total station. Where appropriate, differences in procedure are presented in this chapter.

FIELD WORK

TRAVERSING THE BOUNDARY OF THE SMITH PROPERTY

Your first task is to perform a boundary survey of the Smith property that you have been working with throughout this manual. A sketch of the property is shown here for reference:



You begin by setting your gun on point 1. You have found a point on the adjacent property to the west which has a known azimuth from point 1. You choose this point as a back sight and set the known azimuth as the back azimuth. You then traverse the boundary clockwise closing back on point 1. The following table represents the field notes from the survey:

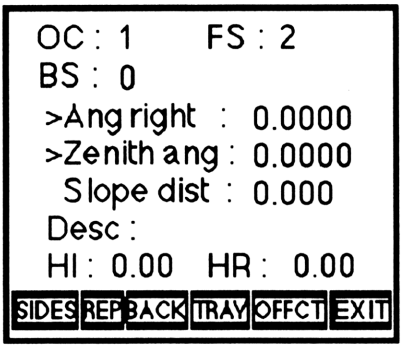
Back Sight [BS]	Occupied Point [OC]	Fore Sight [FS]	Height of Instrument [HI]	Height of Rod [HR]	Horizontal Angle (angle right) [HA]	Zenith Angle [ZA]	Slope Dist. [SD]	Note
0*	1	2	5.32	6.0	86.5412	89.4050	711.42	PT 2
1	2	3	5.43	6.0	262.5448	89.3236	457.76	PT 3
2	3	4	5.40	6.0	208.5710	89.1803	201.31	PT 4
3	4	5	5.39	6.0	247.1657	88.5235	497.12	PT 5
4	5	6	5.35	6.0	277.4835	90.2926	223.98	PT 6
5	6	7	5.40	6.0	92.4143	90.2746	233.88	PT 7
6	7	8	5.42	6.0	261.2756	91.4405	387.25	Close to PT 1

*The known *back azimuth* is 276° 23' 15".

The screen that you will use to enter this data is the Traverse/Sideshot Screen.

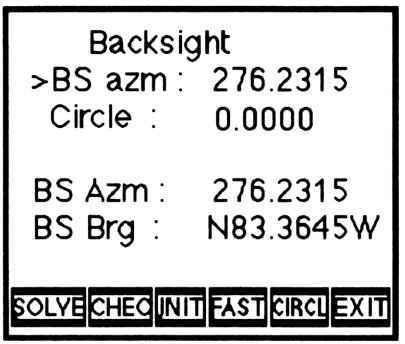
NOTE: If you have been working with the SMITH job in this manual, you will already have established coordinates for the points that you are about to enter from your raw survey data. Thus, as you complete this traverse, the TDS-48 will alert you at each point that the coordinates are used and may be overwritten. You should select the overwrite option in each case. This could be avoided by setting up a new job for this survey. However, since you will be learning how to stakeout the driveway that you designed in Chapter 4 later on in this chapter, you should continue to use the SMITH job for what follows.

To enter the data, return to the Main Menu. Press **[J]** for the Traverse/Sideshot Screen. This screen will appear as:



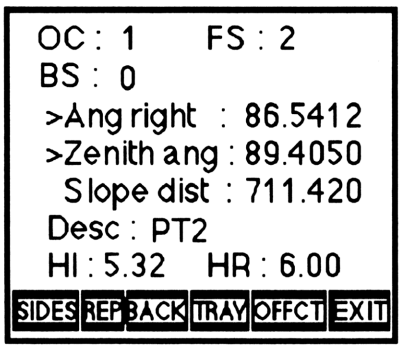
This screen is set up for you to key in your data directly from your field notes. If you have your TDS-48 set up to communicate with your total station, you should disable the automatic mode by returning to the MAIN Menu; selecting **[H]** for the Setup Menu; **[H]** for Devices; and use the horizontal cursor keys to adjust the Instrument scrolling prompt to <<MANUAL>>. This will allow you to enter your field data manually.

To begin: from the Traverse/Sideshot Screen, set the occupied point (OC) as 1: the foresight point (FS) as 2: and press the **[BACKS]** key. This will allow you to set the back azimuth for your first shot. The Backsight Screen, when properly filled out and after pressing **[SOLVE]**, will appear as:



Remember to use the **[>]** or **[<]** key to change the first line prompt to "BS azm" before keying in the back azimuth. The Circle prompt represents the horizontal circle (angle) reading in the gun while sighting on the backsight. This is customarily zero but may be any value.

Pressing **[EXIT]** will return you to the Traverse/Sideshot Screen. That screen should now be filled out as shown below in order to enter the data for the first surveyed point.



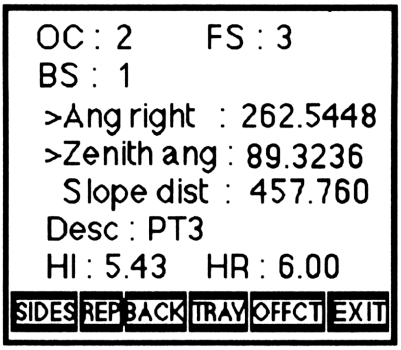
By filling out the screen and pressing **[TRAV]**, the TDS-48 will do several things. First, it will compute the coordinates of your foresight point; in this case, point 2. If you have the "storing pause" set "ON" in the Operating Modes Screen of the Setup Menu, the TDS-48 will also display the coordinates for you. Next, the TDS-48 will add these coordinates along with the point descriptor to the SMITH coordinate file. Next, it will add the raw data information from your Traverse / Sideshot Screen to the SMITH raw data file. The machine will change the occupied point, foresight point and backsight point to be 2, 3, and 1 respectively. Finally, it will also change the back azimuth to reflect the new backsight point. If you have a point with known coordinates specified as the backsight point in the Traverse / Sideshot Screen, it is not necessary to use the **[BACKS]** key. You need to use the **[BACKS]** key only if you wish to set a back azimuth or back bearing or change the

circle angle to your backsight. For the rest of the traverse, you will backsight the previously occupied point. The TDS-48 assumes that this is the mode of operation and will build the screen after each shot accordingly.

NOTE: If you were in the field actually taking data automatically from your electronic total station, you would not key in the horizontal angle, zenith angle, or slope distance. Instead, you would build the rest of the screen (point numbers, and rod and instrument height) and then press **[TRAV]**. From the gun selected in the Setup Screen, the TDS-48 will collect the angles and distance before computing the coordinates and doing the other functions listed above. In this mode, the TDS-48 will prompt you to key in the point descriptor after the gun has taken the shot, but before the coordinates are computed and stored.

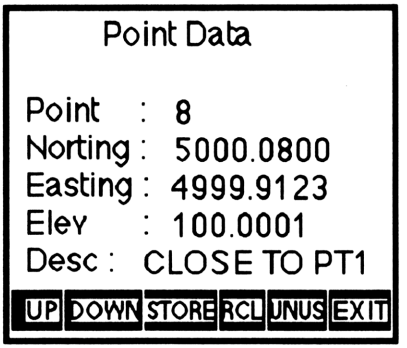
NOTE: Although sideshots will be discussed in more detail later in this chapter, it is appropriate now to point out that, from the standpoint of the TDS-48, the only difference between the **[TRAV]** and **[SIDES]** keys is that, after a sideshot, the data collector will not change the occupied point or the backsight point. Of course, it will increment the foresight point to the next point number as it does for a traverse.

The data for point 3 should appear as shown below prior to pressing **[TRAV]**.



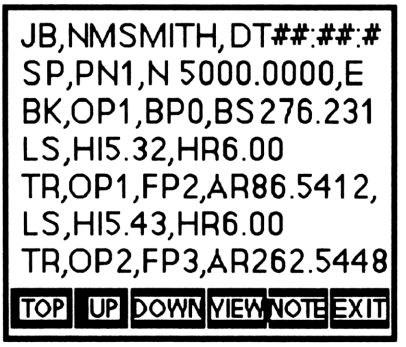
In the same manner, you should enter all of the data from the table into the SMITH job file. When you come to the last (closing) shot, the TDS-48 will have the screen set up with point 8 as the foresight point. Even though you are closing back to point 1, you should enter the last shot as point 8. If you reset the foresight point as point 1, the TDS-48 will alert you to the fact that point 1 is already used; that is, it already has coordinates assigned to it. It will ask you if you want to overwrite these coordinates. By storing the closing point as point 8, you will be able to compare the ending and beginning coordinates to determine (among other things) the precision of the survey. You will also need these points stored separately to do a traverse adjustment. You will be doing adjustments in Chapter 6.

Now return to the Main Menu. Press **[G]** and then **[J]** to view the coordinates. If you entered your data properly, the coordinates for point 8 should appear as:



Since you started with point 1 coordinates of 5000.0000 ft for northing and easting and 100 ft for elevation, the closure is excellent. You will learn how to use the TDS-48 to determine the precision of this traverse in Chapter 6 - Adjustments.

At this time, you may wish to see how the TDS-48 has stored your raw data. From the Job Menu, press **[K]** and then **[G]** to view your raw data. Then press **[TOP]** to move to the top of the raw data file. Your screen should look like:



Each line of the display is the first part of a complete line of a raw data entry. To see the complete line, use the vertical cursor keys to move the scroll bar to the line you want to view and press the **[VIEW]** key. The other lines of data will be temporarily suppressed, and the complete data line in question

will be displayed. As you can see, the raw data file is rather cryptic. It consists of a series of two letter codes and data entries separated by commas. Each code indicates the nature of the data which follows it. Codes are used in the interest of conserving memory in your TDS-48. If you would like to decode your raw data screen, you will find a complete list of the codes in Appendix D of this Manual. Also, if you transfer your job to a personal computer and then print out your raw data file using the TFR software that is available for the TDS-48, the codes will be decoded automatically. The raw data printout will then be much less cryptic.

If you would like to add arbitrary text information to your raw data file in the form of a note, press **[NOTE]**. You may also add notes to the raw data file from any other screen in the TDS-48 by pressing the global note function **[←] [B]**.

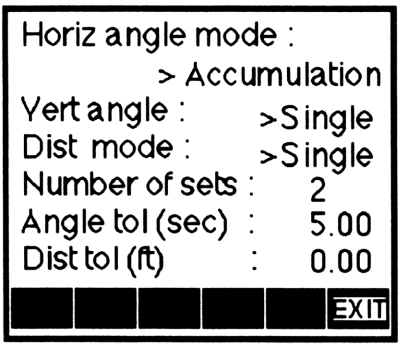
NOTE: By their nature, raw data files typically use more memory per point than coordinate files. For this reason you should be judicious in your use of notes, abbreviating wherever possible to conserve memory. Other options in the Raw Data Menu will allow you to clear, create or delete your raw data file. For example, if you are doing a large project over several days, you may wish to upload your raw data to a PC at the end of each day, and then clear out your raw data file for the next day's work. This will minimize the amount of memory used and allow for more point coordinate storage. At the end of the job, you may merge the individual raw data files back together in the PC using the TFR software.

TRAVERSING WITH MULTIPLE READINGS AND AVERAGING

To improve survey accuracy, you will often take multiple readings at each station and then average the results before

computing coordinates. The TDS-48 will do this automatically for you with any one of the several commonly used averaging techniques. The techniques supported include averaging horizontal angles - direct and reversed (flopped scope); accumulated horizontal angles (windings); direct and reversed zenith angles; and multiple distances. These techniques may be used individually or in combination. If you are connected to an electronic total station in the field, the TDS-48 will prompt you with the proper field procedure. It will also trigger the gun to take the appropriate readings at the proper time. To illustrate the techniques for taking multiple readings, an example using horizontal accumulations or windings is presented here.

First, set up the TDS-48 to use the horizontal accumulation (windings) method of recording horizontal angles. You will use the Repetition Mode Screen accessed from the Setup Menu. From the Main Menu, press **[H]** and then **[J]**. Set your TDS-48 to accumulate two angles for each horizontal angle. Be certain the second line of the screen reads "accumulation", and not "single" or "directional". You expect to take two readings. Therefore, the number of sets is two. You will employ a 5-second tolerance between angle readings. The distance error (tolerance) is immaterial because you will only use one distance reading for each point. The screen should now appear as:



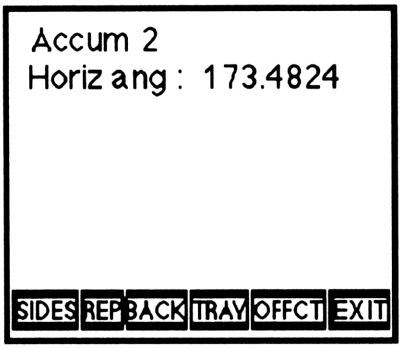
The table of field observations with accumulated horizontal angles is shown below. You may wish to retake some of the

traverse shots from the previous exercise at this time to obtain a feel for how the TDS-48 works with multiple readings.

Back Sight [BS]	Occu-pied Point [OC]	Fore Sight [FS]	Height of Instru-ment [HI]	Height of Rod [HR]	Horizontal Angle (angle right) [HA]	Zenith Angle [ZA]	Slope Dist. [SD]	Note
0*	1	2	5.32	6.0	86.5412 173.4824	89.4050	711.42	PT 2
1	2	3	5.43	6.0	262.5448 165.4936	89.3236	457.76	PT 3
2	3	4	5.40	6.0	208.5710 57.5420	89.1803	201.31	PT 4
3	4	5	5.39	6.0	247.1657 134.3354	88.5235	497.12	PT 5
4	5	6	5.35	6.0	277.4835 195.3710	90.2926	223.98	PT 6
5	6	7	5.40	6.0	92.4143 185.2326	90.2746	233.88	PT 7
6	7	8	5.42	6.0	261.2756 162.5552	91.4405	387.25	Close to PT 1

*The known *back azimuth* is 276° 23' 15".

Set up the first shot in the Traverse /Sideshot Screen as you did before. Now, when you press **[TRAV]**, the screen will prompt you for the data in a prescribed sequence. The sequence is important. In the field and using you total station to gather the data automatically, the gun has to be turned during the gathering of multiple data. Key in the required information in response to the prompts. Press **[ENTER]** *after* each entry. Prior to the last time you press **[ENTER]**, the screen should appear as shown below.

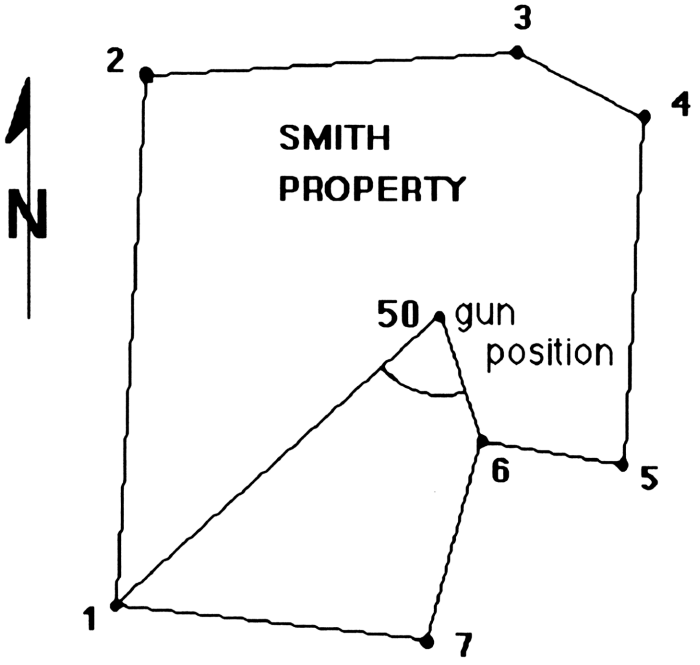


By pressing **[ENTER]** one more time, you will be prompted for a descriptor. Enter the appropriate descriptor. Press **[ENTER]**.

TWO POINT RESECTION

The next segment of the job is to perform a topographic survey of the Smith property. However, none of the known boundary points provide an adequate vantage point to the entire parcel. Therefore, you decide to move the gun to a position near the center of the property from which you have a good line of sight to the rest of the site. In this section, you will learn to establish the coordinates of the new gun position using a two point resection technique. To learn about the three point resection screen, consult the appropriate section in the Reference Manual.

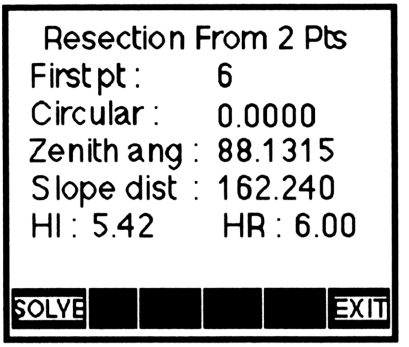
Call this new (unknown) gun position *point 50.* The two point resection requires the rod man to move to two appropriate points that have known coordinates in the SMITH2 job file. For this example, use points 6 and 1. From point 50, you need to determine the zenith angle and slope distance to both points and the horizontal angle between them. From this information, the TDS-48 can determine the coordinates of the gun position and store this information in the SMITH coordinate file. The figure below depicts the situation.



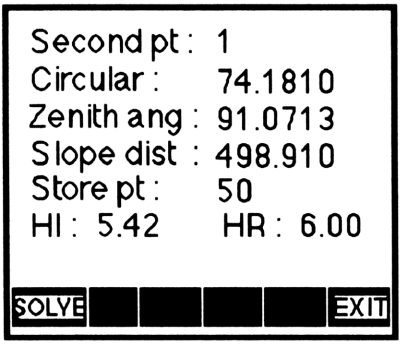
The field notes for this resection problem are shown in the table below.

Back Sight [BS]	Occu-pied Point [OC]	Fore Sight [FS]	Height of Instru-ment [HI]	Height of Rod [HR]	Horizontal Angle (angle right) [HA]	Zenith Angle [ZA]	Slope Dist. [SD]	Note
6	50	6	5.42	6.0	0.0000	88.1315	162.24	PT 6
6	50	1	5.42	6.0	74.1810	91.0713	498.91	PT 1

This data is entered in the Resection From 2 Pts Screen accessed via the CO-GO Menu. Return to the Main Menu; press **[M]**; then **[L]** for the Resection From 2 Pts Screen. When data appropriate to this example are entered, this screen should appear as shown below.



After you press **[SOLVE]**, the TDS-48 will review the data for you. It will then tell you to press a key to go on to the second point. Properly filled out for this example, the second point screen will appear as:



After you press **[SOLVE]** from this screen, the TDS-48 will compute the coordinates of the new gun position (point 50). It will also compute the horizontal distance between the two known points used in this resection (points 6 and 1). It will compare this distance with the distance between these points as determined from the known coordinates of these points stored in the SMITH2 coordinate file. This measurement is expressed as a precision number for the resection. You are prompted for a descriptor for the new point. In this example, the precision of the resection to establish point 50 is reported as 233,849, which

may be interpreted as approximately 1 : 234,000.

> **NOTE:** As in the Traverse / Sideshot Screen, if you are connected to an electronic total station, the Resection Screens will trigger the total station to take its measurements. The data will be automatically loaded into the TDS-48.

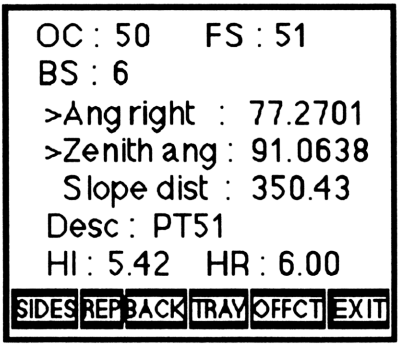
TOPOGRAPHIC SURVEY OF THE SMITH PROPERTY

From your vantage point at point 50, you may now complete a topographic survey of the Smith property. A normal topographic survey would include sideshots taken for all of the features of the property. In the interests of brevity, the data is restricted to the 9 points listed as points 51 to 59 in the table below. The *elevations* of these points are of prime importance. Since you did your resection with the horizontal angle zeroed while sighting point 6 as a backsight, you may as well continue to use point 6 as a backsight for the topographic survey.

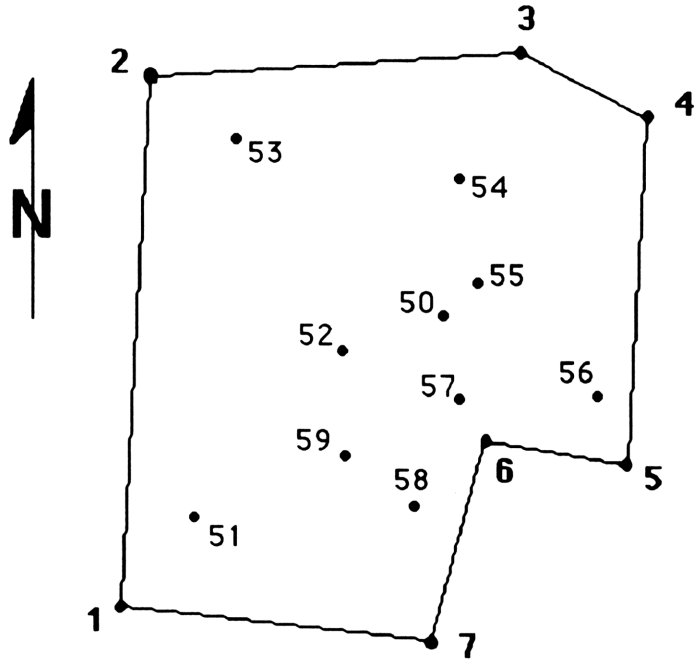
Back Sight [BS]	Occupied Point [OC]	Fore Sight [FS]	Height of Instrument [HI]	Height of Rod [HR]	Horizontal Angle (angle right) [HA]	Zenith Angle [ZA]	Slope Dist. [SD]	Note
6	50	51	5.42	6.0	77.2701	91.0638	350.43	PT 51
6	50	52	5.42	6.0	98.3511	90.2829	106.23	PT 52
6	50	53	5.42	6.0	166.4557	90.4605	378.20	PT 53
6	50	54	5.42	6.0	221.0823	90.2225	237.72	PT 54
6	50	55	5.42	6.0	252.4512	90.4518	55.39	PT 55
6	50	56	5.42	6.0	319.5833	88.5442	287.43	PT 56
6	50	57	5.42	6.0	4.1315	88.3356	99.02	PT 57
6	50	58	5.42	6.0	25.0702	89.3258	253.09	PT 58
6	50	59	5.42	6.0	56.4200	90.2459	182.14	PT 59

With one exception, the procedure for entering sideshot data is exactly the same as that for a traverse. The exception is that you must press the **[SIDES]** key instead of **[TRAV]**. As an

illustration, the Traverse/Sideshot Screen shown below is properly filled out for the first shot prior to pressing **[SIDES]**.



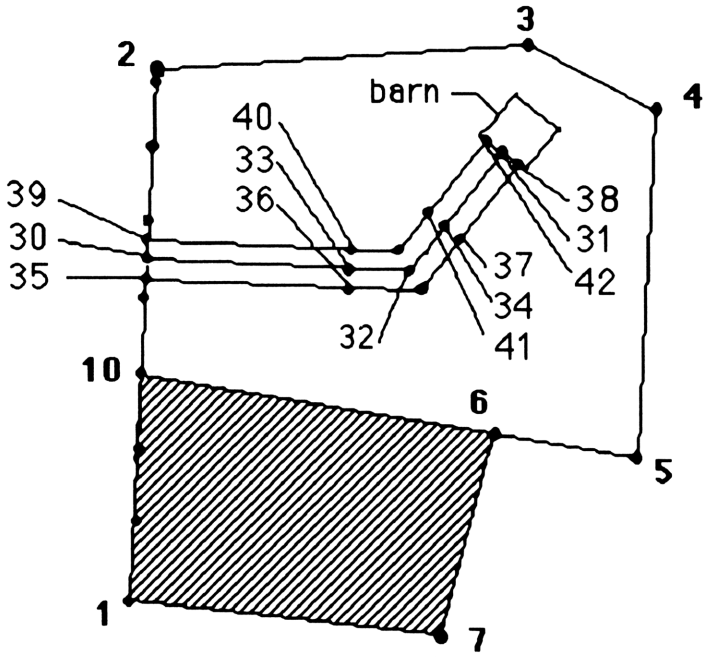
In like manner, the other sideshots may be added to the file. The figure below shows the relative locations of these points. You may use the Screen Plot Screen feature to get a rough idea of the location of the points you have added to the file.



STAKEOUT WITH THE TDS-48

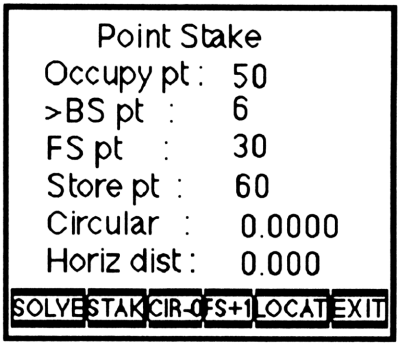
In this section, you will explore two capabilities to accomplish stakeouts. You will see how to stake the center line of the Smith driveway using the *point stake* capability. You will also see how to stakeout the right-of-way for the driveway using the *offset stake* capability.

The sketch of the Smith property indicating some of the points on the driveway which you have already created is shown here for reference.



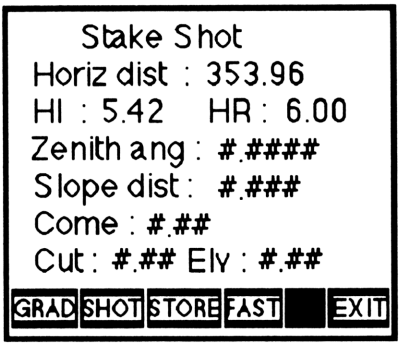
From the Main Menu, press **[I]** for the Stakeout Menu. The *first thing* you should do from this menu is press **[J]** to select the Stakeout Mode. The choices in this screen allow you to store a cut sheet as raw data, to establish an error (or tolerance) for the horizontal angle and to set a slope stake tolerance. If a stakeout computation creates a greater error than the established tolerance, the TDS-48 displays an automatic warning.

Next, from the Stakeout Menu, select **[G]**, Points Stake. Assume that you still have your gun on point 50 and that you are still maintaining point 6 as your backsight. Remember to scroll the prompt in line 3 of the display to "BS pt". Specify point 30 at one end of the center line of the driveway as your foresight. This is what your Points Stake Screen should look like prior to pressing **[SOLVE]**.



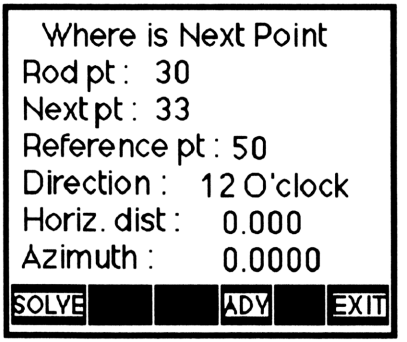
In this screen, the Store pt is the point number where you want to store the actual coordinates of the point to be staked. In this way, you will have a record of the actual locations of the stakes to compare with the designed points. Now, by pressing **[SOLVE]**, the TDS-48 will compute the circle angle and the horizontal distance from point 50 to point 30. The numbers are 135°11'14" for the circle angle and 353.968 for the horizontal distance.

Have your rod man pace off the distance; keep him on line with the gun; and, when he is set, press **[STAKE]**. The Stake Shots Screen is displayed. The Stake Shots Screen will provide you an opportunity to change the gun and/or rod height. If you are working manually, you will take a shot and key in the zenith angle and slope distance. Then press **[SHOT]**. If you are connected to your gun, just press **[SHOT]**. The proper data will be gathered and transferred to your TDS-48 automatically. Either way, the TDS-48 will display a Come (or Go) distance for the rod man and a Cut (or Fill). If he needs to be closer to the design point, have him move the rod the appropriate amount and press **[SHOT]** again. When you are close enough, press **[STORE]**. The coordinates of the most recent shot will be stored in the file at the point number you set up in the Points Stake Screen. The Stake Shot Screen is shown here prior to your adding the field data.

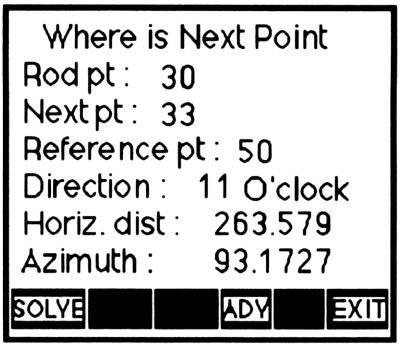


The TDS-48 has a special screen built into the CO-GO Menu that may be used by the rod man to locate the next point to be staked. If your rod man has a TDS-48, he may use it at this time to determine the direction and distance that he should pace to locate the next point to be staked, point 33.

From the Main Menu, the rod man should press **[M]** and then **[P]**. He will see the Where is Next Point Screen which he should fill out as follows (using the gun location as a reference point) before pressing **[SOLVE]**.



After pressing **[SOLVE]** he will see the following:

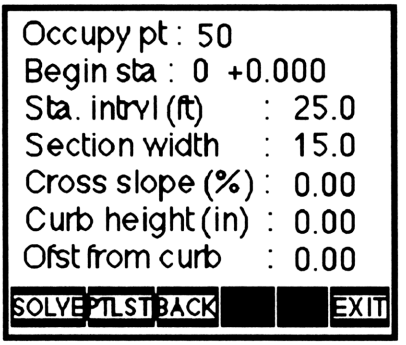


By standing at point 30 and facing the gun (point 50) he can determine that the next point is approximately in the 11 o'clock direction. Imagine a clock at the rod with 12 o'clock facing the gun. He can then turn to the 11 o'clock direction and pace off 263 ft to get close to point 33, the next point to be staked. Or, if he has a compass, he can line up the direction to be paced at an azimuth of approximately 93 degrees from north.

In a similar manner, you can stake the other points on the center line of the driveway. The critical points along the center line are the beginning point, 30; the PC and PT of the curve, points 33 and 34; and the ending point, 31.

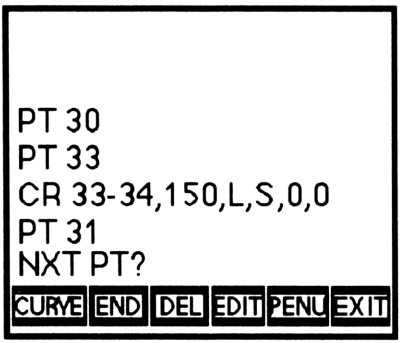
You now want to stake out the *offsets* to the center line to define the edges of the driveway. You want to stake every 25 ft. The Offset Stakeout capability of the TDS-48 makes this task easy and straightforward. Using this feature, you can specify a point to be staked by station along the center line and offset distance. The center line is defined by the points in the active Point List.

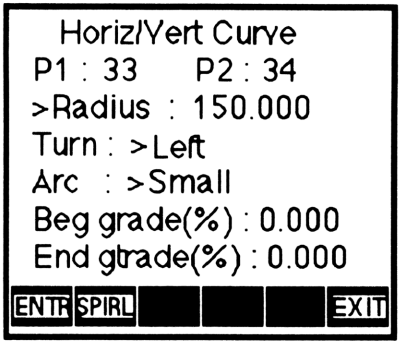
From the Stakeout Menu, choose **[H]** for the Offset Stakeout Screen. The first thing you must do is set up the job. Press **[SETUP]**. The Setup Screen appears here properly filled out for this job. Mr. Smith's driveway will not have a cross section slope or a curb.



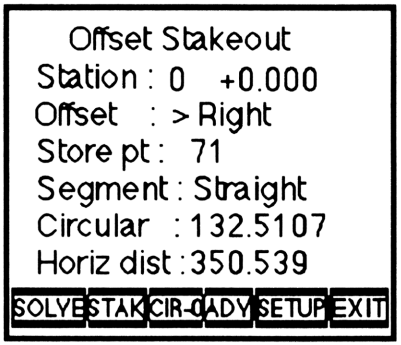
NOTE: When the units are feet, the station interval is in feet and the curb height is in inches. When the units are meters, the station interval is in meters and the curb height is in centimeters.

Before pressing **[SOLVE]**, you should check to be sure the backsight is still set on point 6 with the back azimuth computed. Use the **[BACKS]** key for this. Also, you must store the points along the center line of the driveway in the active Point List. You learned the process for doing this in Chapter 4. The Horiz/Vert Curve Screen from the Point list and the complete Point List Screens are shown below:

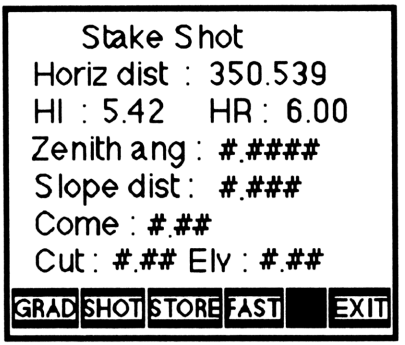




Now that the setup is complete, you may return to the Offset Stakeout Screen and press **[SOLVE]**. The TDS-48 will provide the circle angle and horizontal distance for the first offset point to be staked. The screen should look like:



Have your rod man pace the distance close to the point to be staked. Now press **[STAKE]** and you will see the Stake Shot Screen.



Take a shot to the rod and key in the zenith angle and slope distance into this screen and press **[SHOT]**. (If you are connected to an electronic total station, you just press **[SHOT]** and the TDS-48 will trigger the gun and collect the required data automatically.) Move your rod man based on the Come or Go message and take another **[SHOT]**. Repeat this process until you are close enough to the required stake point. Now press **[STORE]** to store the coordinates of the actual stake point in the coordinate file at the specified store point in this screen.

Now in the Offset Stakeout Screen you may press **[ADV]**. This key will advance the point to be staked to the next station along either the right or left offset depending on the contents of the third line of the screen. To minimize the movement of the rod man, you may want to stake alternatively from right to left for each station. You may do this by using the horizontal cursor keys on the offset line of the display rather than pressing **[ADV]**. Using this technique, the entire driveway may be staked using the same field procedure regardless of curves encountered along the way.

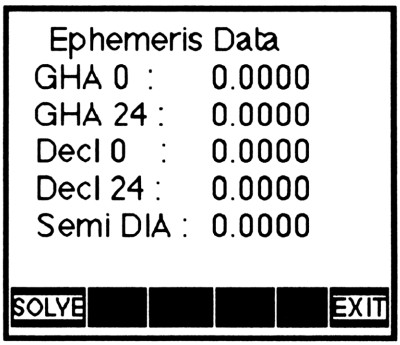
SUNSHOTS

The last section in this chapter on Field Work will cover the use of the TDS-48 in helping you determine the true azimuth of a backsight in the field by solar observations. The TDS-48 has

two methods built into its software. The first is called the *Ephemeris* method. It presumes that you have an ephemeris with you and will prompt you to key in the appropriate values from it. The other method is called the *Almanac* method. In it, the TDS-48 will approximate the values from the ephemeris based on the known date and time information which you provided during the date and time setup routine.

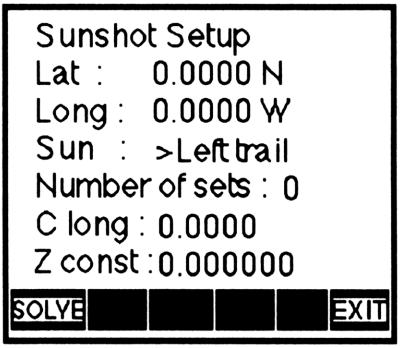
NOTE: Direct viewing of the sun without a solar filter can cause serious and permanent eye damage. Also, sighting your electronic total station toward the sun without an objective lens filter can cause damage to your EDM.

Once the method has been chosen and the setup procedure completed, the field procedures are the same for either method. Since the Ephemeris method is slightly more complicated, this section of the manual will use it for an example. The method used is the hour-angle technique. From the Main Menu choose **[O]** for Sunshots and then **[G]** for the Ephemeris Method. You will see the Ephemeris Data Screen as shown here:



The GHA 0 represents the Greenwich Hour Angle of the sun at

zero hour Universal Time, Greenwich, on the current date. GHA 24 represents the Greenwich Hour Angle of the sun at zero hour Universal time, Greenwich, on the next date (24 hours later). Likewise Decl 0 and Decl 24 represent the declination of the sun on the current date and next date respectively. Finally, Semi Dia is the semi-diameter of the sun expressed in minutes and seconds. All of this may be obtained from an Ephemeris for the current year and should be keyed into each data field as required. Now press **[SOLVE]**. You will see the Sun Shot Setup Screen as:



This screen must be filled out prior to pressing **[SOLVE]**. Lat and Long represent the latitude and longitude of the gun position which may be scaled from a map such as a U.S.G.S. 7.5 minute quadrangle sheet. The Sun prompt indicates which part of the sun will be sighted at the vertical crosshair. The example above indicates the left trailing edge. The number of sets indicates the number of complete sets of observations that will be taken. Each set consists of two sightings on the sun - one direct and one reversed. A complete sunshot requires all of the sets of sightings on the sun and two sightings on the backsight (see below). Obviously, if more sets are taken, individual isolated errors will be minimized in the final averaged computations. If you want your azimuths reported in state plane coordinates rather than true azimuths, you should key in the values of the central meridian longitude and the zone latitudinal constant for your state. These values are printed in Appendices E and F in

this manual. When this screen has been filled out properly, press **[SOLVE]**.

> **NOTE:** The Hour-Angle method of solar observations requires that you have the local time recorded very accurately. You should be sure that the local time has been checked against a precise time standard such as WWV and that the number of hours to GMT is correct.

After pressing **[SOLVE]**, you will see the Sun Shot Screen which will prompt you through the proper field procedure. The procedure is to take a direct sighting on the backsight; then a direct sighting on the sun. Then reverse (flop) your scope and take a reverse reading on the sun. The direct and reversed sightings on the sun are repeated for each of the sets specified in the Setup Screen. For each sighting of the sun, you must record the time of the reading. If you are connected to an electronic total station, the TDS-48 will take all readings automatically, including the time, as you trigger the machine.

After the last data has been entered into the TDS-48, the machine will compute and display the individual and average back azimuths from each reading and for each set. Depending upon whether or not you used state grid constants in the Sun Shot Setup Screen, these azimuths will be relative either to the state grid coordinate system or to true north.

CONTROL FILES

Very often in a job, you would like to differentiate between control points and survey points. One way to do this is by point numbering; control points numbered with one or two digit point numbers, and survey points with three digit numbers. However, if all of these points are in the same job file, the TDS-48 will fill up all of the point numbers between the highest-numbered control point and the lowest-numbered survey point, no matter how many they are or what their numbers are. This

restricts the number of points that can be surveyed with a given set of control points without renumbering them, even if you are willing to use multiple cards. Also, if you have more than one job in the machine that uses the same control points, the points must be copied into each job. The Control File concept resolves these issues.

The concept is quite simple. The control points should be stored in a separate job with a distinct job name. Then, each main job may have a specific control file specified from the Setup Menu. During operation of the TDS-48, whenever a point is referenced by point number, the TDS-48 will first search for a point with that number in the main job file. If there is, that point will be used. However, if there is no point with the specified number in the main job file, then the TDS-48 will search for a point with the specified point number in the control file. If there is, then that point is used. If the specified point number does not occur in either file, then an error message is displayed.

Control point numbers may be used in any screen location in which point numbers are legal. They can be used as occupied points or backsight points in surveys and they may be used in coordinate geometry calculations. For example, you may want to inverse between a point in the main job and one of your control points. Just go to the inverse screen and use it as you would for any other inverse, specifying the point numbers where required.

NOTE: Be careful not to create points in your main job file with the same point numbers as your control points. If you do, the coordinates of these points will be used in calculations rather than the control point coordinates.

The Setup Menu now has two <u>new</u> menu choices: **[K]** Select control file and **[L]** Deselect control file. The Select Control File Screen works like the screen to open an existing job. Move the cursor to the appropriate file name and press **[ENTER]**. To

deselect the control file, merely press **[L]** from the Raw Data Menu.

DESCRIPTOR CODE TABLES

One of the best ways of improving productivity of surveying in the field is to speed up the process of keying in point descriptors. The capability of the Descriptor Code Table is provided for this purpose. Basically, the Descriptor Code Table is a separate file in the FC-48's memory that consists of a table of commonly used point descriptors coupled with codes or abbreviations that may be keyed into the descriptor field in place of the full descriptor.

The TDS-48 allows the user to establish a Code Table for a set of commonly used descriptors in one or several surveying jobs. Then, when the descriptor prompt appears in the TDS-48 program, the code may be keyed in. The TDS-48 will insert the complete descriptor from the code table in the place of the code in the Coordinate and Raw Data files.

The Code Table is actually a special text file in the TDS-48. It requires the unique name "DESCRIPT" and it will appear in the Directory as "DESCRIPT.TXT".

The Code Table itself is composed of a series of lines of text. Each line of text consists of the code followed by the full descriptor separated by exactly one space. A typical Code Table would appear as:

```
1 POB
2 HUB
3 CURB
4 TREE
5 FENCE
6 POST
.....(etc.)
```

Codes may be up to seven characters in length and may be numeric, alphabetic or alphameric. Examples of each of these are: 17, ABC, B17.

During a survey, when the TDS-48 requests a descriptor (typically after the electronic total station is taking a shot), you may key in the full descriptor such as CURB; or, you may key in the corresponding code, such as 3, as a "shorthand" notation to indicate the CURB. In either case, the full descriptor CURB will be stored in the job file. If the data is being collected manually, the code may be keyed into the descriptor line of the Traverse/Sideshot Screen before the **[TRAV]** or **[SIDES]** softkeys are pressed. As in the previous example, the TDS-48 will store the full descriptor from the table into the job file.

SETTING UP AND DELETING A CODE TABLE IN THE TDS-48

To establish a code table in the TDS-48, you should proceed as follows:

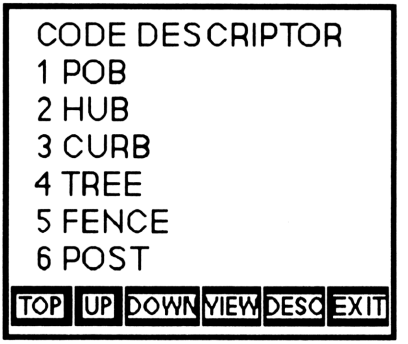
From the Main Menu Press **[G]** Job Menu, **[K]** Raw Data File Menu, **[K]** Create descriptors

These key sequences will establish the file DESCRIPT.TXT in the FC-48's memory. If the file already exists, you will get an error message. There can only be one Descriptor Code Table resident in the TDS-48 at a time.

Likewise the keystrokes **[G]** Job Menu, **[K]** Raw Data File Menu, **[L]** Delete descriptors will delete the Descriptor Code Table.

VIEWING AND ADDING TO THE DESCRIPTOR CODE TABLE

To view the Descriptor Code Table or to add codes to the table, you need to access the Descriptor Code Table Screen. From the Main Menu press **[G]**, **[K]**, and then **[J]**. You will see the current Code Descriptor Table (if one exists).



To add a descriptor to the code table, press **[DESC]**. Then key in the new table entry by keying in the code followed by exactly one space and then the descriptor such as 7 {space} MAN HOLE COVER.

⇨ **NOTE:** Descriptors may be any length, but only the first 16 characters will be stored in the coordinate file when the code is invoked.

⇨ **NOTE:** Within the TDS-48, your options are limited to creating a code table, deleting a code table or adding individual descriptors to an existent table. It is not possible to delete or edit individual entries in a code table from within the TDS-48. For this reason, code tables are usually created and modified on a PC and then downloaded to the TDS-48 for use in the field. The procedure for doing this is described in the next section.

SETTING UP AND EDITING THE DESCRIPTOR CODE TABLE IN A PC

While it is possible to set up a Code-Table from the FC-48's keyboard, the difficulty associated with "typing" a long list into the TDS-48 directly makes it desirable to use a PC to create the Code Table. Also, it is not possible to edit or delete a code from the TDS-48. To facilitate this process, you should use your favorite word processor software. Since most word processors use special characters to control the appearance of the documents they create, you should develop your Code Table in your word processor's "Non-Document" mode. The file should be named "DESCRIPT.TXT" and should consist of the following elements keyed on each line.

"CODE" {exactly one space} "DESCRIPTOR" ENTER (or RETURN).

The completed "DESCRIPT.TXT" file may then be downloaded to your TDS-48 by using your TFR software. In the TFR PC screen, you use the "Send Text File to TDS-500" option. Even though this option refers to the TDS-500, this command will also transfer a text file to the TDS-48.

COMBINING CODES AND USING CODES WITH KEYED IN DESCRIPTORS

Often during a survey, you want to use a predetermined descriptor from a Code Table, but you would like to add additional characters to the descriptor from the keyboard. An example would be a survey that is to contain the descriptors "NE 1/4 CORNER", "SE 1/4 CORNER", etc. For this example assume that the descriptor "1/4 CORNER" has been keyed into a Code Table under the code "15". Also, assume that the descriptors "NE" and "SE" are located at codes 2 and 3

respectively. To combine codes from the Code Table or to use codes with random characters on the keyboard, use the "+" key in the following way: When the descriptor prompt appears in the display and you want the descriptor to read "NE 1/4 CORNER", key in "2+15". The TDS-48 will insert the complete combined descriptor "NE 1/4 CORNER" into the file. Alternatively, you may key in "NE+15". The TDS-48 will combine the keyed-in descriptor "NE" with the descriptor associated with code 15 to create the complete descriptor "NE 1/4 CORNER". This technique may be used to concatenate up to three descriptor codes.

Codes may also be concatenated with fully keyed in descriptors. For example, if you wanted a series of points with descriptors TOP OF CURB A1, TOP OF CURB A2, TOP OF CURB A3, etc, you would set up TOP OF CURB in a Descriptor Code Table, say code 23. Then, in response to the descriptor prompt, key in 23+A1, 23+A2, 23+A3, etc.

6. ADJUSTMENTS

In this chapter you will learn how you may adjust your coordinates under various constraints. You may translate blocks of coordinates in any direction (including elevation). You may rotate blocks of coordinates about any point in the file through any specified angle. You may also adjust a traverse by either the Compass Rule or Transit Rule.

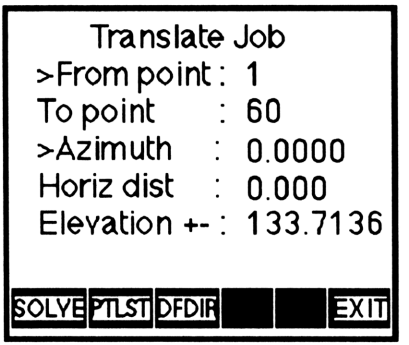
In this chapter, you will be practicing the various adjustment routines. You will be using the coordinates that you computed as a result of the SMITH survey. Be certain that you have the SMITH job as the active job. Your coordinate file should look as follows:

POINT NUM.	NORTHING	EASTING	ELE.	NOTE
1	5000.0000	5000.0000	100.0000	START
2	5710.2358	5040.8379	103.2864	PT 2
3	5740.5392	5497.5792	106.3649	PT 3
4	5654.9688	5679.7808	108.2213	PT 4
5	5158.3949	5658.6257	117.3596	PT 5
6	5198.2460	5438.2277	114.7919	PT 6
7	4970.3168	5385.8389	112.3029	PT 7
8	5000.0800	4999.9123	100.0001	Close to PT 1

This first thing you may wish to do is to compute the precision of the survey. You may determine the precision of the survey from either the Compass Rule or Transit Rule Screens. From the Main Menu, select **[N]:** Survey adjustment; and then choose **[I]** the Compass Rule Screen from the Adjust Menu. Select from point 1 to point 8 and press **[PRECI]**. For this job, the

precision is displayed as 22874 which should be read as 1 in 22,874.

To acquire some practice with the adjustment features of the TDS-48, assume that your beginning elevation was selected as 100 ft as an arbitrary convenience. However, after you returned to the office, you discovered from a map of the adjacent property that point 2 has an actual elevation of 237 ft. You would now like to bring all of the points of your survey into line with this new elevation. Since you have a recorded elevation of 103.2864 ft for point 2, you must add 133.7136 to each elevation in the file. To do this, select **[N]** Survey adjustment from the Main Menu. Then choose **[G]** Translate job. You should fill out the Translate Job Screen as shown below. Press **[SOLVE]**.

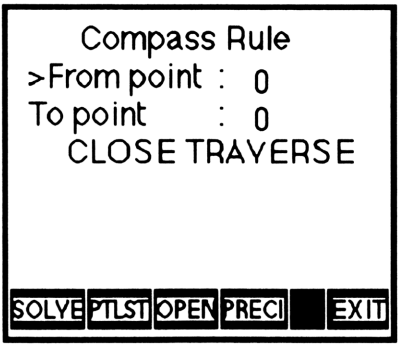


After you press **[SOLVE]**, the TDS-48 will change all of the elevations by the amount you specified. You may return to the Point Data Screen to confirm this.

NOTE: Since you were adding an elevation, you just keyed in the amount to add. To subtract an elevation (or northing or easting), key in a *negative* value for the amount to subtract before pressing **[SOLVE]**.

For practice with a traverse adjustment, use the Compass Rule Screen on the SMITH job. Select **[I]** from the Adjust Menu.

The Compass Rule Screen appears as:



To adjust the coordinates by the Compass Rule, set the points from 1 to 8 and press **[SOLVE]**. After the compass rule adjustment, your coordinates should appear as in the table below:

POINT NUM.	NORTHING	EASTING	ELE.	NOTE
1	5000.0000	5000.0000	233.714	START
2	5710.2147	5040.8611	237.000	PT 2
3	5740.5045	5497.6173	240.078	PT 3
4	5654.9281	5679.8254	241.935	PT 4
5	5158.3394	5658.6865	251.073	PT 5
6	5198.1839	5438.2958	248.506	PT 6
7	4970.2475	5385.9149	246.017	PT 7
8	5000.0000	5000.0000	233.714	Close to PT 1

NOTE: Open traverses may also be adjusted. Select the OPEN TRAVERSE version of the Compass Rule Screen by pressing **[OPEN]**. You will have to key in the actual known northing and easting coordinate values of the last point in the traverse before pressing **[SOLVE]**.

NOTE: It is not necessary for the traverse points to be in numerical order in order to perform an adjustment. If they are not in numerical order, use the Point List to specify the *corner points* of the traverse. If sideshots were taken from the corner points during the traverse, they may be included in the Point List by keying in the point number with a preceding **[S] [S]** [space] (SS ##) in the Point List. By including your sideshots in the Point List, your sideshot as well as your traverse point coordinates will be adjusted when you solve for the various adjustments in the Adjust Menu.

The procedure for adjusting a traverse by the Transit Rule is identical to that for the Compass Rule, except that you use the Transit Rule Screen. Press **[J]** from the Adjust Menu.

7. PRINTING AND DATA COMM WITH YOUR TDS-48

In this chapter you will learn how to print out your coordinates or raw data directly from your TDS-48 on the HP-82240B Infrared Printer. You will also learn how to prepare your TDS-48 to transfer your coordinates and raw data to an office PC.

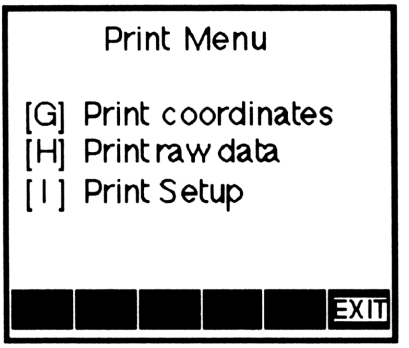
PRINTING COORDINATES

Periodically during a job, you may wish to make a hard copy of your work by printing either the coordinate values of the points that you have surveyed or the raw data. The TDS-48 makes use of the HP-48SX's built-in infrared wireless data communications capability to print on the HP-82240B Infrared Printer. The process for doing this is quite straightforward.

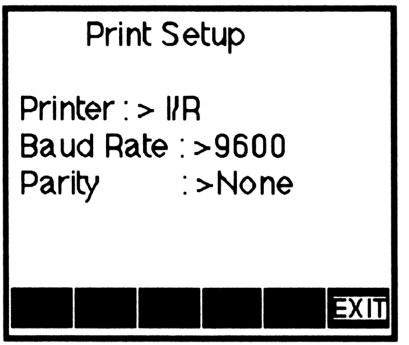
First, you should make sure that the active (open) job is the job whose data you want to print. You may select the proper active job by using the Open Existing Job option from the Job Menu. [Select **[G]** then **[H]** from the MAIN Menu. Move the cursor to the proper job and press **[ENTER]**.]

Next, select **[R]**, Print menu, from the MAIN Menu. The Print Menu will appear as:

PRINT/DATA COMM

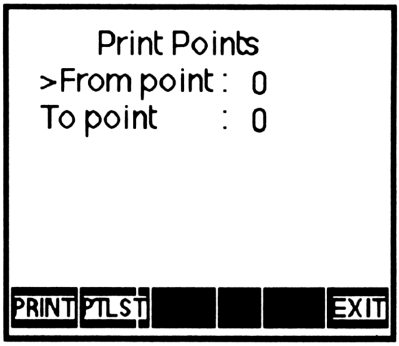


The first thing that you should do is press **[I]** and access the Print Setup Screen:



With this screen you may choose whether or not to use an RS232 "wire" printer or the HP-82240B Infrared "wireless" printer. If you choose the RS232 printer, you may also specify the communication parameters of baud rate and parity. When you have filled out this screen properly for your particular printer press **[EXIT]**. You will return to the Print Menu.

Now, select **[G]** and you will see the Print Points Screen:



As in other screens in the TDS-48, you may control the output coordinates to a block of points by specifying the From point and To point options or by using the currently active Point list. To use the point list, press one of the horizontal cursor keys with the scroll bar at the "From point" line in the display and change the prompt to the "*Using point list*" prompt. The point list itself may be created or edited by pressing the **[PTLST]** softkey.

Once you have set up the screen to output the proper coordinate data, either plug in your TDS-48 to your "wire" printer with the appropriate RS232 cable or configure your TDS-48 to communicate with your infrared printer. Place the HP-82240B Infrared Printer so that there is a direct line of sight between the IR emitter on the top of the HP-48SX and the IR receiver on the front of the Printer. The range of these devices is approximately 3-6 inches. Make sure that the printer has an adequate supply of paper and is turned ON. Now press **[PRINT]**.

NOTE: The infrared output to the printer is only one-way communication. Thus, there is no way for the TDS-48 to know if the printed output is properly received. If the signal is not received or is interrupted during transmission, some or all of the output will not be printed.

PRINTING RAW DATA

The process for printing raw data is quite simple. Since you have no control over the amount of raw data that you can print, the process is to select the proper active (open) job as in printing coordinates above. Then select **[R]** from the MAIN Menu. Again, make sure that your have filled out the Print Setup Screen properly (see above) and configured your equipment to communicate with the specified printer. Now press **[H]**, Print raw data from the Print Menu. The raw data of the currently active job will be printed in its entirety as it is stored in the TDS-48. Consult Appendix D for a listing of the meanings of the various abbreviations that you will see in the printout. You may obtain an unabbreviated version of the raw data by transferring the raw data file to your office PC using a copy of the TDS-48 TFR PC software and generating a printout of the raw data on your PC's printer. (See the TDS-48 TFR Manual.)

PRINTING SCREENS

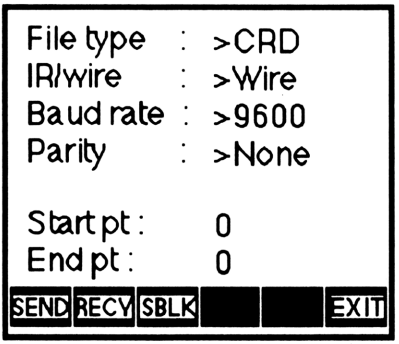
At any time you may print the contents of any screen in your TDS-48 by using the global key sequence **[←] [D]**. When you want to make a hard copy of any screen, just set up your HP-82240B Infrared Printer properly, turn it on, and press **[←] [D]** with the screen you want printed in the display. For example, if you take your infrared printer to the field, you may use this command after each shot to make a hard copy of your raw data as you go.

NOTE: Screens prints may only be sent to the HP-82240B Infrared Printer.

DATA COMM TO AN OFFICE PC

One of the most useful features of the TDS-48 is that you may transfer your coordinates and raw data that you collected in the field to your office personal computer. You may also transfer coordinates from your office PC back to your TDS-48 for stakeout. The process for setting up your TDS-48 to accommodate this transfer is as follows:

From the MAIN Menu, select **[S]**, File transfer. You will now see the File Transfer Screen as shown:



Move the cursor to the first line and, using the horizontal cursor keys, select the CRD option for File type.

The last three lines of this screen are all of the scrolling prompt type and have to do with setting the actual data transfer communication parameters to match those required by your PC. These values will be determined by the particular software that you will be using in your PC to communicate with your TDS-48.

> **NOTE:** If you are using the companion TDS-48 TFR PC software in your PC to communicate with your TDS-48, these parameters should be set to 9600 baud, no parity, and wire interconnection.

FILE TRANSFER BETWEEN TWO TDS-48's

You may use the wireless communication capabilities of the HP-48SX to copy a coordinate or point list file from one TDS-48 to another. The process is to select the I/R communication option in the File Transfer Screen in both units. Position the units so that the I/R data ports are facing each other and about 3-6 inches apart. The I/R port may be located by a small arrow molded on the top case of the HP-48SX just above the Hewlett-Packard logo. When the units have been set up and configured properly, press **[RECV]** on the unit which is to receive the file and **[SEND]** on the unit that is to send the file.

8. ADVANCED TOPICS

Until now, it has not been necessary for you to understand anything about the HP-48SX itself in order to use the TDS-48 Surveying Card. This chapter provides information for those users who wish to write their own program for the HP-48SX using coordinate data gathered by the TDS-48 Surveying Card. Effective understanding of this material requires some understanding of the programming language of the HP-48SX. As a separate advanced topic this chapter also presents an example offset stakeout that includes both horizontal and vertical curves.

QUICK RETURN TO THE TDS-48 FROM THE HP-48SX OPERATING SYSTEM

If you plan on writing you own programs to use in conjunction with the TDS-48, you will want to set up the HP-48SX to access the TDS-48 software from a single softkey when you are in the operating system. This will facilitate a quick transfer back and forth from the Surveying Card software. The process for doing this is:

1) Type {FC48} in the command line. To do this you will actually have to press the following keys: **[←] [{}] [α] [α] [F] [C] [4] [8] [α]**.

2) Press **[ENTER]**.

3) Press **[→] [MODES]**. Even though the **[MODES]** function is printed on the keyboard in gold, you should

use the *blue* shift key for his command.

4) Press the **[MENU]** softkey.

Now if you are in the operating system of the HP-48SX and you want to return to the TDS-48 Surveying Card, press **[CST]** and then the **[TDS48]** softkey.

USING TDS-48 COORDINATE DATA IN YOUR OWN PROGRAMS

Many of the data collection and computational needs of the professional land surveyor are included within the Menus and Screens of the TDS-48 Surveying Card. However, it is recognized that a user proficient in the programming and use of the HP-48SX itself may choose to develop his or her own routines to solve additional problems. To this end, the TDS-48 includes two functions which allow you direct access to the coordinate data files from the standard HP-48SX operating system.

The full understanding of these functions requires some working knowledge of the system organization and programming language of the HP-48SX. It is well beyond the scope of this manual to provide this. The Owner's Manuals that come with your HP-48SX should be your primary source of this information.

RETREIVING DATA FROM A COORDINATE FILE - THE RCLPT FUNCTION.

The RCLPT function will use a point number within level 1 of the stack as a single argument and return the following to the stack:

The point descriptor is returned as an alpha string to level 6.
The point elevation is returned as a real number to level 5.
The point easting is returned as a real number to level 4.
The point northing is returned as a real number to level 3.
The point number is returned as an real number to level 2.
Either the number 1 or 0 is returned to level 1.

The number in level 1 serves as a flag to indicate that indeed the point data recall has taken place. If the value in level 1 is a 1, the point data as listed above is valid. If the value in level 1 is a 0, the point data has failed to be recalled for some reason (such as the specified point number is nonexistent in the active job). In this case levels 2 to 6 will *not* contain valid point data. The stack that existed prior to executing RCLPT will have been lifted one level.

As an example to recall the coordinates of point 2 of the active job to the stack: key in **[2]** into the command line. Press **[ENTER]**. Press **[α] [α] RCLPT [ENTER]**.

STORING DATA TO A COORDINATE FILE - THE STOPG FUNCTION

In order to store data into a coordinate file you must do four things:

1) create a three dimensional vector variable called 'CURPT' that contains the point's northing, easting, and elevation in that order.

2) create a string variable called 'DESC' that contains the point descriptor.

3) place the point number in level 1 or the stack.

4) Execute STOPG.

As an example, to store the following coordinate values for point 7 in the active job -

Northing - 2500
Easting - 3000
Elevation - 100
Descriptor - "POINT"

execute the following keystrokes:

[←] [[]] 2500 **[SPC]** 3000 **[SPC]** 100 **[SPC] [ENTER]**
['] [α] [α] CURPT **[ENTER] [STO]**
[→] ["**"**] [α] [α] POINT **[ENTER]**
['] [α] [α] DESC **[ENTER] [STO]**
7 **[ENTER]**
[α] [α] **STOPG [ENTER]**

If the point is already in use in the current job, you will be prompted if you would like to overwrite it. In any event, if the point data has been stored, the stack will contain the point number in level 2 and the number 1 in level 1. If the data storage has not been accomplished, the number 0 will be returned to level 1 in the stack.

NOTE: Both the RCLPT function and the STOPG function operate on the *active job's* coordinate file. You may establish the active job by using the Jobs Menu and the Open an Existing Job Screen in the TDS-48.

OFFSET STAKEOUT WITH BOTH HORIZONTAL AND VERTICAL CURVES

The TDS-48 Offset Staking is set out along a center line. This center line is defined by a series of straight or curved segments. The curved segments have both a horizontal and vertical

definition. Each change in curve specification along the center line must occur at a coordinate point. A curve definition is only valid between two adjacent coordinate points, even though it might be part of a longer curve. This means that when curve specifications overlap, the overlapping curve must be redefined in both of the overlapped curves. For instance, a long vertical curve may overlap shorter horizontal curves along the way. The vertical curve must be redefined into short segments that match the horizontal curves. Of course, a long horizontal curve overlapping shorter vertical curves requires similar treatment. Both of these conditions are covered in the example below.

POINT LIST

The center line is described in a point list. Straight line segments are described by a sequence of coordinate points. Curved line segments are described by the end points of the segment plus information about the shape of the curve. Each curve segment includes information for both horizontal and vertical curve specification.

A Horizontal curve is defined by its direction of curvature, its radius and whether it is the larger or smaller arc of the circle. Set the **[>]** Radius line in the screen to **[>]** Straight line V. Crv to indicate that the horizontal curve is straight. A Vertical curve requires information on the beginning and ending grade % of the curve. A beginning and ending grade % of zero indicates that the curve is straight.

OVERLAPPING CURVES

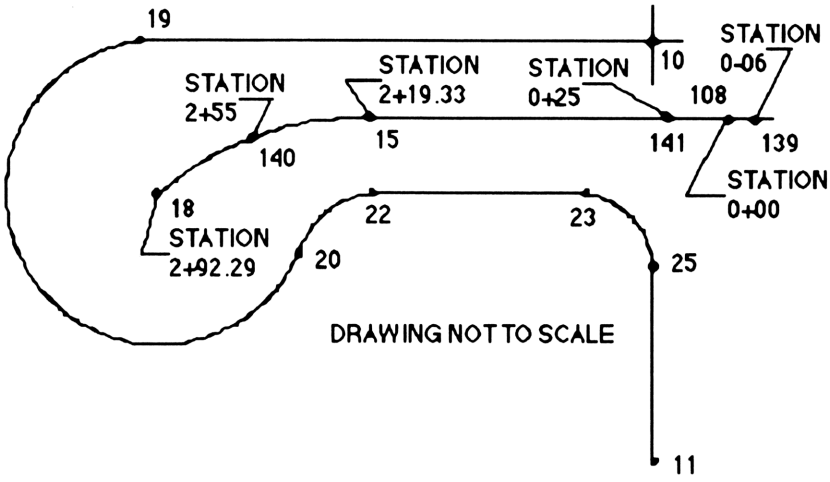
When a horizontal curve overlaps a change in vertical curves, a new point must be created on the horizontal curve at the point of change. The position of the point on the curve is the distance from the station at the beginning of the curve and the station at the point of vertical curve change. Describe the horizontal curve

in the Solving Horizontal Curve Screen. Then use the Store Tangent Point Screen to create the new point. The elevation of the new point is the same as that at the vertical change station.

When a vertical curve overlaps a change in horizontal curves, a point already exists at the point of change; but its elevation and grade % are not known. This point's station on the vertical curve is used to find elevation and grade %. The Vertical Curve Screen is used to setup the vertical curve for the Vertical Curve Layout Screen. In the Layout screen, enter the station of the horizontal curve change and press the **[S->E]** "soft" key to find the elevation and grade % at that station. Use the Point Data Screen to enter the new elevation of the coordinate point. In the center line point list, enter the vertical curve grade % in the description of the two horizontal curves that meet at that point.

EXAMPLE

This Offset Stake example is a cul-de-sac in a small housing tract. It goes west up the side of a hill from a cross road. The center line of the roadway begins in the cross road as a straight vertical curve. It dips down to 399.85 feet at 0+55.67 and then rises to 406.325 feet with grade of 6.5% at 2+55. This vertical curve is designed to pass through 0+25 at 400 feet with grade -1%. The straight portion of the road ends at 2+19.33 (point 15) where it turns left in a 129.6 foot radius to the center of the sac at 2+92.29 (point 18). The end of the vertical curve lies between points 15 and 18. A drawing of this example appears below:



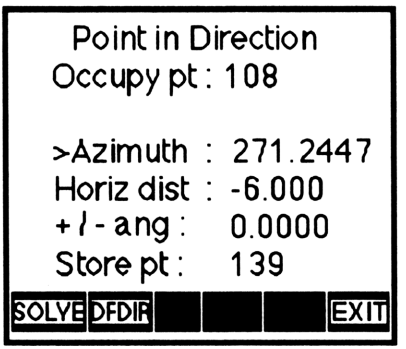
The following coordinates describe the boundary of the tract and the right-of-way of the cul-de-sac.

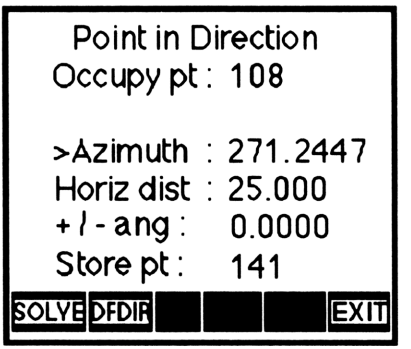
POINT NUM.	NORTHING	EASTING	ELE.	NOTE
10	7438.99630	36836.35130	100.0000	CORNER
11	7231.06420	36831.06280	100.0000	CORNER
12	7241.37200	36413.19000	100.0000	CORNER
13	7449.30500	36418.47800	100.0000	CORNER
25	7366.00000	36834.49500	100.0000	RT - WAY
23	7391.62900	36810.12600	100.0000	RT - WAY
22	7395.61300	36648.61100	100.0000	RT - WAY
20	7378.87200	36624.39500	100.0000	RT - WAY
19	7445.35900	36578.43000	100.0000	RT - WAY

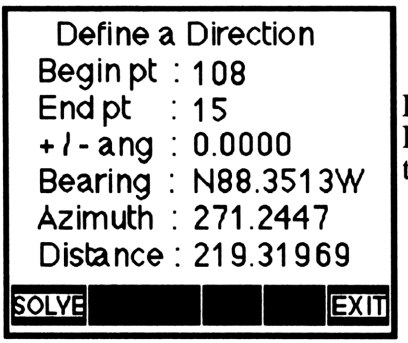
The following points describe the center of the pavement within the right-of-way.

POINT NUM.	NORTHING	EASTING	ELE.	NOTE
108	7408.26700	36865.57900	400.5600	0+00
15	7413.67500	36646.32600	100.0000	2+19.33 bhc
18	7395.37400	36577.19700	408.7500	2+92.29 ehc

The vertical curve begins at 0-06 at 400.68 feet with grade -2% and drops to 400.00 feet with grade -1% at 0+25. It then goes for 230 feet while rising to 406.325 feet with grade 6.5% at 2+55. The first two of these points are easily found in the Point In Direction Screen (R-56). Occupy point 108 and establish a direction along the line 108-15.



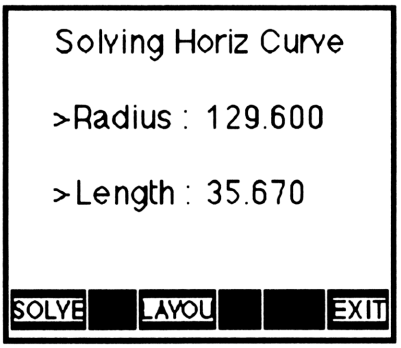


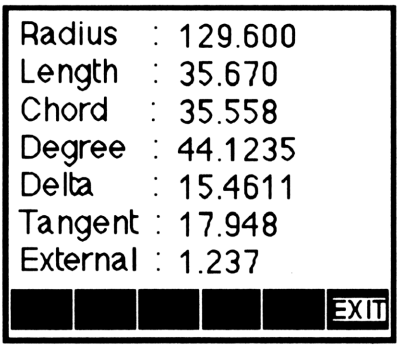


Press **[DFDIR]** in the Point In Direction Screen to get to the Define A Direction Screen

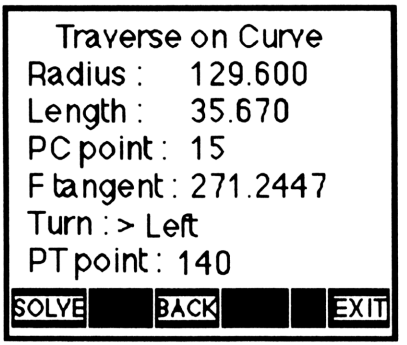
POINT NUM.	NORTHING	EASTING	ELE.	NOTE
139	7408.11905	36871.57718	400.6800	0-06bvc -2%
141	7408.88345	36840.58660	400.0000	0+25bvc -1%

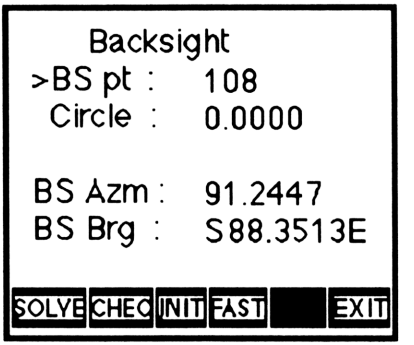
The next point to be found is at the end of the vertical curve, which will be called point 140. The station at point 140 is 2+55 and the station at the beginning of the horizontal curve is 2+19.33 (point 15). Therefore, point 140 is 35.67 feet from the beginning of the horizontal curve. The radius of the curve is 129.6 feet. Enter these numbers in the Solving Horizontal Curve Screen and press **[SOLVE]**.



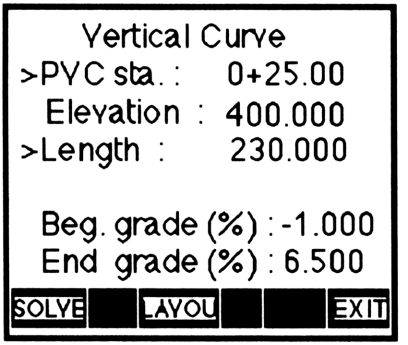


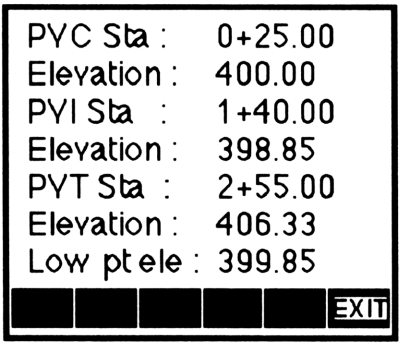
From the Curve Menu, press **[J]** to begin creation of point 140. This will display the Traverse on Curve Screen. Enter point 15 for the PC. Press **[BACKS]** to establish a backsight on point 108. The backsight azimuth is 91.2447 which gives a forward tangent of 271.2447. Back in the Traverse on Curve Screen, indicate a left turn and point 140 at PT. Press **[SOLVE]** to store the new point with an elevation of 406.325.



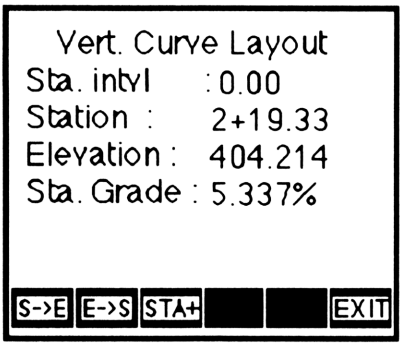


All you need now is the elevation and grade % at point 15. Select the Vertical Curve Screen. Enter the definition of the vertical curve from 0+25 (point 141) to 2+55 (point 140) and press **[SOLVE]**.





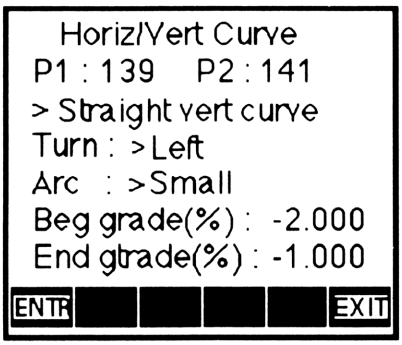
Return to the Vertical Curve Screen and press **[LAYOU]** to display the Vert. Curve Layout Screen. Ignore the station interval and enter 2+19.33, the station of point 15. Press **[S-->E]** to display the elevation of 2+19.33.



elevation of pt 15
vertical grade at pt 15

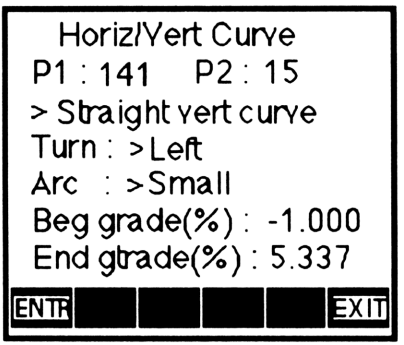
NOTE: The screen uses the appropriate units depending on the distance units setting.

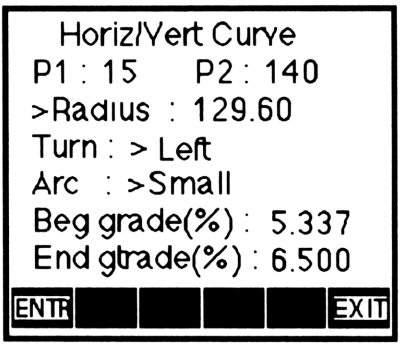
Now, you have all the information required to build the center line point list. Select the Point List Menu through the Offset Stakeout Screen. Press **[H]** to clear the current point list and then press **[G]** to edit the empty list. Press **[CURVE]** to select the Horiz/Vert Curve Screen. Enter the information to define the center line from point 139 to point 141.

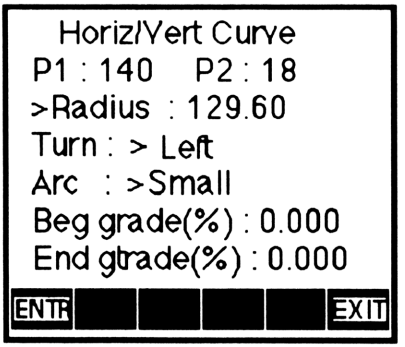


define center line from pt 139 to pt 141
vertical curve only; "straight" horiz. curve
this line is ignored
design grade
design grade

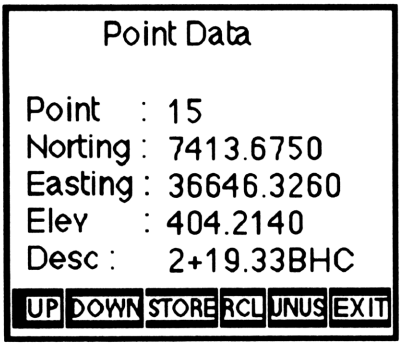
Repeat this for the other segments of the center line.







The last detail to complete the center line definition is to enter the correct elevation for point 15. Select the Point Data Screen. Recall point 15 to the screen. Move the cursor to the elevation line and enter 404.214. Press **[STORE]** to change the job file.


Point Data
Point : 15
Norting : 7413.6750
Easting : 36646.3260
Eley : 404.2140
Desc : 2+19.33BHC
UP
DOWN
STORE
RCL
UNUS
EXIT

REFERENCE

This section of the manual presents the reference material about the TDS-48. Each screen is presented in a common and consistent format. You should read the tutorial sections (chapters 1- 8) to learn the concepts behind the operation of the TDS-48. The reference section should be used as a refresher to understand how specific screens are used and to fill in the detailed information that was omitted from the tutorial section in the interests of brevity.

ORGANIZATION OF THE REFERENCE MANUAL

The reference section of this manual is presented in a complete and consistent format. It is assumed that you have read and understood the tutorial section of this manual. The reference section is not written to be read to learn how to use the TDS-48. It is assumed that you know how the basic user concepts of the machine are organized and, specifically, that you understand the difference between Menus and Screens. (If you do not, reread Chapter 2 - Getting Started.)

Thus, the Menus are not presented individually. They are discussed in general in the beginning of this section. Then each screen is presented. Screens are grouped by class of application from the Main Menu and by access letter within this grouping. Screens which may be accessed via multiple menu paths are cross referenced from the various starting menus.

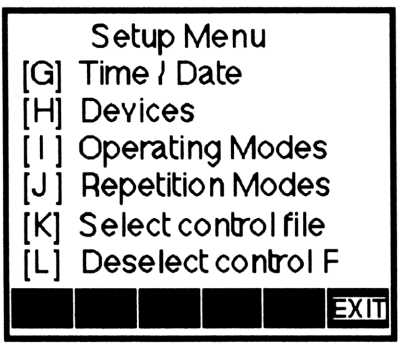
REFERENCE

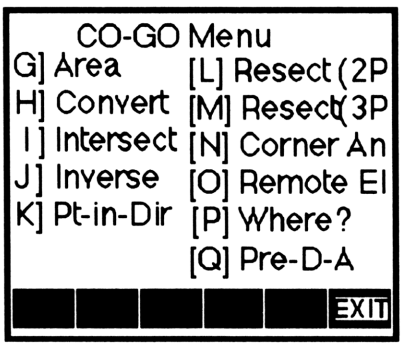
INTRODUCTORY COMMENTS

All work in the TDS-48 is accomplished within the machine's Screens. Access to the various screens is accomplished via the machine's Menus. It is important to understand the difference between Menus and Screens. That material is covered in Chapter 2 - Getting Started. This section of the Reference Manual will discuss Menus and Screen in a generic way. Following sections will cover each Screen in detail. Menus will not be covered beyond the present discussion.

THE GENERIC MENU

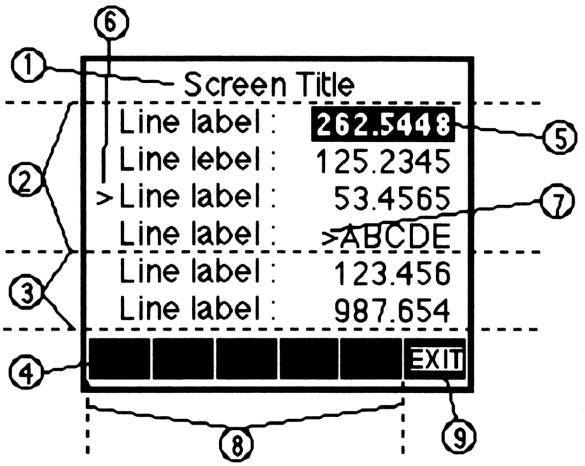
The generic Menu is characterized by a sequence of choices in the display, each of which is preceded by a letter of the alphabet. In most menus, the letter is shown with a space between the letter and the choice. For those menus where there are many choices (more than one per line of display), the space is omitted. In either case, the choice is made by pressing the appropriate letter-key on the keyboard. The generic menu is also characterized by the single "soft" key **[EXIT]** shown in the right hand key position in the display. Sample menus of each type are shown below for reference:





THE GENERIC SCREEN

The figure below is of an imaginary generic screen labeled to show the various features of real screens.



None of the screens in the TDS-48 has all of these features. However, by understanding the nature of the generic features as shown in this screen, you will have a firm understanding of the use of the real screens that you will encounter as you use the TDS-48.

Each of the features is described by reference to the feature number as shown in the figure above:

1. Screen Title: The screen's title is always shown in the top line of the display. Some screens which require more lines of information will not show the title at all. If the title is shown, it will be in the top row.

2. Input Region: Some of the lines in the display are reserved for data input. The left part of the line shows the label defining the data to be input. The right side is where the data goes. The input lines will allow the screen cursor to be placed in the data field of that line. (See 5., below) Some screens that only show

the results of computations will not have any input region.

3. Output region: Some of the lines in the display are reserved for data output: the results of computations based on the contents of the input region. The left part of the line shows the label defining the nature of the output. The right side shows the output itself. The output lines will not allow the screen cursor to occupy the data field of the line. (See 5., below.) Some screens that require a significant amount of data input will not have an output region. The solution will be shown on a separate output screen. Separate output screens normally follow immediately when data input is complete and the necessary function key is pressed.

4. "Soft" Key Region: Every screen will have the bottom row reserved for the definition of up to six "soft" keys which are activated by pressing the six keys in the top row of the TDS-48. The first five keys can be any of a variety of functions dependent on the particular screen being used. (See 8., below.) The sixth key will contain the label **[EXIT].** (See 9., below)

5. Data Entry Cursor: In any screen which has an input region, there will be a data entry screen cursor that will be positioned on the line that is active and ready to receive data from the keyboard. The cursor is recognized by the fact that it shows the data in "inverse video". The cursor may be moved to the next legal input line by pressing either of the vertical cursor keys **[Λ]** or **[V]**. The **[Λ]** key will move the cursor to the previous data input line; the **[V]** key will move it to the next following data input line. When the cursor is in position at a data input field, the field will only accept entries from the keyboard which are legal for the kind of data being entered. For example, it is not possible to key in alpha data into a field for which only numeric data makes sense (such as a distance). Entering *alpha data* into an input line *requires* pressing the **[α]** key *once* both before and after the entry.

6. Scrolling Prompt Symbol: Input lines which have a ">" character *before* the line label provide you with a choice of the

kind of data which may be keyed in to solve the problem represented by the screen. For example, in many cases, angles may be keyed into the TDS-48 as an azimuth or as a bearing. The scrolling prompt gives you an opportunity to change the prompt (line label) of the input line to match the kind of input data that you want to use. To *"scroll"* (change the prompt), move the data entry cursor to the line in question and press either of the horizontal cursor keys **[>]** or **[<]**. Pressing one of these keys successively will allow you to review all of the prompt options which are permissible for this particular input line.

7. Scrolling Data Symbol: When the ">" character appears in *front* of an *input data* field, you know that you have a very restricted choice of inputs that you may specify for this data line. All of the choices may be reviewed by moving the data entry cursor to the line in question and pressing either one of the horizontal cursor keys **[>]** or **[<]**. Pressing one of these keys successively will allow you to review all of the data input options which are permissible for this particular input field.

8. Command "Soft" Keys: The first five "soft" key positions are reserved for the screen commands. These are the keys that will cause the TDS-48 to perform some action based on the data which has been entered into the input data lines prior to invoking the command. The action may be any number of things. Some commands transfer control to another screen. Others will perform some computation and return the results to the output lines of the current screen. Still others will compute some results and transfer control to another screen. Most often, given the problem being solved and the name of the command, the action taken will be obvious. In any event, all of the commands are described in detail in this reference manual. Consult the section that describes the screen in question.

9. The **[EXIT]** Key: The right hand "soft" key position is reserved for the label **[EXIT]**. The **[EXIT]** key will always return you to an immediately previous screen or menu.

NOTE: Some screens will have more than one data input field contained within a single display line. For example, the Traverse / Sideshot Screen shows both the occupied point and the foresight point on the top line. It also shows the height of the instrument and the height of the rod on the same line, just above the command "soft" key line. To move the cursor from one data field to the other, you still use the vertical cursor keys, **[∧]** or **[∨]**, even though the cursor is moving "sideways". The horizontal cursor keys **[>]** and **[<]** are reserved for scrolling prompts and scrolling data.

GENERALIZED OPERATION OF A SCREEN

The generalized operation of a TDS-48 screen is to enter all of the required input data by moving the cursor key to the various data fields and keying in the required information. For those data fields that are preceded by a scrolling data symbol ">", you should use the horizontal cursor keys and scroll to the data input option that you want. Data may be entered in any order. During the data entry procedure, no "action" is being taken by the TDS-48. TDS-48 action is initiated by pressing one of the "soft" command keys at the bottom of the screen.

NOTE: In certain screens, some of the data input fields may be "filled out" by data transferred automatically from an electronic total station. Such data fields are described in the detailed screen descriptions in this reference manual. In these screens, you may trigger the data collection and transfer to the TDS-48 by pressing the appropriate "soft" key in the command line.

DESCRIPTION OF SCREENS

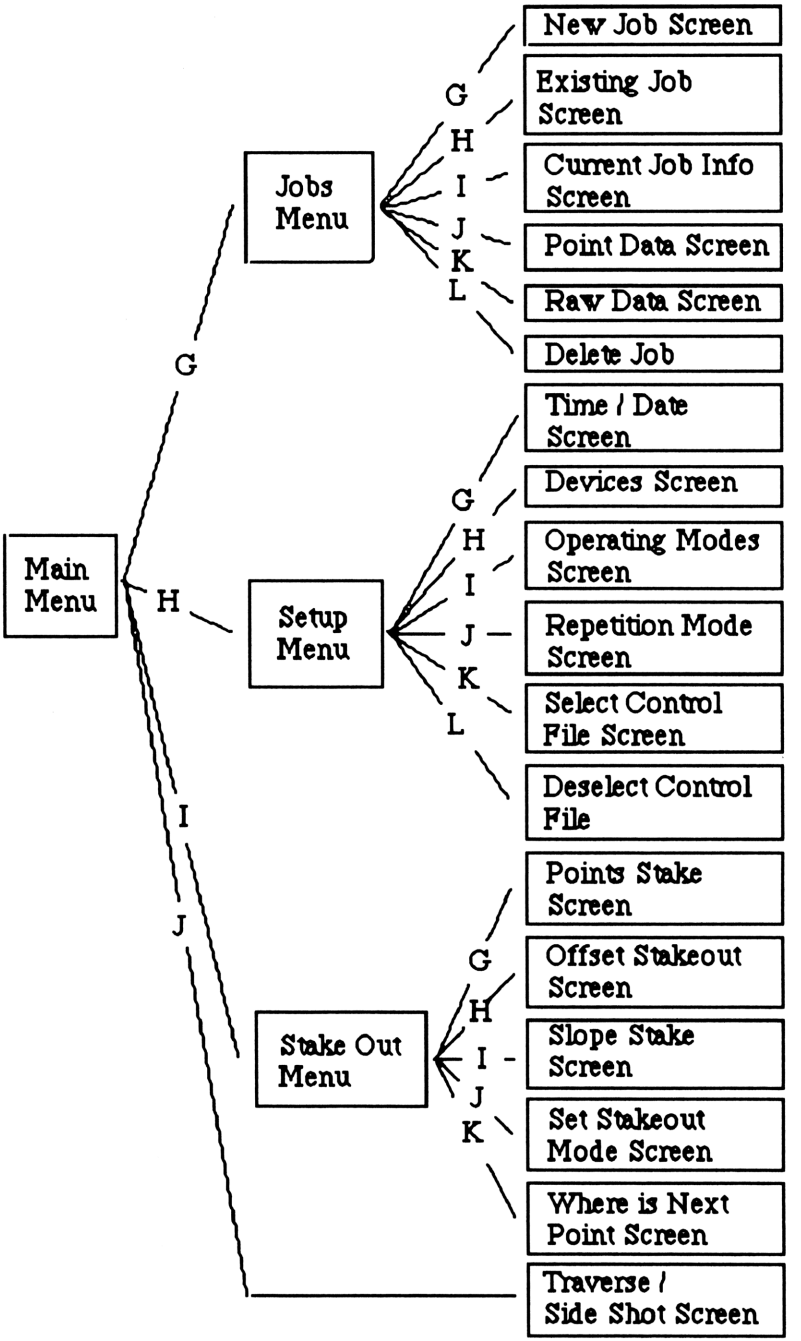
In the sections of the reference manual that follow, each screen will be described as follows:

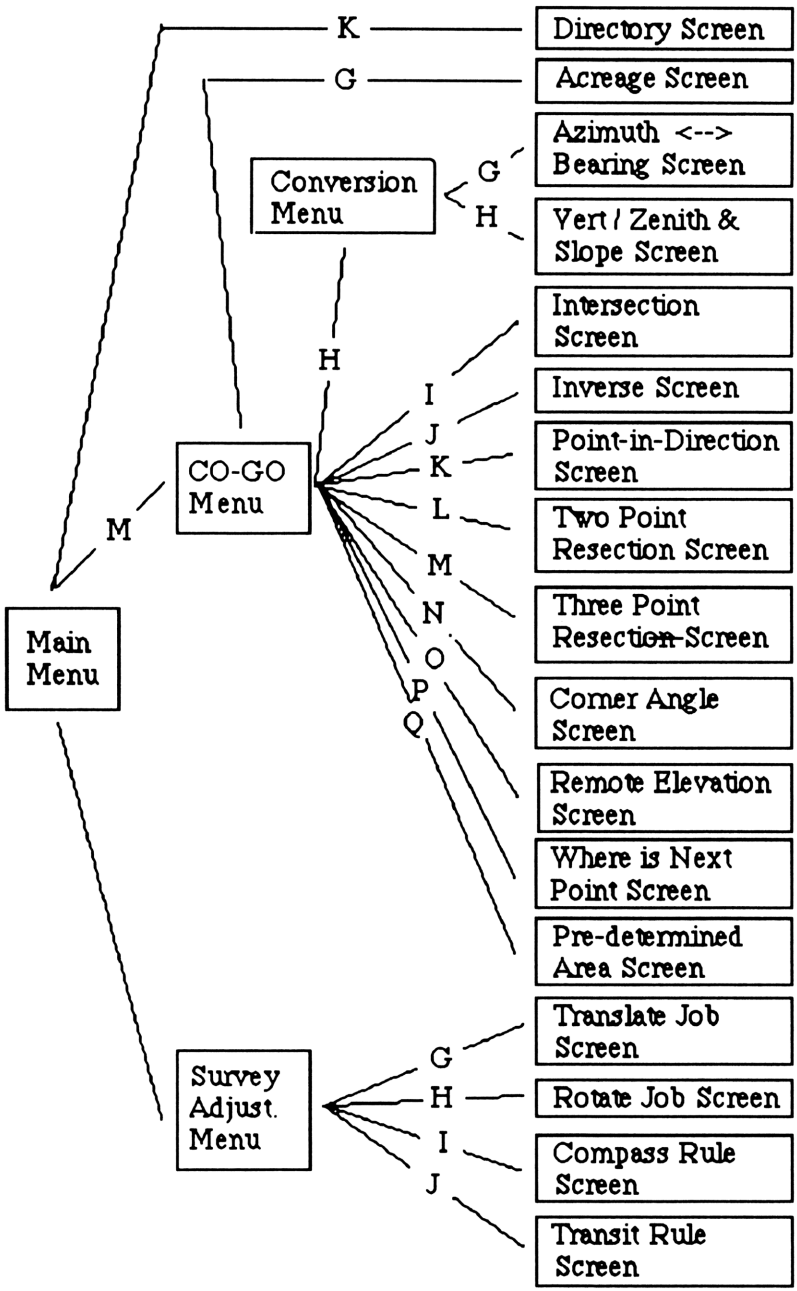
First, the title of the screen will be in a box at the top of the page. This will be followed by the primary menu path to arrive at the screen. If there are alternative paths to the screen, they will also be given. Next, the screen itself is presented. Alternative scrolling prompts are shown to the left of the screen picture. Alternative scrolling data fields are shown to the right of the screen picture. Below the screen picture are two framed groups of information. The first framed group is reserved for a detailed description of each input and output line of the display. The second framed group is reserved for a detailed description of the command "soft" keys.

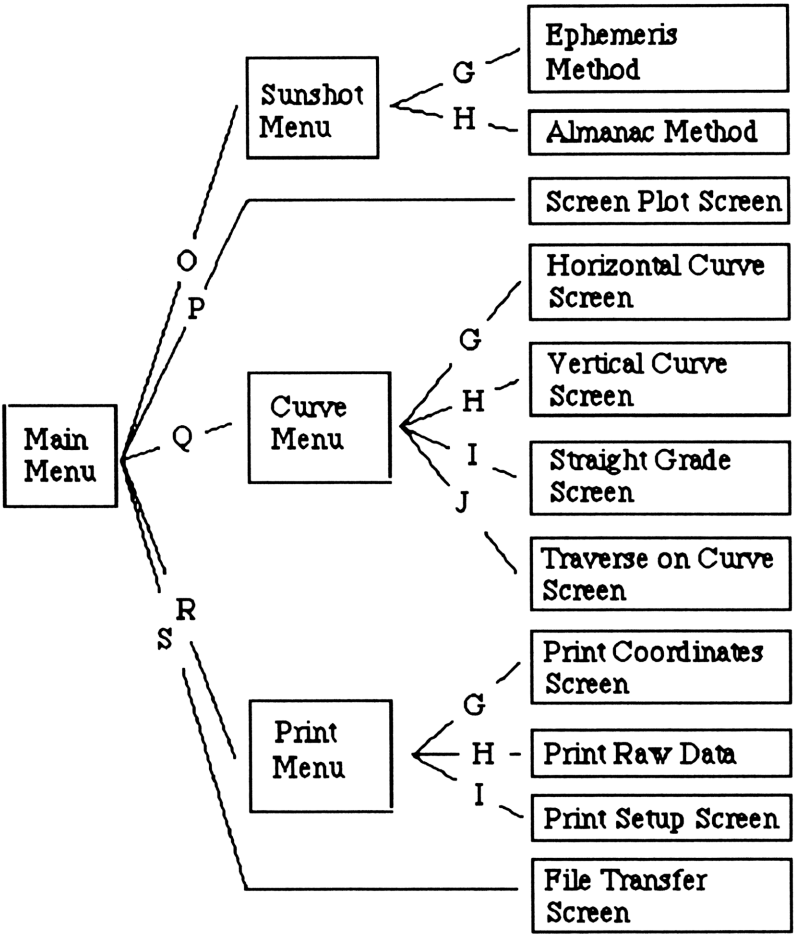
The screens are organized within this reference section by class and order of screen. At the end of the screen descriptions, there is an alphabetical reference list of screens by title.

SCREEN TREE MAP

The next three figures provide a pictorial "map" of the TDS-48 screen tree. Using this tree, you can determine the sequence of menus and alpha keys required to access any of the screens that you may need to use to solve surveying problems with your TDS-48.


Main Menu
G
H
I
J
Jobs Menu
G
H
I
J
K
L
New Job Screen
Existing Job Screen
Current Job Info Screen
Point Data Screen
Raw Data Screen
Delete Job
Setup Menu
G
H
I
J
K
L
Time / Date Screen
Devices Screen
Operating Modes Screen
Repetition Mode Screen
Select Control File Screen
Deselect Control File
Stake Out Menu
G
H
I
J
K
Points Stake Screen
Offset Stakeout Screen
Slope Stake Screen
Set Stakeout Mode Screen
Where is Next Point Screen
Traverse / Side Shot Screen


Main Menu
M
CO-GO Menu
K
G
H
Conversion Menu
G
H
I
J
K
L
M
N
O
P
Q
Directory Screen
Acreage Screen
Azimuth <--> Bearing Screen
Vert / Zenith & Slope Screen
Intersection Screen
Inverse Screen
Point-in-Direction Screen
Two Point Resection Screen
Three Point Resection Screen
Corner Angle Screen
Remote Elevation Screen
Where is Next Point Screen
Pre-determined Area Screen
Survey Adjust. Menu
G
H
I
J
Translate Job Screen
Rotate Job Screen
Compass Rule Screen
Transit Rule Screen


Main Menu
O
P
Q
R
S
Sunshot Menu
G
H
Ephemeris Method
Almanac Method
Screen Plot Screen
Curve Menu
G
H
I
J
Horizontal Curve Screen
Vertical Curve Screen
Straight Grade Screen
Traverse on Curve Screen
Print Menu
G
H
I
Print Coordinates Screen
Print Raw Data
Print Setup Screen
File Transfer Screen

GLOBAL TOP-ROW KEY COMMANDS

ESCAPE COMMAND

Purpose of command - to allow you to escape from the TDS-48 program and return to the operating system of the HP-48SX in order to run some other software or to do manual calculations.

Path - From any screen, press **[←] [A]**.

This command will allow you to escape temporarily from the TDS-48 program and return to the main operating system of the HP-48SX. This function will also "bring with it" the contents of the current screen at the current cursor location and load this value into the HP-48SX operational stack at level 1. Then you can perform any calculation that you want on this value, including running your own software. When you return to the TDS-48, the system will return to the screen that you were in prior to the escape; and whatever is in level 1 of the stack when you return will be loaded at the cursor location in the screen that you were in prior to the escape. The keystrokes to return to the TDS-48 are **[←] [CONT]**. (The **[CONT]** key is the orange shifted key above the **[ON]** key.)

NOTE COMMAND

Purpose of command - to allow you to key in a note of arbitrary text into your currently active raw data file.

Path - From any screen or menu, press **[←] [B]**.

This command will present a screen that is blank except for the message "Enter Note". You may then key in arbitrary text information which will be recorded as a note in your active raw

data file. The only facility you have to edit this note is with the back space key. When you are finished keying in the note, press **[ENTER]** to place it in the raw data file and return to your previous screen or menu.

PRINT COMMAND

Purpose of command - to allow you to print any screen or menu in the TDS-48 with the HP-82240B Infrared Printer.

Path - From any screen or menu, press **[←] [D]**.

This command will output whatever is in the display of the TDS-48 to the HP-82240B Infrared Printer. Before issuing this command, you should be certain that the printer is properly positioned to receive the information; that the printer has an adequate supply of paper; and, that it has been turned ON.

MAIN COMMAND

Purpose of command - to allow you to return to the MAIN MENU from any other screen or menu in the TDS-48.

Path - From any screen or menu, press **[←] [F]**.

This command will immediately return to the MAIN MENU of the TDS-48.

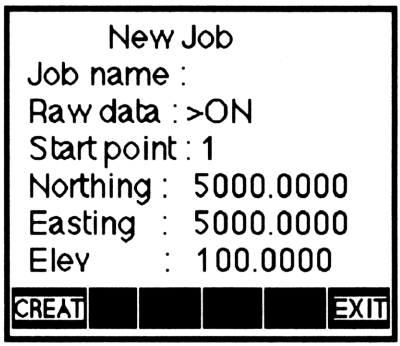
MENU SCREENS

JOBS MENU SCREENS

NEW JOB SCREEN

Purpose of screen - to allow for the creation of a new, named job file.

Path - From the Main Menu, press **[G]** Jobs Menu - **[G]**



ON - OFF

Job name: is the name of the new job to be created

Raw data: indicates whether or not a raw data file is to be set up and raw data stored for this particular job.

Start point: is the lowest numbered point for this job. Once this number has been selected you may *not* use a point with a smaller point number in this job.

Northing: is the north coordinate for the start point.

Easting: is the east coordinate for the start point.

Elevation: is the elevation for the start point.

[CREAT] will establish the job file for this job with the parameters selected as shown in the screen. If the raw data line is ON, then a raw data file will also be established.

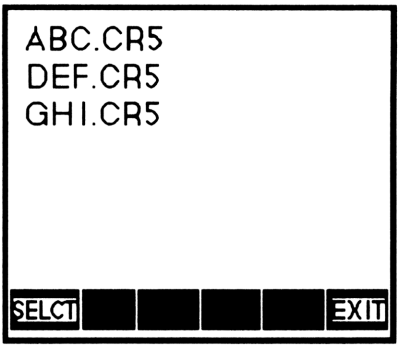
[EXIT] will return to the previous screen or menu.

NOTE: If your starting point for the survey is not the lowest numbered point, you should still specify the lowest numbered point in the Start point line. If you do not know the coordinates of this point at the time that you create the job, you may use any coordinates and edit (overwrite) them later. If some other point is the actual starting point with known coordinates, you may key them in the Point Data Screen.

OPEN EXISTING JOB SCREEN

Purpose of screen - to allow you to select an existing job to be opened.

Path - From the Main Menu press **[G]**, Jobs Menu - **[H]**



This screen shows the names of the jobs that have been created in the TDS-48. Move the scroll bar to the job you want to open by using the vertical cursor keys [Λ] and [V]. Then press **[SELCT]**.

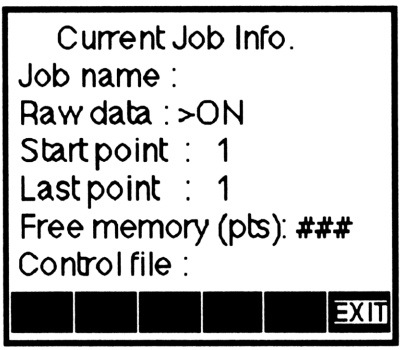
[SELCT] will chose the highlighted name as the job to open.

[EXIT] will return to the previous screen or menu.

CURRENT JOB INFO SCREEN

Purpose of screen - to provide for a way of reviewing many of the important parameters of the currently active job.

Path - From the Main Menu press **[G]**, Jobs Menu - **[I]**
From the Main Menu press **[G]**, Jobs Menu - **[H]**, Open Existing Job Screen - **[SELCT]**



ON - OFF

Job: is the name of the currently opened and active job.

Raw data: indicates whether or not a raw data file has been established and is open.

Start point: is the lowest-numbered point in the job file.

Last point: is the current highest-numbered, used point in the job file.

Free mem (points): is the approximate amount of unused memory in the TDS-48 expressed in number of points.

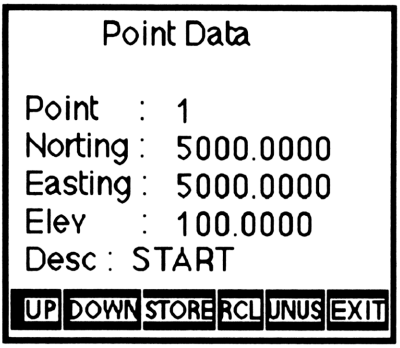
Control file: is the name of the currently selected control file.

[EXIT] will return to the previous screen or menu.

POINT DATA SCREEN

Purpose of screen - to provide a way to review and edit the coordinate data for the currently active job file.

Path - From the Main Menu, press **[G]** Jobs Menu - **[J]**



Point number: is the value of the point number for which the rest of the data in the screen applies.

Northing: is the north coordinate of the current point.

Easting: is the east coordinate of the current point.

Elevation: is the elevation of the current point.

Desc: is the point descriptor of the current point.

[UP] will increment the point number to the next largest used point and display its coordinate information.

[DOWN] will decrement the point number to the next smallest used point and display its coordinate information.

[STORE] will store the coordinate information currently shown in the display as the information in the job file at the currently displayed point number. If the current number already exists in the file, a warning screen will be displayed to confirm that the point is to be overwritten.

[RCL] will temporarily shift to a recall point number screen. You may then specify the point number to be recalled and press **[ENTER]** to return to the Point Data Screen.

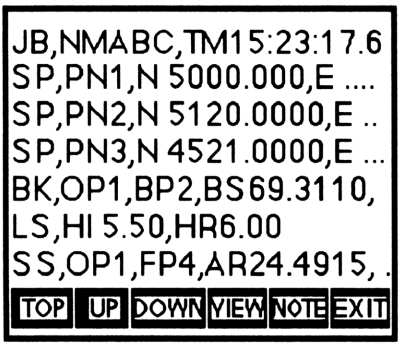
[UNUS] will display the next occurrence of an unused point with a point number greater than the current point number in the file.

[EXIT] will return to the previous screen or menu.

RAW DATA SCREEN

Purpose of screen: to provide a mechanism for reviewing the raw data file for the current job, if such a file exists.

Path - From the Main Menu, press **[G]** Jobs Menu - **[K]** Raw Data Menu **[G]**



[TOP] will display the first screen of the raw data file (including the first line).

[UP] will display the previous screen of the raw data file.

[DOWN] will display the next screen of the raw data file.

[VIEW] will display the entire contents of the highlighted line of the raw data file.

[NOTE] will temporarily transfer to a Note screen where you may key in an arbitrary note into the next line of the raw data file. Pressing **[EXIT]** from this screen will return to the Raw Data Screen.

[EXIT] will return to the previous screen or menu.

NOTE: Other than the ability to add notes to the raw data file, it is not possible to edit the contents of this file from the Raw Data Screen. In particular, it is not possible to delete any information from the raw data file from any of the screens in the TDS-48.

DESCRIPTOR CODE TABLE SCREEN

Purpose of screen - to provide for a way of reviewing the Descriptor Code Table and adding new descriptor codes while in the field.

Path - From the Main Menu press **[G]**, Jobs Menu - **[K]**, Raw Data File - **[J]** View Descriptors

The top line is the heading for the file indicating that the code is

followed by the descriptor separated by exactly one space.

Each subsequent line is a separate code/descriptor pair.

[TOP] will display the descriptor file from the top.

[UP] will move up to the next screen of descriptor codes

[DOWN] will move back to the previous screen of descriptor codes.

[VIEW] will display the entire descriptor at the cursor.

[DESC] will allow you to key in another code/descriptor pair. At the prompt key in CODE {space} DESCRIPTOR.

[EXIT] will return to the previous screen or menu.

NOTE: Descriptors may be any length, but only the first 16 characters will be stored in the coordinate file when the code is invoked.

CREATE DESCRIPTORS COMMAND

Purpose of command - to provide for a way of creating a Descriptor Code Table in your TDS-48, if one does not already exist.

Path - From the Main Menu press **[G]**, Jobs Menu - **[K]**, Raw Data File - **[K]**

This sequence of keystrokes will create an empty descriptor code table, if one does not already exist in the TDS-48. If one already exists, an error message will appear.

DELETE DESCRIPTORS COMMAND

Purpose of screen - to provide for a way of deleting the Descriptor Code Table from your TDS-48.

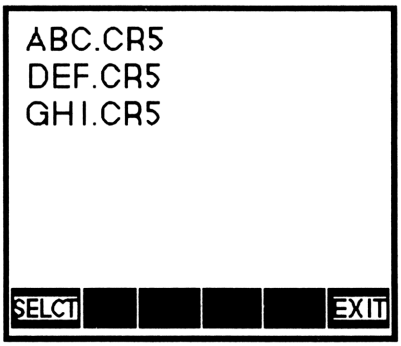
Path - From the Main Menu press **[G]**, Jobs Menu - **[K]**, Raw Data File - **[L]**

This sequence of keystrokes will delete the descriptor code table from your TDS-48. If one does not exist, an error message will appear.

DELETE JOB SCREEN

Purpose of screen - to allow a job to be deleted from the TDS-48.

Path - From the Main Menu, press **[G]** Jobs Menu - **[L]**



This screen shows the names of the jobs that have been created in the TDS-48. Move the scroll bar to the job you want to delete by using the vertical cursor keys **[∧]** and **[V]**. Then press **[SELECT]**.

[SELCT] will chose the highlighted name as the job to delete.

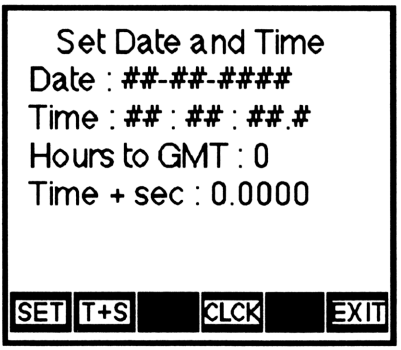
[EXIT] will return to the previous screen or menu.

SETUP MENU SCREENS

TIME / DATE SCREEN

Purpose of screen - to enable you to set the date, time, and time offset from GMT into your TDS-48.

Path - From the Main Menu, press **[H]** Setup Menu - **[G]**



Date: is the current date as this screen is displayed.

Time: is the current time as this screen is displayed.

Hours to GMT: is the number of hours that GMT is in advance of local time.

Time + sec: is the number of seconds to be added to the current time when **[T + S]** is pressed.

[SET] will prompt for a new date and new time. After each is keyed in, press **[ENTER]**. The current displayed date and time will be adjusted accordingly. If you do not wish to change either the date or the time, press **[ENTER]** at that prompt without keying in new data.

[T + S] will adjust the current time by the number of seconds shown in the Time + sec: line of the display.

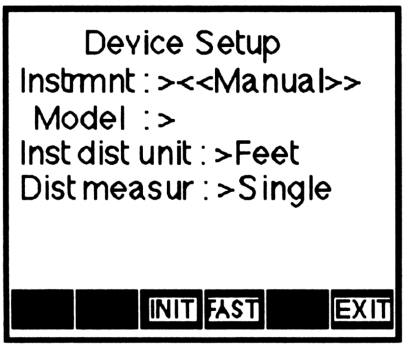
[CLOCK] will display the current time continuously.

[EXIT] will return to the previous screen or menu.

DEVICE SETUP SCREEN

Purpose of screen - to allow you to establish manual input or communication with an electronic total station; to establish single or multiple distance readings with averaging.

Path - From the Main Menu, press **[H]** Setup Menu - **[H]**



Feet - Meters

Single - Averaging

Instrument brand and model list - <<MANUAL>>; Topcon: RS232 Port; Lietz: SETs - SETsB - SDM3F - SDM3FR - SDM3E - SDM3ER - DT20E; Nikon: TOPGUN; Wild: T2000 + EDM - T1000 + EDM - T2000 - T1000; Pentax: PTS-10 - PTS II; Kern: E1/E2; Zeiss: Elta/C - Old Elta; Geodimeter: RS232 port.

Instrument: is the line in which you use the horizontal cursor keys to scroll to the instrument brand name that you intend to

use with the TDS-48. (see list above)

Model: After the instrument brand name is selected, you may scroll to the appropriate model number on this line. (see list above)

Instr dist unit: Allows you to set the TDS-48 to assume that the insturment is measuring distances in either feet or meters.

Dist meas: Allows you to select whether or not you intend to take single or multiple distance measurements with averaging with your gun.

[INIT] will initialize an instrument.

[FAST] will toggle the *instrument coarse* mode on and off. Coarse mode is only available for certain brands of guns. If coarse mode is not available for your gun model, the computer will display: "Fast (Coarse) Mode not Applicable". The effect of coarse mode is to put the gun in a fast measurement mode. This mode may be used for topographic surveys to speed up the gathering of data or for stakeout. However, when used from the Stakeout Screen, coarse mode will not cause the TDS-48 to take shots continuously.

[EXIT] will return to the previous screen or menu.

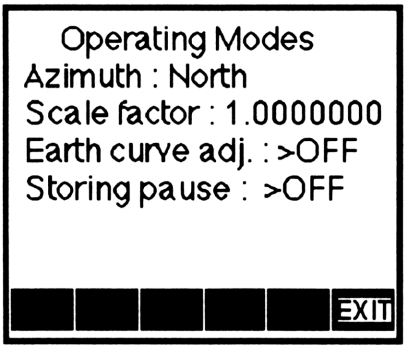
NOTE: If you use an electronic theodolite with a top mounted EDM, you should set up your equipment so that the theodolite sights to a point on the rod below the prism at a distance equal to the distance that the EDM is offset from the optical axis of the theodolite.

NOTE: Specific information concerning the operation of each of the brands of electronic total stations with the TDS-48 may be found in Appendix B.

OPERATING MODES SCREEN

Purpose of screen - to allow you to establish the operating modes of the TDS-48.

Path - From the Main Menu, press **[H]** Setup Menu - **[I]**



ON - OFF
ON - OFF

Azimuth: indicates the assumed direction of a zero azimuth, either North or South.

Scale factor: is the factor by which all distances entered in the field will be multiplied before coordinate values are computed.

Earth curve adjust: when set ON, will include calculations to compensate for earth curvature and refraction in the computation of coordinates.

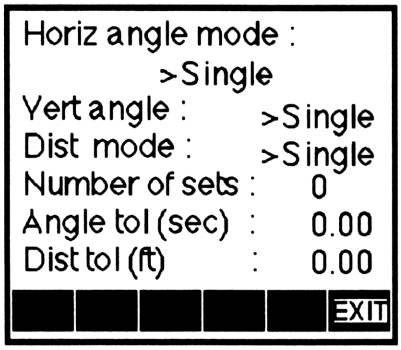
Storing pause: when set ON, will pause and display the computed coordinates as each point is shot.

[EXIT] will return to the previous screen or menu.

REPETITION MODE SCREEN

Purpose of screen - to allow you to establish the technique to be used in acquiring angles and distances in your survey.

Path - From the Main Menu, press **[H]** Setup Menu - **[J]**
From the Main Menu, press **[J]** Traverse/Side Shot
Screen - **[REP]** Repition Modes Menu - **[K]**



Single - Directional - Accum.
Single - Multiple
Single - Multiple

Horiz. angle mode: may be set in one of four modes -
Single - a single horizontal angle shot will be taken for each point.
Directional - the sequence of shots to determine the horizontal angle for each point is as follows:
direct to the backsight; direct to the foresight; reverse (flop) the scope; reverse to the backsight; reverse to the foresight.
Accumulation - multiple angles (windings) are taken to determine each horizontal angle. The value of the circle angle from each foresight sighting is used as the circle angle for the next backsight; thus, accumulating the readings.

Vertical angle: may be set as either a single or multiple readings to be averaged to determine the vertical or zenith angle for each point.

Dist. mode: may be set to take either a single or multiple distances to be averaged in the TDS-48 for each point.

Number of sets: is where you specify the number of readings to be taken for each multiple mode. If you choose a multiple mode, the number of sets must be entered as 1 or more.

Angle err (sec): lets you specify the error among multiple angle readings that will be tolerated before you are alerted by the TDS-48 that an error has occurred.

Dist. err (Ft): lets you specify the error among multiple distance readings that will be tolerated before you are alerted by the TDS-48 that an error has occurred. When the units are feet, the distance tolerance is in feet. When the units are meters, the distance tolerance is in centimeters.

[EXIT] will return to the previous screen or menu.

NOTE: To use the accumulation mode for horizontal angles, you must have a gun that has a lower motion screw or some other device that will allow you to move the gun through a horizontal angle without changing the circle angle reading.

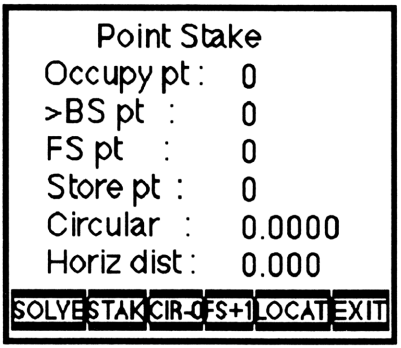
STAKEOUT MENU SCREENS

POINTS STAKE SCREEN

Purpose of screen - to allow you to stake out points that have their coordinates stored in the current job file.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[G]**

BS pt.- BS azm - BS brg



Occupy pt: is the point number of the currently occupied gun position from which the stakeout will be done.

BS pt - BS azimuth - BS bearing: specifies the backsight either by point number, azimuth, or bearing.

FS point: is the number of the foresight point (the point to be staked).

Store pt: is the point number that will be used to store the actual coordinates of the point staked.

Circular: {output only} is the horizontal angle reading of the foresight.

Horiz. dist: {output only} is the horizontal distance from the occupied point to the foresight point to be staked.

[SOLVE] will compute the circular angle and the horizontal distance from the rest of the information in the screen.

[STAKE] will transfer you to the Stake Shots Screen (see below).

[CIR-0] will set the circular angle of your gun such that, when you are sighting the foresight, the circle (horizontal) angle reading in the gun will be zero. You must be sighting the backsight and zero your gun when you press this key for the first time; and, you must be sighting the previous foresight when you press it for subsequent points.

[FS +1] will increment the foresight number in the screen by one. This is useful when you have completed staking a point and you want to move on to the next one. **[FS +1]** will also perform the **[SOLVE]** command on the point after incrementing the point number.

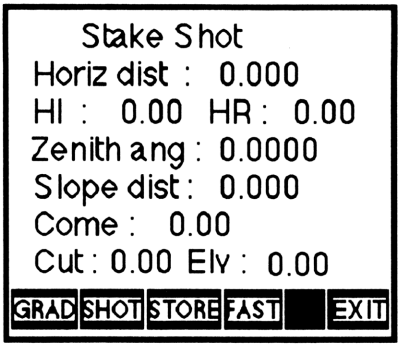
[LOCAT] will transfer to the Define a Location Screen (see below).

[EXIT] will return to the previous screen or menu.

STAKE SHOTS SCREEN

Purpose of screen - to allow you to interact with your gun and your rod man in actually performing a stakeout.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[G]**
Points Stake Screen - **[STAKE]**
From the Main Menu, press **[I]** Stakeout Menu - **[H]**
Offset Stakeout Screen - **[STAKE]**



Horiz dist: is the horizontal distance to the foresight as computed in the previous screen (Points Stake).

HI: is the height of the instrument above the occupied point on the ground.

HR: is the height of the target on the rod above the ground.

Zenith ang: is the actual zenith angle to the rod at the proposed stake point. This data may either be entered in manual mode or it may be collected automatically from an electronic total station by pressing **[SHOT]**.

Slope dist : is the actual slope distance to the rod at the proposed stake point. This data may either be entered in manual mode or it may be collected automatically from an electronic total station by pressing **[SHOT]**.

Come - Go: {output only} is the distance that the rod man must move toward or away from the gun to locate the stake point exactly.

Cut - Fill: {output only} is the amount of earth that must be removed from or added to the ground at the stake point to bring the actual point even with the design elevation.

Ele: {output only} is the actual elevation of the stake point.

[GRADE] will prompt you for a different grade for this point; then it will recompute the "Cut/Fill" accordingly.

[SHOT] will compute the Come or Go and Cut or Fill information based on the angle and distance information which has been provided. *If you are connected to an electronic total station, it is not necessary to key in the angle and distance.* Pressing **[SHOT]** will trigger the gun to gather this information for you. After that, the Come or Go and Cut or Fill information will be computed and displayed.

[STORE] will store the actual staked coordinates at the point number specified in the previous screen (Points Stake). If **[STORE]** is pressed before a shot is taken, it will store the computed values of the coordinates. This feature may be used to generate points which may be staked later using the Points Stake Screen. This latter feature is only operative if the Stake Shots Screen is entered from the Offset Stakeout Screen.

[FAST] if your gun supports it, will put your gun in tracking mode. Thereby, you may track the movement of the rod man continuously without having to trigger the gun from the TDS-48 keyboard.

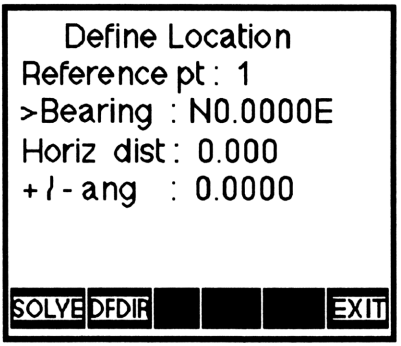
[EXIT] will return to the previous screen or menu.

DEFINE A LOCATION SCREEN

Purpose of screen - to allow you to stakeout a point that may not exist in the coordinate file, but whose position is known relative to a point that is in the file.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[G]** Points Stake Screen - **[LOCAT]**

Azimuth - Bearing



Reference pt: is the point number of the point from which the point to be staked is referenced.

Azimuth: - Bearing: is the angle from the reference point to the point to be staked (as modified by the +/- ang parameter below).

Horiz dist: is the horizontal distance from the reference point to the point to be staked.

+/- ang: is the angular deviation from the azimuth or bearing listed above from the reference point to the point to be staked. A + angle represents a clockwise deviation; a - angle represents a counter-clockwise deviation.

[SOLVE] will compute the angle right and the horizontal distance from the occupied point to the point to be staked. The TDS-48 will return to the Points Stake Screen automatically with the foresight point reported as "0".

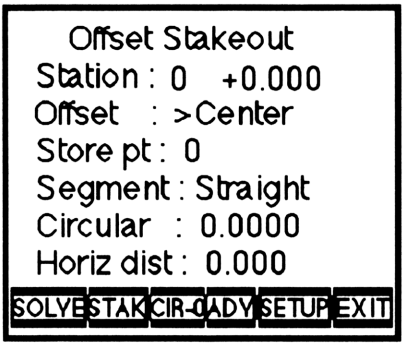
[DFDIR] will transfer you to the Define a Direction Screen.

[EXIT] will return to the previous screen or menu.

OFFSET STAKEOUT SCREEN

Purpose of screen - to allow you to stakeout a right-of-way by specifying the station on the center line and the offset distance from the center line.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[H]**



Center -
Right - Left

Station: is the station number currently being staked.

Offset: is the direction of the offset from the center line; either right, left, or directly on the center line.

Store pt: is the point number that will be used to store the actual coordinates of the point staked.

Segment: {output only} describes the nature of the road segment at the current station, either straight or curved.

Circular: {output only} is the horizontal angle reading from the backsight to the foresight.

Horiz. dist: {output only} is the horizontal distance from the occupied point to the foresight point to be staked.

[SOLVE] will compute the circular angle and the horizontal distance from the rest of the information in the screen. You must execute **[SETUP]** at least once before you may press **[SOLVE]**.

[STAK] will transfer you to the Stake Shots Screen. (see Points Stake Screen).

[CIR-0] will set the circular angle of your gun so that, when you are sighting the foresight, the circle (horizontal) angle reading in the gun will be zero. You must be sighting the backsight and zero your gun when you press this key for the first time; and, you must be sighting the previous foresight when you press it for subsequent points.

[ADV] will increment the station in the screen by the distance established in the Offset Stakeout Setup Screen (see below). This is useful when you have completed staking a point and you want to move on to the next one. **[ADV]** will also execute the **[SOLVE]** command on the next station.

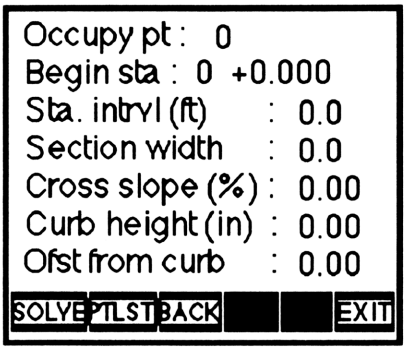
[SETUP] will transfer to the Offset Stakeout Setup Screen (see below).

[EXIT] will return to the previous screen or menu.

OFFSET STAKEOUT SETUP SCREEN

Purpose of screen - to establish the setup parameters of the offset stakeout.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[H]** Offset Stakeout Screen - **[SETUP]**
From the Main Menu, press **[I]** Stakeout Menu - **[I]** Slope Sake Screen - **[SETUP]**



Occupy pt: is the point number of the currently occupied gun position from which the stakeout will be done.

Begin sta: is the station number of the first point in the point list.

Sta. intvl(ft): is the interval between stations in feet. (see figure). When the distance units are set to meters, the station interval is in meters.

Section width: is the width of the road in feet from the center line to the edge of the right-of-way or to the *inside* edge of the curb (if any). (see figure)

Cross slope (%): is the slope of the cross section of the road expressed as a per cent. (see figure)

Curb height (in): is the height of the curb (if any) in inches. (see figure) When the distance units are set to meters, the curb height is in cm.

Ofst from curb: is the distance of the stake point from the true location of the *inside* edge of the curb. (see figure)

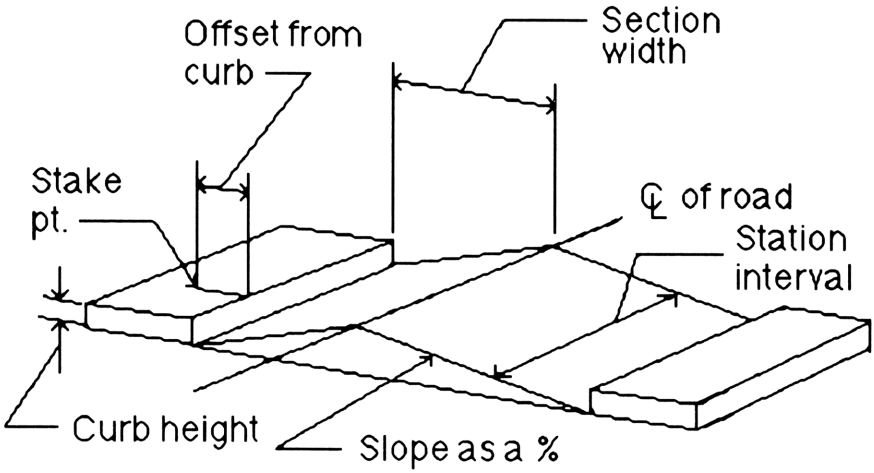
[SOLVE] will compute and store the parameters of the stakeout once all of the information has been entered in the screen. You must set the backsight and setup the Point List before using this

key for the first time.

[PTLST] will transfer to the Point List Screen (see Point List Screen in Utility Screens section).

[BACKS] will establish the backsight for the stakeout (see Backsight Screen below).

[EXIT] will return to the previous screen or menu.



BACKSIGHT SCREEN

Purpose of screen - to allow you to establish a backsight for your field work.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[H]** Offset Stakeout Screen - **[SETUP]** Offset Stakeout Setup Screen - **[BACKS]**

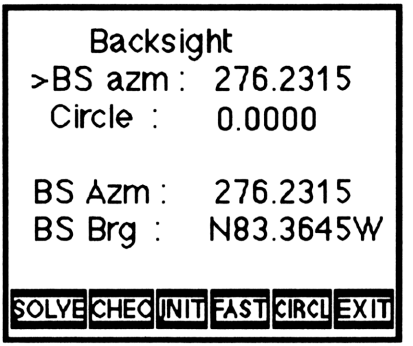
From the Main Menu, press **[I]** Stakeout Menu - **[H]** Slope Stake Screen - **[SETUP]** Offset Stakeout Setup Screen -

REFERENCE

[BACKS]

From the Main Menu, press **[J]** Traverse/Sideshot Menu - **[BACKS]**

BS pt - BS
azm - BS brg



BS azm - BS brg - BS pt: specifies the azimuth or bearing to be used as a back azimuth or back bearing or the point number that is to be used for a back sight.

Circle: is the horizontal angle reading of the gun when you are sighting the back sight.

BS azm: {output only} the computed back azimuth from the data supplied in this screen.

BS brg: {output only} the computed back bearing from the data supplied in this screen.

[SOLVE] will take the information provided in the first two lines of this screen; compute the back azimuth; and display it in the output line. this key must be pressed prior to pressing **[EXIT]** or the backsight will <u>not</u> be set properly.

[CHEC] will take a shot to a prism located at the backsight, and if you have specified the backsight as a back point, the TDS-48 will compute the horizontal and vertical angle arror between the actual backsight in the field and the presumed location based on

the coordinates of the occupied point and the backsioght point as stored in the coordinate file.

[INIT] will send out an initial command to your gun to inform it that there is a data collector attached to its communication port. Some guns require this *initializing* step each time that they are turned on before they can be triggered from the TDS-48. To see if your gun requires this, press this key. The TDS-48 will report in its display if this step is required.

[FAST] will toggle the *instrument coarse* mode on and off. Coarse mode is only available for certain brands of guns. If coarse mode is not available for your gun model, the computer will display: "Fast (Coarse) Mode not Applicable". The effect of coarse mode is to put the gun in a fast measurement mode. This mode may be used for topographic surveys to speed up the gathering of data or for stakeout. However, when used from the Stakeout Screen, coarse mode will not cause the TDS-48 to take shots continuously.

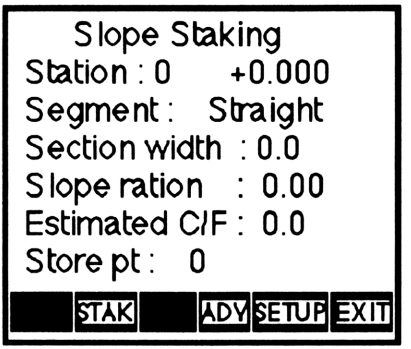
[CIRCL] (if connected to an electronic total station) will trigger the gun to read the horizontal angle and record it in the backsight screen as the circle angle to the backsight.

[EXIT] will return to the previous screen or menu.

SLOPE STAKE SCREEN

Purpose of screen - to allow you to slope stake a road.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[I]**



Station: is the current station being staked.

Segment: {output only} describes the nature of the road (straight or curved) at the current station.

Section width: is the width of the road in feet from the center line to the edge of the right-of-way. (see figure)

Slope ratio: the slope ratio of the section being staked. This is expressed as the horizontal component of the slope / vertical component of slope.

Estimated C/F: The estimated cut or fill at the catch point: - for fill; + for cut.

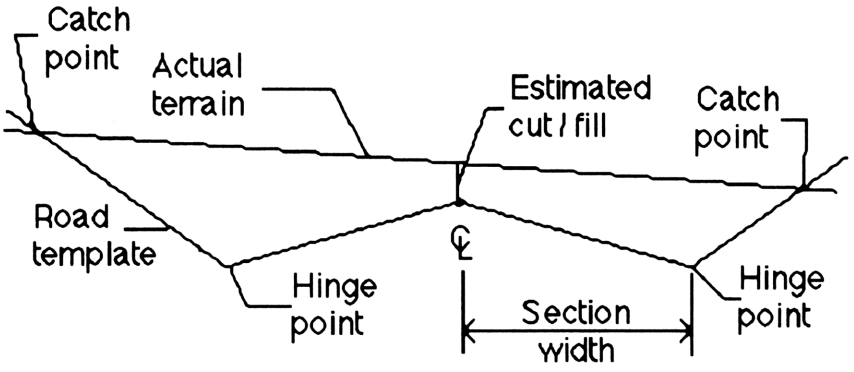
Store pt: the point number to be used to store the actual coordinates of the point staked.

[STAKE] will transfer you to the Slope Stake Shots Screen. (see below).

[ADV] will increment the station in the screen by the distance established in the Offset Stakeout Setup Screen (see above). This is useful when you have completed staking a point and you want to move on to the next one.

[SETUP] will transfer to the Offset Stakeout Setup Screen (see above). You must complete a setup before you can execute **[STAKE]**.

[EXIT] will return to the previous screen or menu.

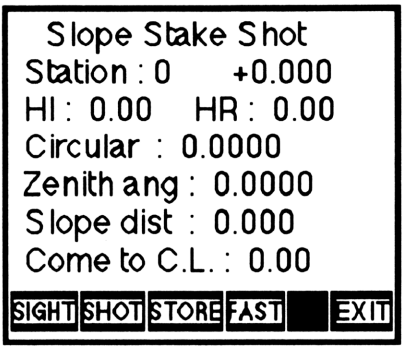


NOTE: Since the TDS-48 does not know the actual terrain features during slope staking, the process of locating catch points is iterative. Therefore, it is necessary for you to provide an estimate of the amount of cut or fill that will be required at the center line of the road.

SLOPE STAKE SHOTS SCREEN

Purpose of screen - to allow you actually to take slope stake shots.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[I]** Slope Stake Screen - **[STAKE]**



Station: {output only} is the the current station being staked.

HI: is the height of the instrument above the occupied point on the ground.

HR: is the height of the target on the rod above the ground.

Circular: is the horizontal angle right from the backsight to the "trial" catch point.

Zenith ang: is the actual zenith angle to the rod at the proposed stake point. This data may either be entered in manual mode or it may be collected automatically from an electronic total station by pressing **[SHOT]**.

Slope dist : is the actual slope distance to the rod at the proposed stake point. This data may either be entered in manual mode or it may be collected automatically from an electronic total station by pressing **[SHOT]**.

GO (or COME) from C.L.: {output only} is the computed distance for the rod man to move away from or toward the center line to establish the next "trial" catch point.

[SIGHT] will display distance and angle information related to the location of the next "trial" shot from the vantage point of the

gun. This information is displayed as:

Stake elev: the current elevation at the rod.

Stake to hinge: the distance from the current location of the rod to the hinge point (see figure).

Sight C.P. from gun:

Circular:

Horiz dist:

Cut:

This information is the horizontal angle and horizontal distance from the gun to the next trial point as well as the current Cut (or Fill). Press any key to return to the Slope Stake Shots Screen.

[SHOT] will compute the Come or Go and Cut or Fill information based on the angle and distance information which has been provided. *If you are connected to an electronic total station, it is not necessary to key in the angle and distance.* Pressing **[SHOT]** will trigger the gun to gather this information for you. After that, the Come or Go and Cut or Fill information will be computed and displayed.

[STORE] is the key that you may use if you want to store the coordinates of the stake locations in the job file. It will first prompt for an offset distance from the catch point to a reference point where the stake is to be set. If you want to store the coordinates of the catch point itself, you should enter zero in response to this prompt. Then press **[ENTER]**. The coordinates of the reference pont will be stored at the point number that has been specified in the Slope Stake Screen. The offset is on a line from the catch point to the center line of the road. The unit will then prompt you with the message "Wish to store line stake? [Y/N]". If you would like to store the coordinates of another point on the line from the catch point to the center line, press **[Y]** in response to this prompt. Then you will see the prompt "Offset from ref:". Key in the offset from the previously specified reference point in response to this prompt. Then press **[ENTER]**. These coordinates will be stored at the next point number from the previous reference point.

[FAST] if your gun supports it, will put your gun in coarse

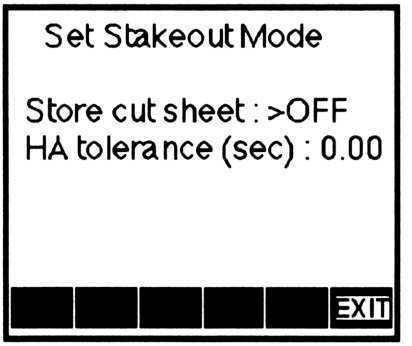
mode.

[EXIT] will return to the previous screen or menu.

SET STAKEOUT MODE SCREEN

Purpose of screen - to allow you to set the horizontal angle error limit, to set the slope stake error limit, and to specify whether or not you want to store a cut sheet.

Path - From the Main Menu, press **[I]** Stakeout Menu - **[J]**



Store cut sheet: may be set either On or OFF depending on whether or not you want to store a cut sheet of the stakeout.

HA tolerance (sec): is the *maximum* deviation allowed between the observed horizontal angle and the true computed horizontal angle before the TDS-48 will alert you of an error.

Slope stake tol (ft): is the maximum allowed deviation of the rod from the true station location before the TDS-48 will alert you of an error.

[EXIT] will return to the previous screen or menu.

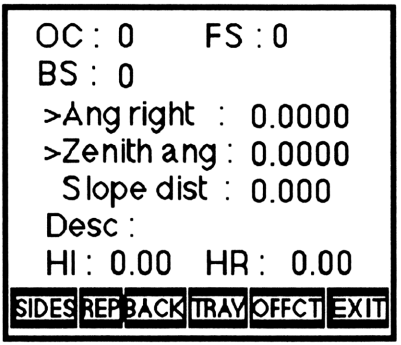
TRAVERSE/SIDESHOT SCREENS

TRAVERSE/SIDESHOT SCREEN

Purpose of screen - to organize the gathering of the data required to perform traverses and sideshots in the field.

Path - From the Main Menu, press **[J]**

a) see below
b) see below



a) Ang right - Azimuth - Bearing - Ang left - Def right - Def left
b) Zenith ang - Vert ang - Chng elev
Slope dist Slope dist Horiz dist

OC: is the currently occupied gun position point number.

FS: is the point number of the foresight.

BS: is the point number of the backsight. If the backsight point is shown as 0, this indicates that the backsight has been specified as a known azimuth or bearing, but not by point number.

Ang. right - Azimuth - Bearing - Ang left - Def right - Def left: are the descriptions for the various ways that a horizontal angle

may be entered into the TDS-48.

Zenith ang - Vert ang - Ch elev:
Slope dist Slope dist Horiz dist: these two lines scroll together to specify the various combinations of angles and distances (or elevation changes and distances) that may be used to enter field data into the TDS-48.

Desc: is the descriptor for the point (limited to 16 alpha, numeric, or special characters).

HI: is the height of the instrument above the point on the ground.

HR: is the height of the target on the rod above the ground.

[SIDES] will take the information which has been input into the screen and will compute the coordinates of the foresight point as a sideshot from the occupied point. These coordinates will be displayed depending upon whether or not the "Storing Pause" setting in the Operating Modes Screen. The coordinates will be stored in the job file at the foresight point number; and, the foresight point number will be incremented by one to prepare for the next shot. (See note below for more information.)

[REP] will transfer to the TR/SS Repetition Menu (see below).

[BACKS] will transfer to the Backsight Screen.

[TRAV] will take the information which has been input into the screen and will compute the coordinates of the foresight point as a traverse from the occupied point. These coordinates will be displayed depending upon whether or not the "Storing Pause" setting in the Operating Modes Screen. The coordinates will be stored in the job file at the foresight point number; and, the foresight point, occupied point, and backsight point number will be adjusted to prepare for the next shot. (See note below for more information.)

[OFFCT] will transfer to the Off Center Shot Screen (see below).

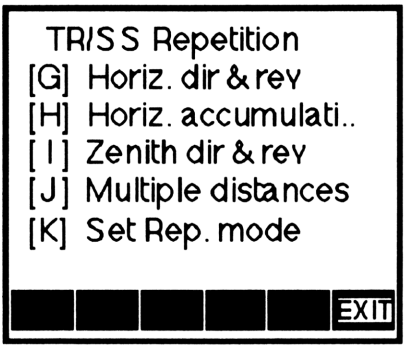
[EXIT] will return to the previous screen or menu.

NOTE: if you are gathering data automatically from an *electronic total station,* it is not necessary to fill in the horizontal angle, vertical angle or distance lines in the screen before pressing either **[SIDES]** or **[TRAV]**. When **[SIDES]** or **[TRAV]** are pressed, the TDS-48 will trigger the gun to make the appropriate measurements and transfer them to the data collector. Also, after the total station is taking the measurements and transferring them to the TDS-48, the unit will display a descriptor screen for you to key in the descriptor.

TR/SS REPETITION MENU

Purpose of menu - to establish a variety of repetition (repeated readings) modes for doing filed work.

Path - From the Main Menu, press **[J]** Traverse/Sideshot Screen - **[REP]**



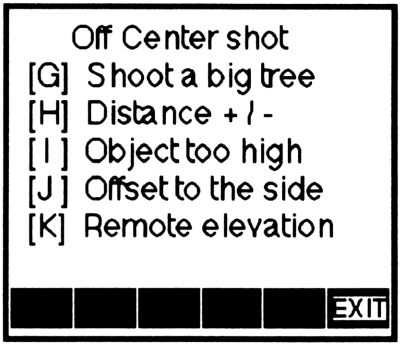
[EXIT] will return to the previous screen or menu.

NOTE: If you have preset the Repetition Mode Screen from the Setup Menu with some number of "sets" other than zero, pressing **[SIDES]** or **[TRAV]** from the Traverse/Sideshot Screen will cause the TDS-48 to prompt you for input (either manual or electronic) in the proper sequence to take the repeated readings and compute the average angles and distances. Pressing **[REP]** from the Traverse/Sideshot Screen will display the menu choices shown above. Selecting any of these will prompt you for input (either manual or electronic) in the proper sequence to take repeated readings and compute either the average angles or average distances (depending on which menu choice you make). Pressing **[EXIT]** from this menu will return you to the Traverse/Sideshot Screen. Pressing **[SIDES]** or **[TRAV]** now will cause the TDS-48 to complete collecting the data for this point (either angles or distance - whichever is missing - in the normal way) and compute the coordinates of the new point from a combination of average data and single readings as required by the TR/SS Repetition Menu choice.

OFF CENTER SHOT MENU

Purpose of menu - to allow you to shoot points for which you cannot place the rod target exactly on the point.

Path - From the Main Menu, press **[J]** Traverse/Sideshot Screen - **[OFFCT]**



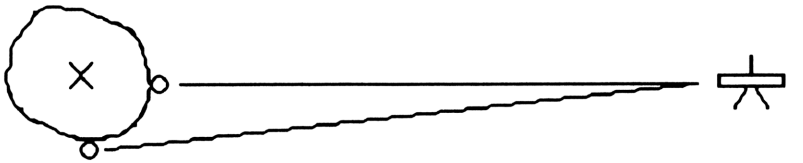
[EXIT] will return to the previous screen or menu.

The Off Center Shot Menu covers four common situations that are encountered in the field when it is not possible for the rod to occupy the point that is to be shot. Those four situations are specified in the menu and illustrated in the sketches shown below. If you are taking the data *manually*, you should fill out the Traverse/Sideshot Screen with the data as obtained from the shot to the prism in each of the four cases. Then press **[OFFCT]**. You will be prompted to key in the missing data for each situation as required. After following the prompts, you will be returned to the Traverse/Sideshot Screen where the input data will have been modified to reflect the actual point to be shot. Then you should press **[SIDES]** to complete the shot.

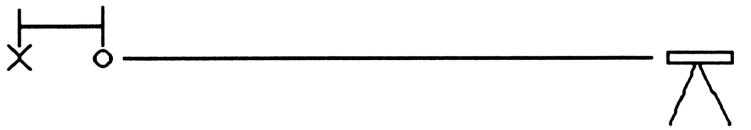
If you are collecting your data *electronically*, pressing **[OFFCT]** will take the appropriate shots and prompt you to

move the rod or key in the data to the actual point as required. After the final prompt, the sideshot to the unknown point will be completed and you will be returned to the Traverse/Sideshot Screen for the next shot.

G - Shoot big tree

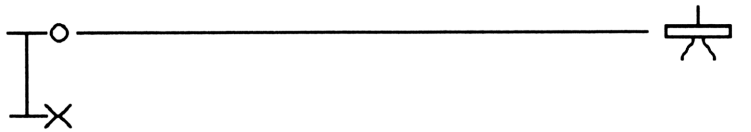


H - Distance + / -



I - Object too high

J - Offset to the side



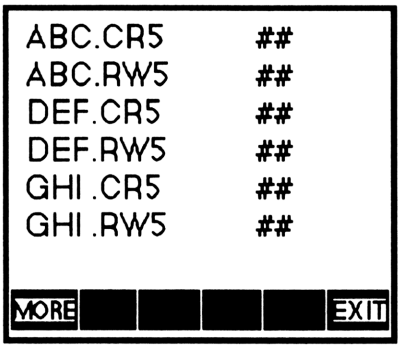
K - Remote elevation [See Remote Elevation Screen in CO-GO Menu Section of this manual.]

DIRECTORY SCREEN

DIRECTORY SCREEN

Purpose of screen - to allow you to review the directory of files in the TDS-48.

Path - From the Main Menu, press **[K]**



This screen will prompt you to enter a file specification. The file extensions which are stored in the TDS-48 are:

Coordinate files - .CR5
Raw data files - .RW5
Point list files - .PL5

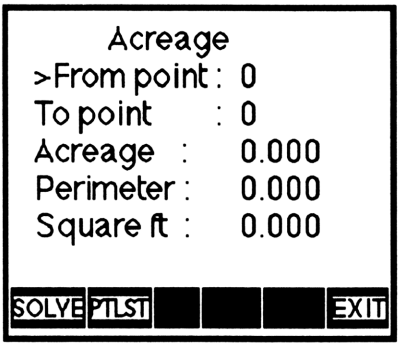
CO-GO MENU SCREENS

ACREAGE SCREEN

Purpose of screen - To allow the computation of the area of a parcel of land defined by a series of points stored in the TDS-48.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[G]**

From pt
To pt -
<Using pt list>



NOTE: When the units are feet, the area is reported in both acres and square feet and the perimeter is in feet. When the units are meters, the screen is called the Area Screen, the area is in square meters and the perimeter is in meters.

From point: - <Using point list>
To point: These are the alternative methods of specifying a sequence of points that are to make up the boundary of the parcel. From point To point specifies that the points are to be connected in numerical sequence. Also, the last point is connected to the first to complete the closed area. The point list is a technique that you may use to specify a boundary that is made up of points that are not in numerical sequence. (See the Section of this Reference Manual that covers

the Point List Screen.)

Acreage: {output only} is the computed area in acres.

Perimeter: {output only} is the computed perimeter of the parcel in feet.

Sq feet: {output only} is the computed area in square feet.

[SOLVE] will compute the output lines based on the input points specified at the top of the display.

[PTLST] will transfer to the Point List Screen.

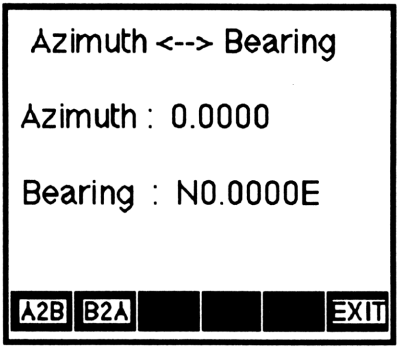
[EXIT] will return to the previous screen or menu.

NOTE: If the boundary of the area to be computed includes sections of horizontal curves, they may be included in the point list. Point lists that have curves included will compute the area with the curved boundaries.

AZIMUTH <---> BEARING SCREEN

Purpose of screen - to allow you to convert azimuths to bearings or bearings to azimuths

Path - From the Main Menu, press **[M]** CO-GO Menu - **[H]** Conversion Menu - **[G]**



Azimuth: is the angle of a line expressed as an azimuth.

Bearing: is the angle of the same line expressed as a bearing.

[A 2 B] (read azimuth to bearing) will compute the bearing based on the value of the azimuth line in the screen.

[B 2 A] (read bearing to azimuth) will compute the azimuth based on the value of the bearing line in the screen.

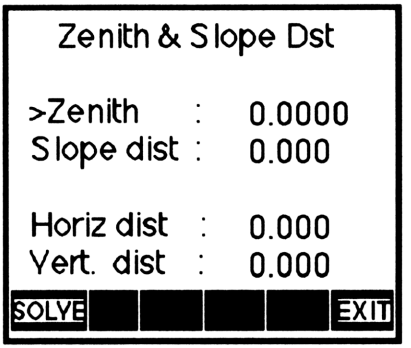
[EXIT] will return to the previous screen or menu.

VERT/ZENITH & SLOPE SCREEN

Purpose of screen - to allow you to convert a vertical angle, or a zenith angle and slope distance to a horizontal distance and a change in elevation.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[H]** Conversion Menu - **[H]**

Zenith
Slope dist - Vert
Slope dist



Zenith - Vert ang -Nadir: is the specification of a vertical angle that is to be used in the conversion.

Slope dist: is the specification of the slope distance to be used in the conversion.

Horiz dist: {output only} is the computation of the horizontal distance from the data which has been entered into the screen.

Vert dist: {output only} is the vertical distance (change in elevation) which has been computed from the data which has been entered into the screen.

[SOLVE] will compute the output values of horizontal and vertical distance from the data which has been entered into the input lines of the screen.

[EXIT] will return to the previous screen or menu.

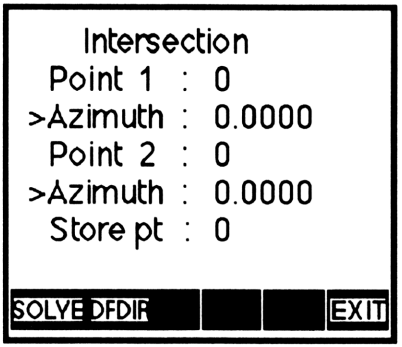
INTERSECTION SCREEN

Purpose of screen - to find a point at the intersection of two lines emanating from two known points. The intersection may be specified as Bearing-Bearing, Bearing-Distance, or Distance-

Distance.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[I]**

Azimuth - Bearing - Distance
Azimuth - Bearing - Distance



Point 1: is the point number of the first point from which the intersection line is to be defined.

Azimuth - Bearing - Distance: is the known parameter from point 1, either an azimuth, bearing, or distance.

Point 2: is the point number of the second point from which the intersection line is to be defined.

Azimuth - Bearing - Distance: is the known parameter from point 2, either an azimuth, bearing, or distance.

Store pt: is the point number of the intersection point at which the coordinates should be stored.

[SOLVE] will compute the coordinates of the intersection point from the data provided in the screen and store these coordinates at the specified point number in the job coordinate file. After **[SOLVE]** has been pressed, the **[<]** and **[>]** may be used on the appropriate lines of this screen to see the other quantites to the intersection point. For example if you have solved for a bearing-bearing intersection, you may display the distances from

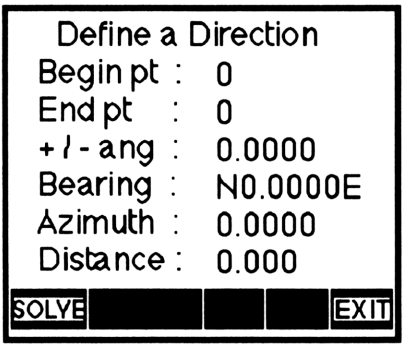
the two ponts to the intersection point.

[DFDIR] will transfer to the Define A Direction Screen, where the azimuth required for a direction specification for this screen may be computed from other point information (see below).

[EXIT] will return to the previous screen or menu.

DEFINE A DIRECTION SCREEN

Path - From the Main Menu, press **[M]** CO-GO Menu - **[I]** Intersection Screen - **[DFDIR]**
From the Main Menu, press **[M]** CO-GO Menu - **[K]** Pre-Determined Area Screen **[DFDIR]**
From the Main Menu, press **[N]** Survey Adjustment Menu - **[G]** Translate Job **[DFDIR]**



Begin point: is the first point on the line to define a direction.

End point: is the second point on a line to define a direction.

+/- ang: is the deviation from the computed azimuth or bearing from the first point to the second point on the line that is to be returned as the azimuth or bearing to be used in subsequent calculations. A + angle is in the clockwise direction from the

first point to the second point; a - angle is in the counter-clockwise direction.

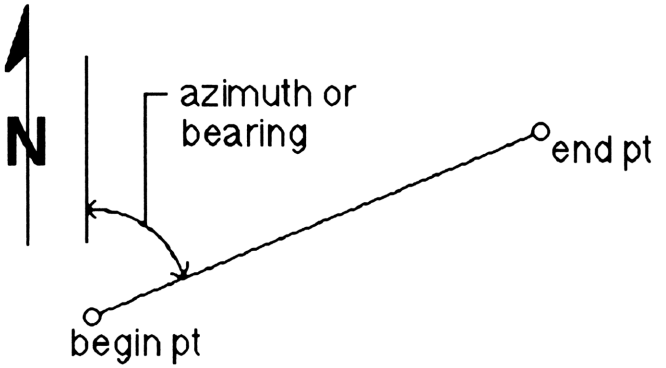
Bearing: {output only} the bearing from the beginning point to the end point.

Azimuth: {output only} the azimuth of the line from the beginning point to the end point.

Horiz dist: {output only} the horizontal distance from the first point on the line to the second point on the line.

[SOLVE] will compute the output bearing and azimuth from the point numbers of the two points on the line as specified in the screen.

[EXIT] will first prompt for the azimuth or bearing that is required in the intersection being solved and then return to the Intersection Screen.

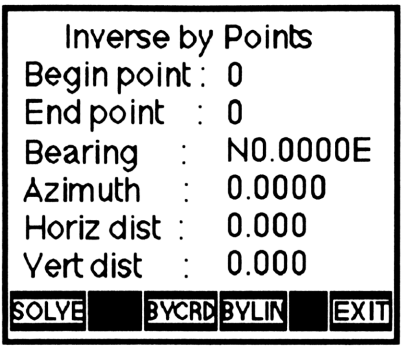


INVERSE BY POINT SCREEN

Purpose of screen - to compute the inverse (bearing and

distance) between two points expressed as point numbers.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[J]**



Begin point: is the first point on the line for which the inverse is to be computed.

End point: is the second point on the line for which the inverse is to be computed.

Bearing: {output only} is the bearing of the line from the first point to the second point.

Azimuth: {output only} is the azimuth of the line from the first point to the second point.

Horiz dist: {output only} is the horizontal distance between the two inputs in this screen.

Vert dist: {output only} is the vertical distance between the two points in this screen.

[SOLVE] will compute the azimuth, bearing and distance between the points specified in the screen.

[BYCRD] will transfer to an alternate Inverse Screen that will

compute the inverse between points specified by coordinates (see below).

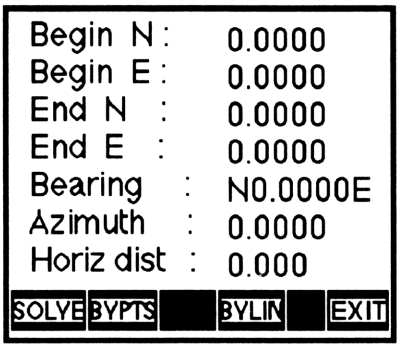
[BYLIN] will transfer to an alternate Inverse Screen that will compute the perpendicular bearing and distance from a point to a line (see below).

[EXIT] will return to the previous screen or menu.

INVERSE BY COORDINATES SCREEN

Purpose of screen - to compute the inverse (bearing and distance) between two points expressed as coordinates.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[J]** Inverse By Points Screen - **[BYCRD]**



Begin N: is the north coordinate of the first point on the line for which the inverse is to be computed.

Begin E: is the east coordinate of the first point on the line for which the inverse is to be computed.

End N: is the north coordinate of the second point on the line for

which the inverse is to be computed.

End E: is the east coordinate of the second point on the line for which the inverse is to be computed.

Azimuth: {output only} is the azimuth of the line from the first point to the second point.

Bearing: {output only} is the bearing of the line from the first point to the second point.

Horiz dist: {output only} is the horizontal distance between the two points in this screen.

[SOLVE] will compute the azimuth, bearing and distance between the points specified in the screen.

[BYPTS] will transfer to an alternate Inverse Screen that will compute the inverse between points specified by point numbers (see above).

[BYLIN] will transfer to an alternate Inverse Screen that will compute the perpendicular bearing and distance from a point to a line (see below).

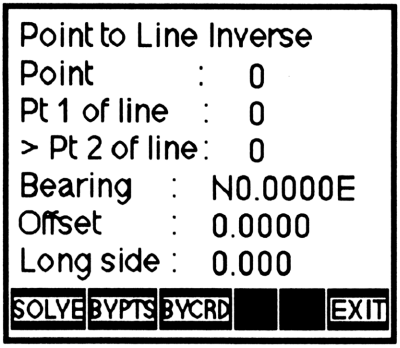
[EXIT] will return to the previous screen or menu.

POINT TO LINE INVERSE SCREEN

Purpose of screen - to compute the inverse (bearing and distance) between a point and a line defined by two other points.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[J]** Inverse By Points Screen - **[BYLIN]**

Pt 2 of line - Bearing



Point: is the point from which the inverse is to be computed.

Pt 1 of line: is the the first point that defines the line to which the inverse is to be computed.

Pt 2 of line - Bearing: is the method that you use to define the line to which the inverse is to be computed.

Bearing: {output only} is the bearing of the line from the first point to the second point.

Offset: {output only} is the perpendicular distance from the offset point to the line from Point 1 to Point 2. If this distance is positive, the offset is to the right of the line from Point 1 to Point 2. If this distance is negative, the offset is to the left of the line from Point 1 to Point 2.

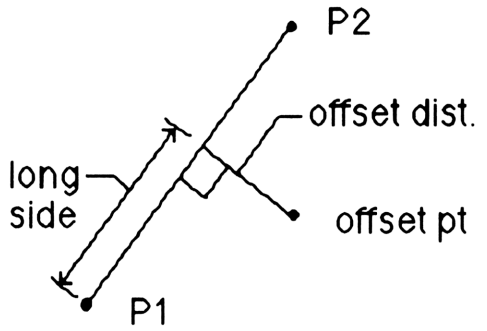
Long side: {output only} is the distance from Point 1 to the projection of the offset point to the line from Point 1 to Point 2. If this distance is positive, the distance is from Point 1 in the direction of Point 2. If this distance is negative, the distance is from Point 1 away from Point 2.

[SOLVE] will compute the bearing and distances and display the results in the Results Screen as shown above.

[BYPTS] will transfer to an alternate Inverse Screen that will compute the inverse between points specified by point numbers (see above).

[BYCRD] will transfer to an alternate Inverse Screen that will compute the inverse between points specified by coordinates (see above).

[EXIT] will return to the previous screen or menu.

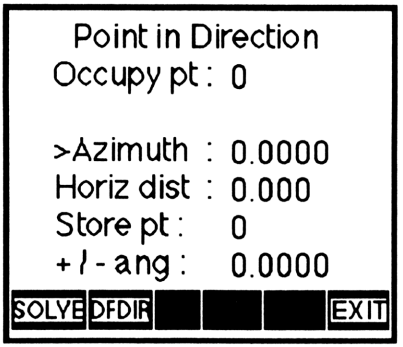


POINT IN DIRECTION SCREEN

Purpose of screen - to allow you to compute the coordinates of a new point by specifying a known point and a direction and distance from the known point.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[K]**

Azimuth - Bearing



Occupy point: is the point number of the known point.

Azimuth: - Bearing: is the direction from the known point to the unknown point.

Horizontal dist: is the distance from the known point to the unknown point.

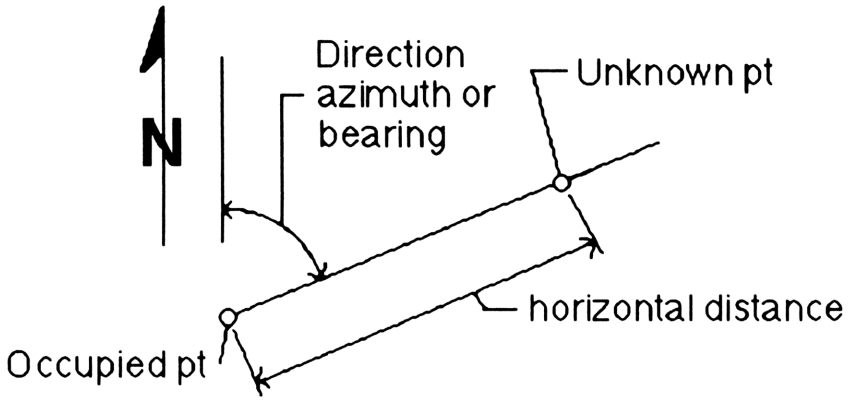
+ / - ang is the angle that will be added to or subtracted from the azimuth.

Store pt: is the point number of the unknown point whose coordinates are to be computed.

[SOLVE] will solve for the unknown point coordinates based on the input information in the screen and will store these coordinates into the current job file at the specified point number.

[DFDIR] will transfer to the Define A Direction Screen.

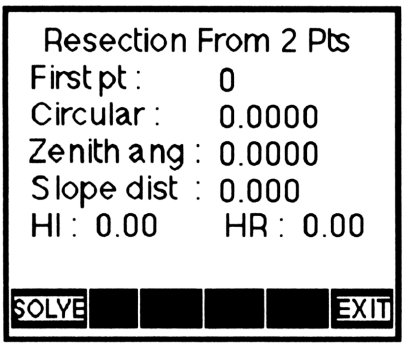
[EXIT] will return to the previous screen or menu.



RESECTION FROM TWO POINTS SCREEN

Purpose of screen - to allow you to determine the coordinates of an occupied point by field measurements (angles and distances) to two known points.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[L]**



First point: is the number of the first known point.

Circular: is the horizontal angle reading when sighting the first

point.

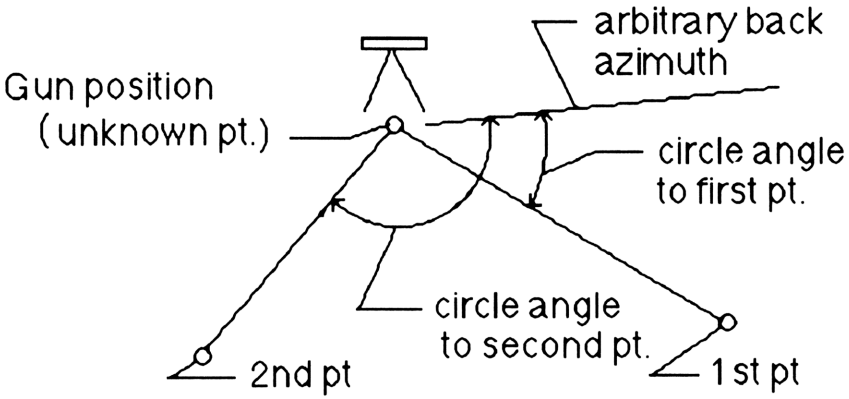
Zenith ang: is the zenith angle to the 1st point.
Slope dist : is the slope distance to the 1st point.

HI: is the height of the instrument above the unknown point on the ground

HR: is the height of the target on the rod above the ground.

[SOLVE] will transfer to the Second Point Screen for this two point resection.

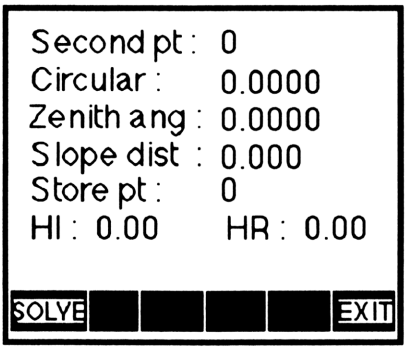
[EXIT] will return to the previous screen or menu.



SECOND POINT SCREEN

Purpose of screen - to complete the two point resection begun in the previous screen.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[L]** Resection From Two Points Screen - **[SOLVE]**



Second point: is the number of the second known point.

Circular: is the horizontal angle reading when sighting the second point.

Zenith ang: is the zenith angle to the 2nd point.
Slope dist: is the slope distance to the 2nd point.

Store pt: is the number of the occupied point whose coordinates are to be determined.

HI: is the height of the instrument above the unknown point on the ground

HR: is the height of the target on the rod above the ground.

[SOLVE] will solve for the coordinates of the unknown

occupied point based on the contents of this and the previous screen. It will also store these coordinates in the job file at the specified point number.

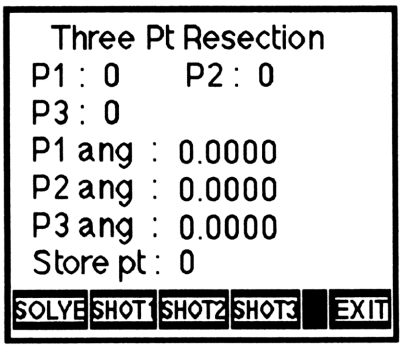
[EXIT] will return to the CO-GO Menu.

NOTE: In both this and the previous screen, if you are in the field and connected to an *electronic total station*, pressing **[SOLVE]** will trigger the gun to collect the data for each point of the resection.

RESECTION FROM THREE POINTS SCREEN

Purpose of screen - to allow you to determine the coordinates of an occupied point by field measurements (angles) to three known points.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[M]**



P1: is the point number of the first known point.

P2: is the point number of the second known point.

P3: is the point number of the third known point.

P1 ang: is the circular (horizontal) angle reading when sighting the first known point.

P2 ang: is the circular (horizontal) angle reading when sighting the second known point.

P3 ang: is the circular (horizontal) angle reading when sighting the third known point.

Store pt: is the point number of the unknown occupied point.

[SOLVE] will compute the coordinates (northing and easting) of the unknown occupied point and store them in the job file at the specified point number.

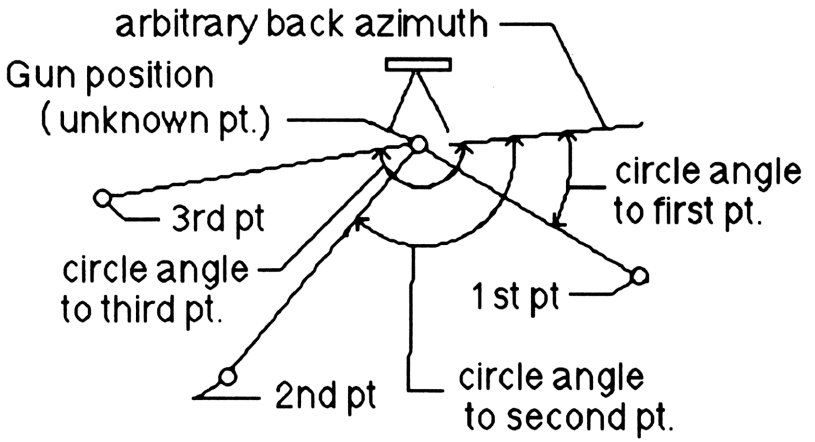
[SHOT1] will trigger an electronic total station to read the horizontal angle from the first point automatically.

[SHOT2] will trigger an electronic total station to read the horizontal angle from the second point automatically.

[SHOT3] will trigger an electronic total station to read the horizontal angle from the third point automatically.

[EXIT] will return to the previous screen or menu.

NOTE: P1, P2, and P3 are required to be in *clockwise* order as viewed from above the gun position.

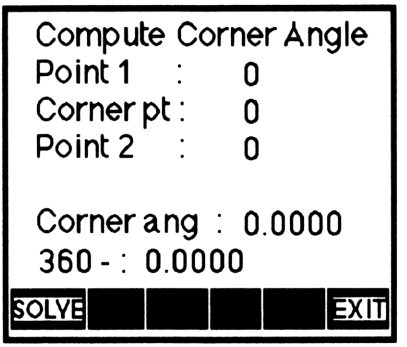


NOTE: Since a three point resection only requires horizontal angles to be measured, it is *not* possible to use this method to determine the elevation of the unknown point. Only the north and east coordinates are solved.

COMPUTE CORNER ANGLE SCREEN

Purpose of screen - to allow you to compute the angle made by two lines that meet at a common (corner) point.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[N]**



Pt 1: is a point on the first line.

Corner pt: is the common point (corner) of the two lines.

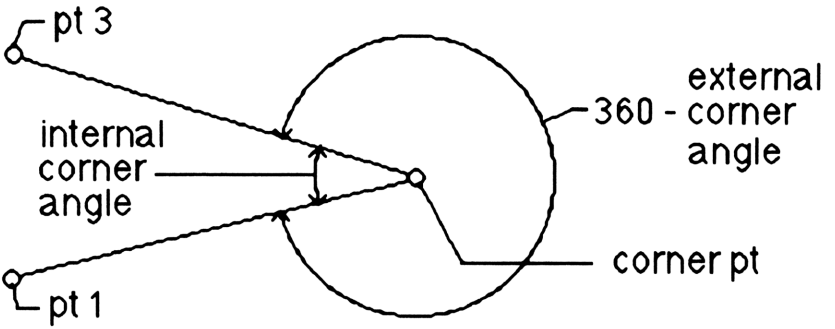
Pt 3: is a point on the second line.

Corner angle: {output only} is the *internal* corner angle determined at the intersection of the two lines.

360 - : {output only} is 360° minus the corner angle computed above.

[SOLVE] will compute the *internal* corner angle determined by the two lines defined by points 1 and 3 and the corner point.

[EXIT] will return to the previous screen or menu.



REMOTE ELEVATION SCREEN

Purpose of screen - to allow you to compute the elevation of the occupied point given the known elevation of the foresight.

Path - From the Main Menu, press **[J]** Traverse/Sideshot
Screen - **[OFCTR]** Off Center Shot Menu - **[K]**
From the Main Menu, press **[M]** CO-GO Menu - **[O]**

FS elev - FS pt

OC elev - OC pt

```
Remote Elevation

>FS elev :    0.000
Zenith ang :  0.0000
Slope dist :  0.000
HI :  0.00   HR :  0.00
>OC elev :    0.000
SOLVE                 EXIT
```

FS elev: - FS point: is the specification of the remote foresight elevation either by elevation or by the point number of the foresight.

Zenith ang: is the zenith angle from the occupied point to the foresight.

Slope Dst: is the slope distance from the occupied point to the foresight.

HI: is the height of the instrument.

HR: is the height of the rod.

OC elev: is the computed elevation of the occupied point. If this prompt is set at OC point, the computed elevation will be stored in the coordinate file of the designated point. The northing and easting values will not be changed.

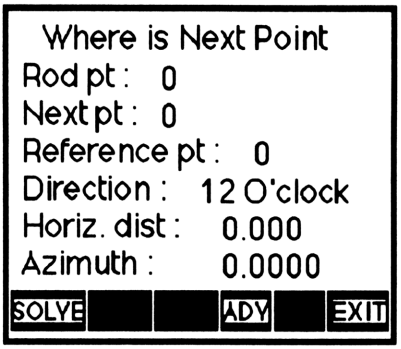
[SOLVE] if the TDS-48 is connected to an electronic station, this key will trigger the gun to take a shot. If the TDS-48 is in manual mode, the elevation of the occupied point will be computed from the values of zenith angel and slope distance that have been keyed in the screen.

[EXIT] will return to the previous screen or menu.

WHERE IS NEXT POINT SCREEN

Purpose of screen - to allow the rod man to find quickly the next point relative to his own point of view during a stakeout by point number.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[P]**
From the Main Menu, press **[I]** Stake Out Menu - **[K]**



Rod pt: is the point number of the current location of the rod.

Next pt: is the point number of the next point to be staked.

Reference pt: is any other point number in the job that is clearly visible by the rod man. For example, this point can be the point number location of the gun.

Direction: {output only} is the direction expressed as a "clock-face" direction from the rod point to the next point. If the rod man is standing at the rod point and facing the reference point and the direction, is computed as 2 o'clock, the next point is in the two o'clock direction assuming that 12 o'clock on the clockface is pointing toward the reference point.

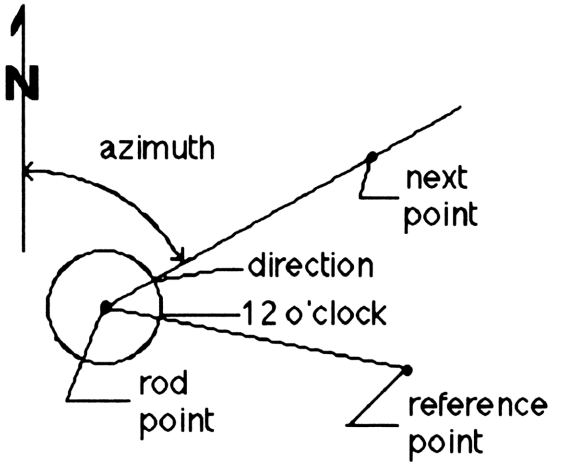
Horiz. dist: {output only} is the computed horizontal distance from the rod point to the next point.

Azimuth: {output only} is the actual azimuth angle (based on north or south being zero azimuth) of the direction from the rod point to the next point. This value may be used in conjunction with a field compass to located the direction of the next point. This value is independent of the reference point.

[SOLVE] will compute the direction, horizontal distance, and azimuth based on the values of the input data for this screen.

[ADV] will put the next point as the rod point and increment the next point by one.

[EXIT] will return to the previous screen or menu.

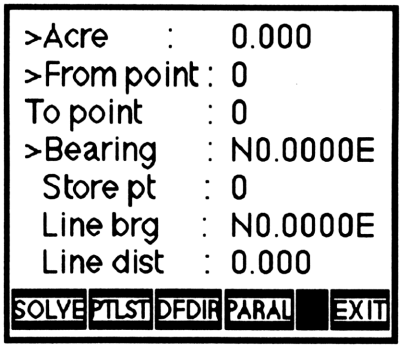


PRE-DETERMINED AREA SCREEN

Purpose of screen - To enable you to find the coordinates of the missing boundary line of a parcel that will result in a pre-determined area for that parcel. The primary screen will assume that the unknown boundary is hinged at the last point in the point list and intersects the first line at an unknown point whose coordinates are to be determined.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[Q]**

Acre: - Sq ft:
From pt:
To pt : -
<Using pt list>
Bearing:-
Pt on line:



Acre: - Square ft: is the predetermined area expressed as acres or square feet.

From point: - <Using point list>
To point: These are the alternative methods of specifying a sequence of points that are to make up the boundary of the parcel.

Bearing: - Pt on line: is the technique for describing the direction of the first side of the parcel.

Store pt: - is the point number of the unknown boundary point whose coordinates are to be determined.

Line brg: {output only} is the bearing of the missing last boundary line of the parcel.

Line dist: {output only} is the length of the first line segment of the parcel.

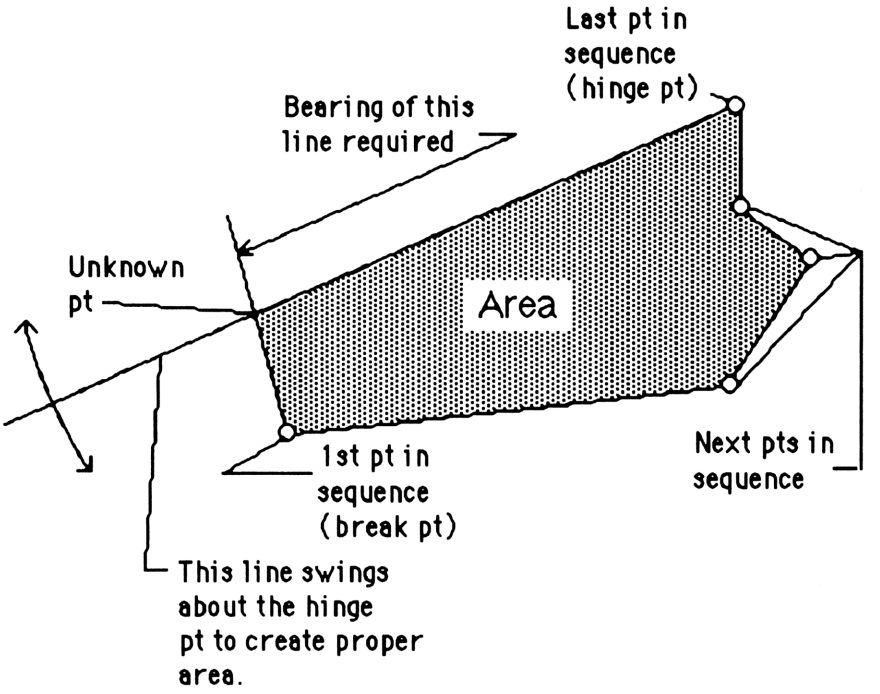
[SOLVE] will solve for the unknown point coordinates based on the input information in the screen and will store these coordinates into the current job file at the specified point number.

[PTLST] will transfer to the Point List Screen.

[DFDIR] will transfer to the Define a Direction Screen. In this way, the bearing of the first line may be computed from two points on the line.

[PARAL] will transfer to the Parallel Pre-determined Area Screen, an alternative technique for bounding a pre-determined area. (see below).

[EXIT] will return to the previous screen or menu.



NOTE: If the distance units setting has been specified as meters in the Operating Modes Screen, the area specification in this screen must be input as square meters. All output distances will be in meters.

PARALLEL PRE-DETERMINED AREA SCREEN

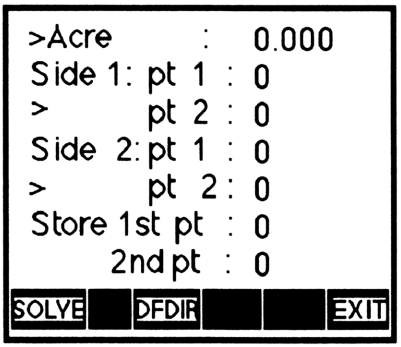
Purpose of screen - To allow a pre-determined area to be bounded by a sequence of boundary points and an unknown line that is parallel to a known line.

Path - From the Main Menu, press **[M]** CO-GO Menu - **[Q]** Pre-determined Area Screen - **[PARAL]**

Acre: - Sq ft:

Pt 2: - Bearing

Pt 2: - Bearing



Acre: - Square ft: is the predetermined area expressed as acres or square feet.

Side 1: Pt 1: is the first point that defines the first side of the parcel.

Pt 2: - Bearing: is the second point (or bearing) that defines the first side of the parcel.

Side 2: Pt 1: is the first point that defines the second side of the parcel.

Pt 2: - Bearing: is the second point (or bearing) that defines the second side of the parcel.

[Note: The line that defines the bearing of the unknown line is the line that connects the two Pt 1's above.]

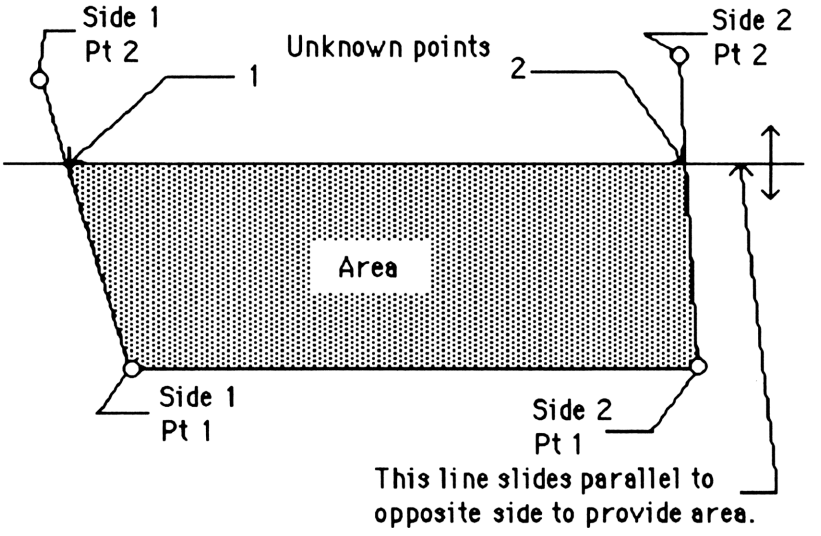
Store 1st pt: is the point number of the intersection of the unknown boundary line with line 1.

Store 2nd pt: is the point number of the intersection of the unknown boundary line with line 2.

[SOLVE] will solve for the unknown point coordinates based on the input information in the screen and will store these coordinates into the current job file at the specified point numbers.

[DFDIR] will transfer to the Define a Direction Screen. In this way, the bearing of the first line may be computed from two points on the line.

[EXIT] will return to the previous screen or menu.



NOTE: If the distance units setting has been specified as meters in the Operating Modes Screen, the area specification in this screen must be input as square meters. All output distances will be in meters.

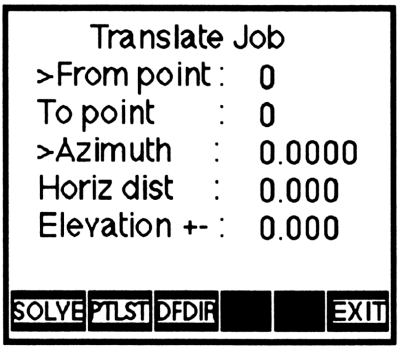
SURVEY ADJUSTMENT MENU SCREENS

TRANSLATE JOB SCREEN

Purpose of screen - to move all of the coordinates in a block of points to the north and/or east and/or change in elevation by a constant distance.

Path - From the Main Menu, press **[N]** Survey Adjustment Menu - **[G]**

From pt
To pt -
<Using pt list>
Azimuth -
Bearing



From pt: - <Using point list>
To: are the alternative methods of specifying the points that are to be included in the translation.

Azimuth: - Bearing: is the *direction* in which the specified points in this job are to be translated. This screen does *not rotate* the job.

Horiz dist: is the horizontal distance through which the specified points in this job are to be translated in the direction noted by the azimuth or bearing in this screen.

Elevation + -: is the amount of change in the elevation of the

specified points in this job.

[SOLVE] will compute new coordinates for all of the points identified in the top of the screen by the amounts specified in the +/- lines of the screen.

[PTLST] will transfer to the Point List Screen.

[DFDIR] will transfer to the Define a Direction Screen.

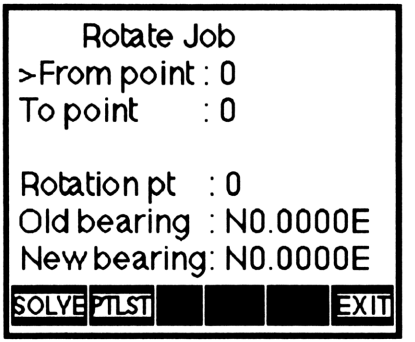
[EXIT] will return to the previous screen or menu.

ROTATE JOB SCREEN

Purpose of screen - to allow you to rotate a block of points about a central point and change the northings and eastings accordingly.

Path - From the Main Menu, press **[N]** Survey Adjustment Menu - **[H]**

From pt
To pt -
<Using pt list>



From pt: - <Using point list>
To: are the alternative methods of specifying the points that are to be included in the rotation.

Rotation pt: is the point about which the rotation is to be taken.

Old bearing: is the bearing of a line on the survey *before* the rotation.
New bearing: is the bearing of the same line on the survey *after* the rotation.

[SOLVE] will rotate all of the points specified in the top of the screen about the rotation point and at the rotation angle specified in the screen. New northings and eastings for these points will be computed.

[PTLST] will transfer to the Point List Screen.

[EXIT] will return to the previous screen or menu.

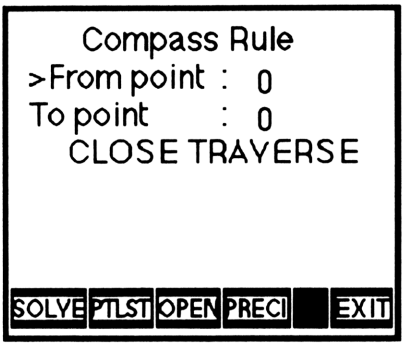
COMPASS RULE SCREENS

CLOSED TRAVERSE

Purpose of screen - to allow you to adjust a *closed* traverse by the Compass Rule.

Path - From the Main Menu, press **[N]** Survey Adjustment Menu - **[I]**

From pt
To pt -
<Using pt
list>



From pt: - <Using point list>
To: are the alternative methods of specifying the points that are to be included in the angular adjustment.

[SOLVE] will apply the Compass Rule to the points specified in the closed traverse in the screen. It will compute new coordinates for all points *but the first point* and store these new coordinates in the job file.

[PTLST] will transfer to the Point List Screen.

[OPEN] will transfer to the Compass Rule Screen for open traverses (see below).

[PRECI] will compute the precision of the closed traverse based on the original data. The **[PRECI]** key should be used to check the precision *before* **[SOLVE]** is used.

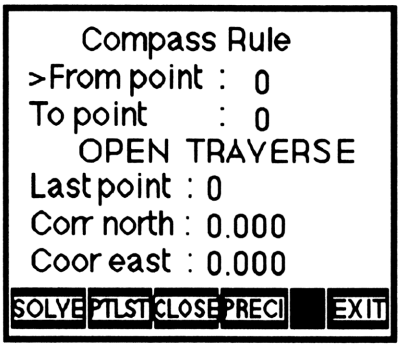
[EXIT] will return to the previous screen or menu.

OPEN TRAVERSE

Purpose of screen - to allow you to adjust an *open* traverse by the Compass Rule.

Path - From the Main Menu press **[N]** Survey Adjustment
Menu - **[I]** Compass Rule - **[OPEN]**

From pt
To pt -
<Using pt list>



From pt: - <Using point list>
To: are the alternative methods of specifying the points that are to be included in the angular adjustment.

Last pt: is the last point of the open traverse.

Corr north: is the true northing of the last point.

Corr east: is the true easting of the last point.

[SOLVE] will apply the Compass Rule to the points specified in the open traverse in the screen. It will compute new coordinates for all points *but the first point* and store these new coordinates in the job file.

[PTLST] will transfer to the Point List Screen.

[CLOSE] will transfer to the Compass Rule Screen for closed traverses (see above).

[PRECI] will compute the precision of the open traverse based on the original data. The **[PRECI]** key should be used to

check the precision *before* **[SOLVE]** is used.

[EXIT] will return to the previous screen or menu.

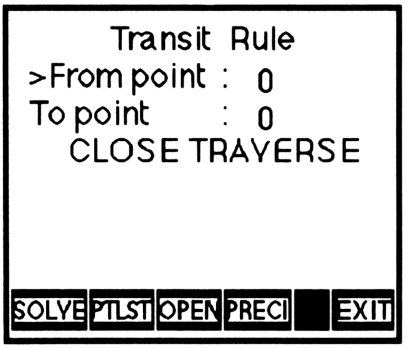
TRANSIT RULE SCREENS

CLOSED TRAVERSE

Purpose of screen - to allow you to adjust a *closed* traverse by the Transit Rule.

Path - From the Main Menu, press **[N]** Survey Adjustment Menu - **[J]**

From pt
To pt -
<Using pt list>



From pt: - <Using point list>
To: are the alternative methods of specifying the points that are to be included in the angular adjustment.

[SOLVE] will apply the Transit Rule to the points specified in the closed traverse in the screen. It will compute new coordinates for all points *but the first point* and store these new coordinates in the job file.

[PTLST] will transfer to the Point List Screen.

[OPEN] will transfer to the Transit Rule Screen for open traverses.

[PRECI] will compute the precision of the closed traverse based on the original data. The **[PRECI]** key should be used to check the precision *before* **[SOLVE]** is used.

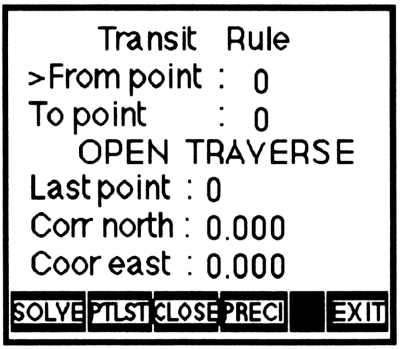
[EXIT] will return to the previous screen or menu.

OPEN TRAVERSE

Purpose of screen - to allow you to adjust an *open* traverse by the Transit Rule.

Path - From the Main Menu, press **[N]** Survey Adjustment Menu - **[J]** Transit Rule - **[OPEN]**

From pt
To pt -
<Using pt list>



From pt: - <Using point list>
To: are the alternative methods of specifying the points that are to be included in the angular adjustment.

Last pt: is the last point of the open traverse.

Corr north: is the true northing of the last point.

Corr east: is the true easting of the last point.

[SOLVE] will apply the Transit Rule to the points specified in the open traverse in the screen. It will compute new coordinates for all points *but the first point* and store these new coordinates in the job file.

[PNTS] will transfer to the Point List Screen.

[CLOSE] will transfer to the Transit Rule Screen for closed traverses.

[PRECI] will compute the precision of the closed traverse based on the original data. The **[PRECI]** key should be used to check the precision *before* **[SOLVE]** is used.

[EXIT] will return to the previous screen or menu.

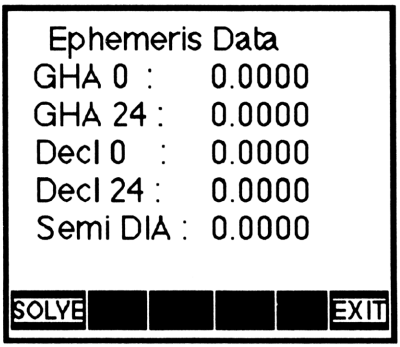
SUNSHOT MENU SCREENS

Note: Direct viewing of the sun without a solar filter can cause serious and permanent eye damage. Also, sighting your electronic total station toward the sun without an objective lens filter can cause damage to your EDM.

EPHEMERIS DATA SCREEN

Purpose of screen - to allow you to key in data from an ephemeris in preparation for performing sunshots in the field.

Path - From the Main Menu, press **[O]** Sunshot Menu - **[G]**



GHA0: is the Greenwich Hour Angle of the sun at zero hour Universal Time, Greenwich on the current date.

GHA24: is the Greenwich Hour Angle of the sun at zero hour Universal Time, Greenwich on the next date (24 hours later).

Decl0: is the declination of the sun on the current date.

Decl24: is the declination of the sun on the next date (24 hours later).

Semi Dia: is the semidiameter of the sun expressed in minutes and seconds.

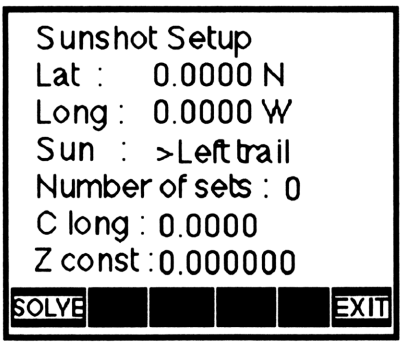
[SOLVE] will transfer to the Sun Shot Setup Screen in preparation for taking the sunshots.

[EXIT] will return to the previous screen or menu.

SUNSHOT SETUP SCREEN

Purpose of screen - to set the proper local constants into the TDS-48 in preparation for taking sunshots.

Path - From the Main Menu, press **[O]** Sunshot Menu - **[G]** Ephemeris Data Screen - **[SOLVE]**
From the Main Menu, press **[O]** Sunshot Menu - **[H]**



Lat: is the latitude of the *observer.*

Long: is the longitude of the *observer.*

Sun: indicates the location of the cross hair of the gun with respect to the sun at the time of the sunshot: either left trailing edge, right trailing edge, or center.

Number of sets: is the number of sets of sunshots (direct and reverse) that are to be taken.

C long: is the central meridian longitude.

Z const: is the zone latitudinal constant for your region.

[SOLVE] will prompt you for the proper positioning of the gun and the sequence of readings to be taken.

[EXIT] will return to the previous screen or menu.

NOTE: If you are connected to an electronic total station, pressing the **[SOLVE]** key from this screen will prompt you with the proper positioning of the gun. You will then trigger each shot at the proper time by pressing **[ENTER]**. The TDS-48 will collect the proper data automatically prior to computing the correct value for your back azimuth.

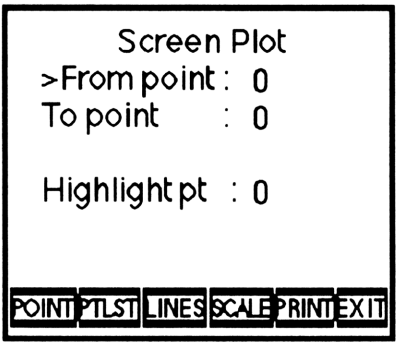
SCREEN PLOT SCREENS

SCREEN PLOT SCREEN

Purpose of screen - to allow you to view a plot of a block of points in the TDS-48 screen display.

Path - From the Main Menu, press **[P]**

From pt
To pt -
<Using pt list>



From point: - <Using point list>
To Point: are the techniques used to specify a sequence of points.

Highlight pt : will highlight the designated point by plotting a small circle around it on the screen. To disable this feature, specify point number 0 to be highlighted.

[POINT] will cause the points indicated at the top of the screen to be plotted in the TDS-48's display (see below).

[PTLST] will transfer to the Point List Screen.

[LINES] will cause the points indicated at the top of the screen to be plotted in the TDS-48's display and to be connected by straight lines in the assigned sequence (see below).

[SCALE] will compute a scale for the plot that will display all of the specified points to be shown in the "square" virtual display.

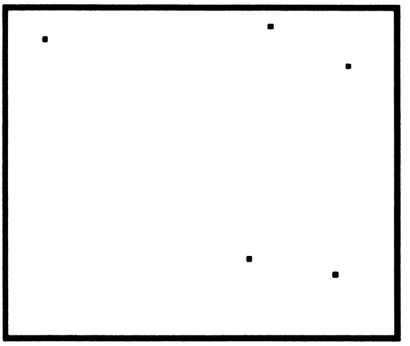
[PRINT] will send the current screen plot to an HP-82240B Infrared Printer.

[EXIT] will return to the previous screen or menu.

POINTS SCREEN

Purpose of screen - to show the point plot from the previous screen.

Path - From the Main Menu, press **[P]** Plot Menu - **[POINTS]**

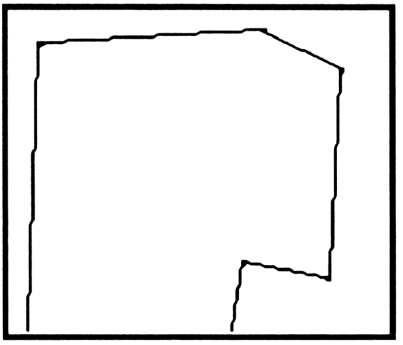


The points on this screen are shown on a square virtual display with the north direction at the top of the display. You may press and hold down the vertical cursor keys **[∧]** and **[v]** to scroll to the rest of the display. To return to the Screen Plot Screen, press **[ON]**.

LINES SCREEN

Purpose of screen - to show the line plot from the previous screen.

Path - From the Main Menu, press **[P]** Plot Menu - **[LINES]**



The lines on this screen are shown on a square virtual display with the north direction at the top of the display. You may press and hold down the vertical cursor keys **[∧]** and **[v]** to scroll to the rest of the display. To return to the Screen Plot Screen, press **[ON]**.

⇨ **NOTE:** If you are using the Point List option to specify the point sequence and you want to show a figure that has more than one separate connected line sequence, you may "lift the pen" in this screen plot by inserting a PENUP command in the point list. Use the **[PENU]** softkey in the Point List Screen.

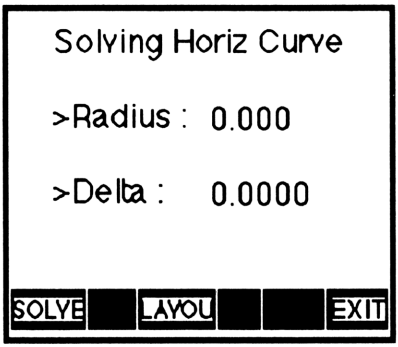
CURVE MENU SCREENS

SOLVING HORIZONTAL CURVE SCREEN

Purpose of screen - to solve for the properties of a horizontal curve.

Path - From the Main Menu, press **[Q]** Curve Menu - **[G]**

Radius -
Degree -
Delta
Delta -
Length -
Chord -
Tangent -
Mid ord



Radius: - Degree (of curvature): - Delta: is a measure of the curvature of the curve.

Delta: -Length: - Chord: - Tangent: - Mid ord: is a measure of the size of the curve segment:

[SOLVE] will solve for the remaining curve parameters and display them on the Curve Solution Screen (see below).

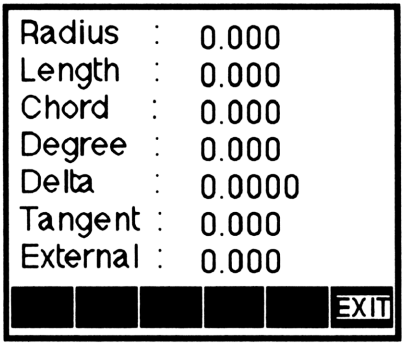
[LAYOU] will transfer to the Horizontal Curve Layout Menu (see below).

[EXIT] will return to the previous screen or menu.

CURVE SOLUTION SCREEN

Purpose of screen - to display the results of the horizontal curve solution.

Path - From the Main Menu, press **[Q]** Curve Menu - **[G]** Horizontal Curve Screen - **[SOLVE]**



All terms are defined as in the figure shown below.

Radius: - R

Length: - L

Chord: - C

Degree: - (18000/(Π R)) expressed in degrees. minutes seconds

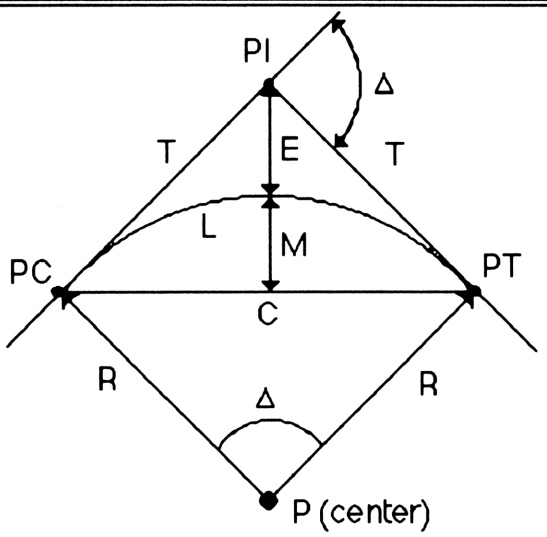
Delta: - Δ

Tangent: -T

External: - E

Mid ordinate: - M

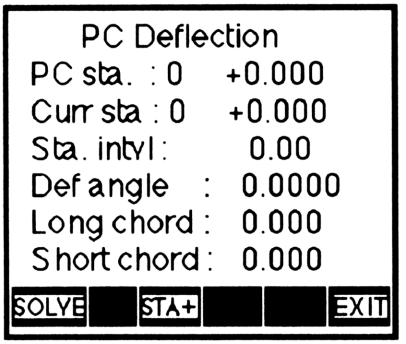
[EXIT] will first show the value of the mid ordinate. Then pressing any key will return to the previous screen or menu.



PC DEFLECTION SCREEN

Purpose of screen - to allow you to lay out a horizontal curve by deflection angles from the PC and entered from within the Curve Menu.

Path - From the Main Menu, press **[Q]** Curve Menu - **[G]** Horizontal Curve Screen - **[LAYOU]** Horizontal Curve Layout Menu - **[G]**



PC sta : is the station number of the PC. Your gun should be occupying the PC and backsighting the PI.

Sta interval is the interval from the current station to the next station.

Curr sta: is the station number of the current station.

Def ang: {output only} is the deflection angle from the PC-PI line to the next station assuming the current station is occupied.

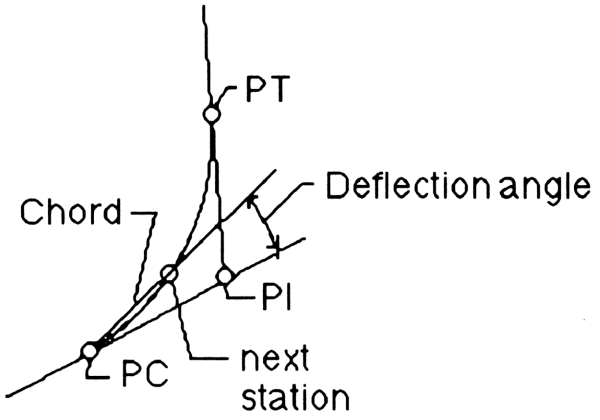
Long chord: {output only} is the length of the chord from the next station to the PC.

Short chord: {output only}is the length of the chord from the next station to the current station.

[SOLVE] will compute the deflection angle and chord lengths from the screen data.

[STA+] will increment from the current station to the next station using the assigned station interval.

[EXIT] will return to the previous screen or menu.



PI DEFLECTION SCREEN

Purpose of screen - to allow you to layout a horizontal curve by deflection angles from the PI from within the Curve Menu.

Path - From the Main Menu, press **[Q]** Curve Menu - **[G]** Horizontal Curve Screen - **[LAYOU]** Horizontal Curve Layout Menu - **[H]**

```
      P I Deflection
PC sta. : 0    +0.000
Curr sta : 0   +0.000
Sta. intvl :     0.00

Def angle   :  0.0000
Distance    :  0.000
SOLVE  STA+  EXIT
```

PI sta : is the station number of the PI. Your gun should be occupying the PI and backsighting the PC.

Sta interval is the interval from the current station to the next station.

Curr sta: is the station number of the current station.

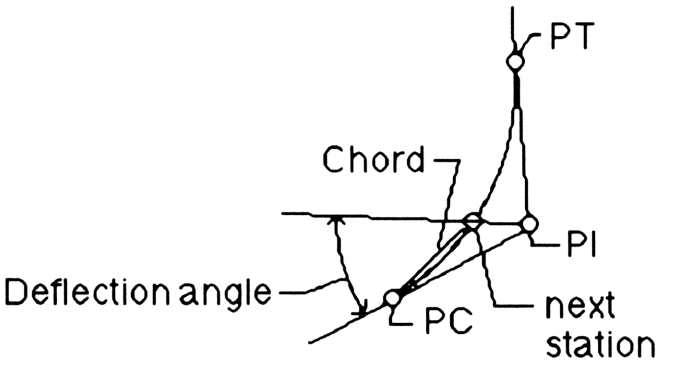
Def ang: {output only} is the deflection angle from the PI- PC line to the next station.

Distance: {output only} is the distance from the PI to the next station.

[SOLVE] will compute the deflection angle and distance from the screen data.

[STA+] will increment from the current station to the next station using the assigned station interval.

[EXIT] will return to the previous screen or menu.



VERTICAL CURVE SCREEN

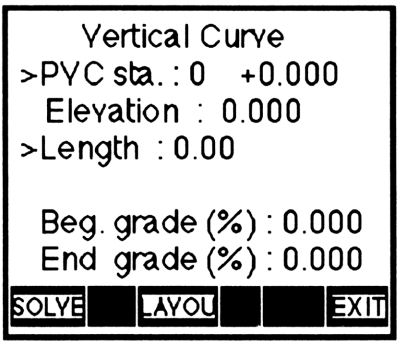
Purpose of screen - to allow you to compute the elevations at various stations along a vertical curve; also, to allow you to

layout a vertical curve from the Curve Menu.

Path - From the Main Menu, press **[Q]** Curve Menu - **[H]**

PVC sta -
PVI sta

Length -
Sta
Elev -
H/L El



PVC sta: - PVI sta: is the station number of either the PC or the PI of the vertical curve.

Elevation: is the elevation at the PVC or PVI station.

Beg grade (%): is the beginning grade of the vertical curve expressed as a % (+ for uphill; - for downhill).

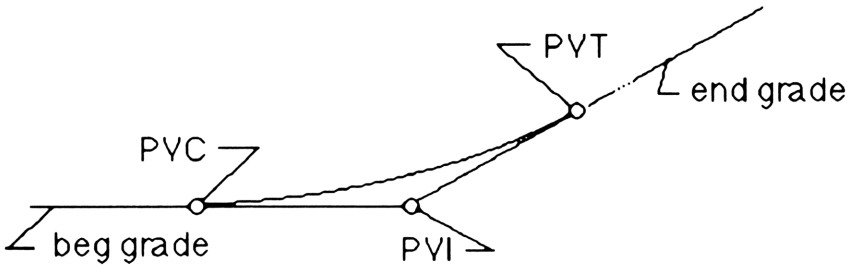
End grade (%): is the ending grade of the vertical curve expressed as a % (+ for uphill; - for downhill).

Length: - H/L pt ele: - Sta:
Elevation: is the horizontal length between the PC and PT or another station number and elevation along or the elevation of the high or low point of the vertical curve.

[SOLVE] will compute the properties of the vertical curve and display the results in the Vertical Curve Solution Screen (see below)

[LAYOU] will transfer to the Vertical Curve Layout Screen (see below).

[EXIT] will return to the previous screen or menu.



VERTICAL CURVE SOLUTION SCREEN

Purpose of screen - to display the results of the vertical curve solution from the data in the previous screen.

Path - From the Main Menu, press **[Q]** Curve Menu - **[H]** Vertical Curve Screen - **[SOLVE]**

PVC Sta :	0	+0.000
Elevation :		0.000
PVI Sta :	0	+0.000
Elevation :		0.000
PVT Sta :	0	+0.000
Elevation :		0.000
H/L pt ele :		0.000

EXIT

PVC Sta: {output only} is the station number of the PC of the vertical curve.

Elevation: {output only} is the elevation of the PC of the vertical curve.

PVI Sta: {output only} is the station number of the PI of the vertical curve.

Elevation: {output only} is the elevation of the PI of the vertical curve.

PVT Sta: {output only} is the station number of the PT of the vertical curve.

Elevation: {output only} is the elevation of the PT of the vertical curve.

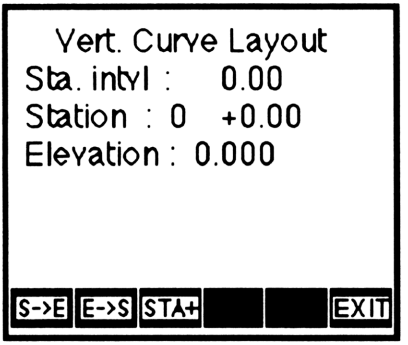
H/L pt ele: {output only} is the elevation of the highest or lowest point along the vertical curve.

[EXIT] will return to the previous screen or menu.

VERTICAL CURVE LAYOUT SCREEN

Purpose of screen - to allow you to layout a vertical curve by station number from the Curve Menu.

Path - From the Main Menu, press **[Q]** Curve Menu - **[H]** Vertical Curve Screen - **[LAYOU]**



Sta. intvl: is the interval between stations to be laid out.

Station: is the current station.

Elevation: is the elevation at the current station.

Grade: {output only} is the grade of the vertical curve at the specified station expressed as a %. (This line only appears after **[S->E]** is pressed.)

[S-->E] will assume the station in the current station line; compute the elevation at that station; and display it in the elevation line of this screen

[E-->S] will assume the elevation in the elevation line; compute the station at which that elevation occurs; and display it in the station line of this screen.

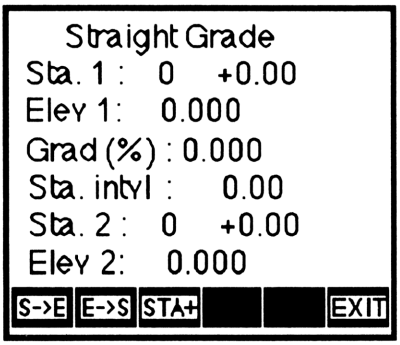
[STA+] will increment the current station line in the display by an amount equal to the station interval.

[EXIT] will return to the previous screen or menu.

STRAIGHT GRADE SCREEN

Purpose of screen - to solve for the elevation at various stations along a straight grade.

Path - From the Main Menu, press **[Q]** Curve Menu - **[I]**



Sta. 1: is the station number of a station with a known elevation.

Elev 1: is the elevation at Sta 1.

Grade (%): is the grade of the section (+ for uphill; - for downhill).

Sta. intvl: is the interval to the next station

Sta. 2: is the station number of the next station.

Elev 2: is the elevation of the next station.

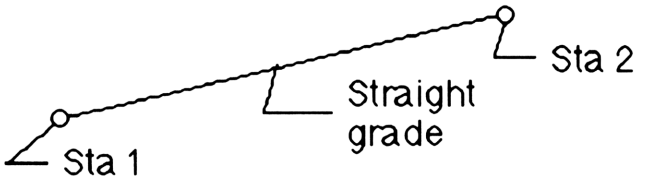
[S-->E] will assume the station in the Sta 2 line; compute the elevation at that station; and display it in the Elev 2 line of this screen.

[E-->S] will assume the elevation in the Elev 2 line; compute

the station at which that elevation occurs; and display it in the Sta 2 line of this display.

[STA+] will increment the Sta 2 line in the display by an amount equal to the station interval.

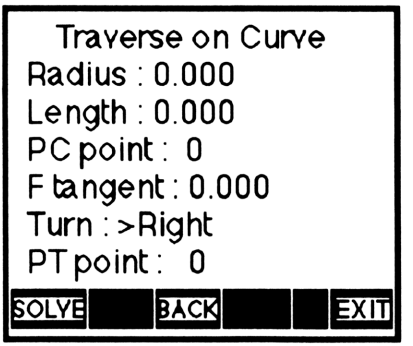
[EXIT] will return to the previous screen or menu.



TRAVERSE ON CURVE SCREEN

Purpose of screen - to include a horizontal curve in a traverse.

Path - From the Main Menu, press **[Q]** Curve Menu - **[J]**



Right - Left

Radius: is the radius of the curve.

Length: is the arc length of the curve.

PC point: is the point number of the PC.

F tangent: is the azimuth of the tangent to the curve from the PC in the forward direction of the curve (toward the PT).

Turn: is the direction (right or left) that the curve turns from the forward tangent.

PT point: is the point number of the PT.

[SOLVE] will compute the coordinates of the PT and add this point to the coordinate file from the data in the rest of the screen.

[BACK] will transfer to the Backsight Screen. The Backsight Screen may be used to compute the azimuth of the forward tangent. When you return to this screen from the Backsight Screen, the value of the azimuth of the forward tangent will be automatically computed to be in the *opposite* direction of the backsight azimuth.

[EXIT] will return to the previous screen or menu.

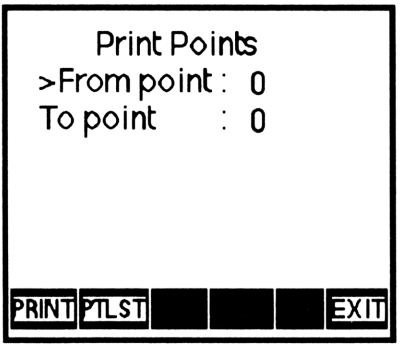
PRINT POINTS SCREEN

PRINT POINTS SCREEN

Purpose of screen - to print out the coordinates of a block of points on a printer.

Path - From the Main Menu, press **[R]** Print Menu - **[G]**

From pt
To pt -
<Using pt list>



From pt: - <Using point list>
To pt: are the techniques for specifying the points to be printed.

[PRINT] will begin printing the coordinates of the specified points.

[PTLST] will transfer to the Point List Screen.

[EXIT] will return to the previous screen or menu.

PRINT RAW DATA COMMAND

Purpose of command - to obtain a printout of the raw data of a

job.

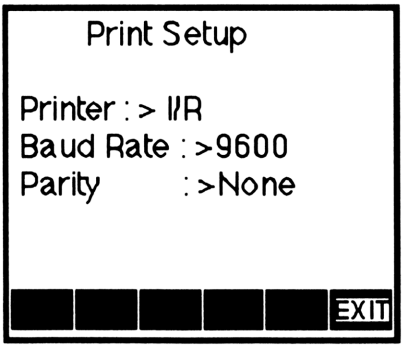
Path - From the Main Menu, press **[R]** Print Menu - **[H]**

Pressing **[H]** from the Print Menu will cause the TDS-48 to print out the contents of the raw data file of the *currently active* job.

PRINT SETUP SCREEN

Purpose of screen - to setup your TDS-48 for printing.

Path - From the Main Menu, press **[R]** Print Menu - **[I]**



I/R - Wire
1200 - 2400 - 4800 - 9600
Odd - Even - None

Printer: indicates whether or not the data communication is to be via the RS232 link or via the wireless infrared link.

Baud rate: is the data communication rate expressed in baud.

Parilty: is the data communication parity setting (even, odd, or none)

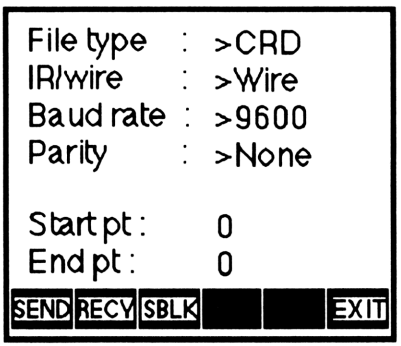
[EXIT] will return to the previous screen or menu.

FILE TRANSFER MENU

FILE TRANSFER SCREEN

Purpose of screen - to transfer data to or from the TDS-48 from or to an office PC.

Path - From the Main Menu, press **[S]**



CRD - RAW - PLST
Wire - I/R
1200 - 2400 - 4800 - 9600
None - Odd - Even

File type: is the type of file to be transferred, either coordinate, raw data, or point list.

IR/Wire: indicates whether or not data communication is to be via the RS232 link or via the wireless infrared link.

Baud rate: is the data communication rate expressed in baud.

Parity: is the data communication parity setting (even, odd, or none).

Start pt: is the starting point if a block of points is to be sent.

End pt: is the ending pont if a block of points is to be sent.

[SEND] will cause the designated data to be sent from the

TDS-48 to another device according to the established screen parameters.

[RECV] will set up the TDS-48 to receive data from another device according to the established screen parameters and store it as the named job.

[SBLK] will cause a block of data to be sent as determined by the start and end points in the screen.

[EXIT] will return to the previous screen or menu.

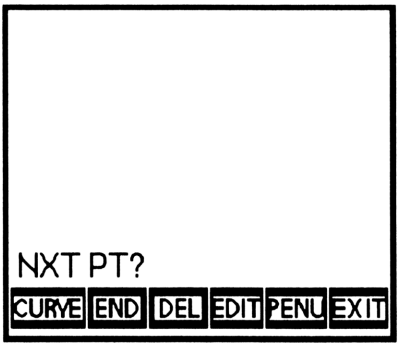
NOTE: If you are using the companion TDS-48 TFR PC software, the proper communication parameter settings are: Baud rate - 9600, Parity - None, IR/Wire - Wire.

UTILITY SCREENS

POINT LIST SCREEN

Purpose of screen - to allow you to specify a block of points that are not consecutively numbered for a variety of operations within the TDS-48. You may also use the point list to specify a curve within the list of points as well as controlling several functions of the plotter.

Path - from any screen which has a **[PTLST]** "soft" key, press **[PTLST]** Point List Menu - **[G]**



The Point List is a mechanism with which you can specify a block of points for some operations in the TDS-48. You may build the list one point at a time or by specifying sequentially numbered points as groups by keying in the first and last point in the group with a **[-]** between. (such as "10-15"). Another special command is to insert a sideshot in a point list. To do this, press **[α] [S] [S]** [space] followed by the point number of the sideshot. These features may be combined. To insert a group of consecutively numbered sideshots into a point list, press **[α] [S] [S]** [space] followed by the first point number; then **[-]**; then the last point number in the sequence. This

feature is particularly useful if you want to do an adjustment of a traverse that has sideshots in it. The traverse point coordinates will be adjusted according to the selected rule. The sideshot coordinates will be adjusted according to the adjusted values of the traverse coordinates. The screen plot will also recognize the SS symbol.

[CURVE] will transfer to the Horiz/Vert Curve Screen (see below).

[END] will move the scroll bar to the end of the point list.

[DEL] will delete the Point List entry line that is in the screen *immediately above* the data entry bar.

[PENU] will "lift the pen" and not draw a line to the next point when doing a screen plot of the lines in this point list.

[EDIT] will replace the entry above the data entry bar with the contents of the bar.

[ENTER] (main keyboard) will insert the contents of the data entry bar *after* the last entry currently on view in the screen.

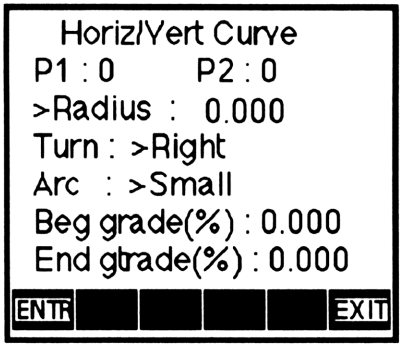
[EXIT] will return to the previous screen or menu.

HORIZ/VERT CURVE SCREEN

Purpose of screen - to allow you to insert a curve in a point list.

Path - from any screen which has a **[PTLST]** "soft" key, press **[PTLST]** Point List Menu - **[G]** Point List Screen - **[CURVE]**

Radius - Straight vert curve



Right - Left
Small - Large

P1: is the first point on the curve.

P2: is the second point on the curve.

Spur azm: is the azimuth angle for a spur to use to place a call on the curve by the plotter.

Radius: is the radius of a horizontal curve.
Straight line V. crv: indicates that there is a straight grade with a change in elevation.

Turn: indicates that the horizontal curve will turn to the right or left of the forward tangent.

Arc: indicates whether the arc is small (less than 180^{o} central angle) or large (greater than 180^{o} central angle).

Beg grade(%): is the beginning grade for a vertical curve (+ for uphill; - for downhill).

End grade(%): is the ending grade for a vertical curve (+ for uphill; - for downhill).

[ENTER] will place the curve in the Point List.

REFERENCE

[EXIT] will return to the previous screen or menu.

ALPHABETICAL LIST OF SCREENS

APPENDIX A

Technical Specifications*

Main Operating Functions
- job creation
- initialization
- setup

Data collection

Traverse/Sideshot
- single readings
- multiple readings and averaging
- descriptor code tables
- control files

Stakeout
- by points
- by station and offset
- slope staking

CO-GO
- areas
- conversions
- intersections
- inverses
- point-in -direction
- remote elevation
- rod man next point
- 2 and 3 point resections
- pre-determined area

Curves
- horizontals
- verticals

Job rotations, translations, scale changes & adjustments
- Compass Rule
- Transit Rule

Sunshots

APPENDIX A

Interfaces to:

Partial list of electronic total stations supported:

LIETZ: Set2,3,4, SETsB, SDM3FR, DSM3F, SDM3ER, SDM3E, DT20E
TOPCON: RS232 port
NIKON: TOP GUN
WILD: T2000+EDM, T1000+EDM, T2000, T1000
PENTAX: PTS-10, PTS II
KERN: E1/E2
ZEISS: ELTA/C, Old ELTA
GEODIMETER: RS232 port

File transfer to office equipment:

Office computers and workstations
Coordinate files and raw data
Printers
Coordinate files and raw data

Physical: 7.1" x 3.2" x 1.15"
Weight: 11 oz (including batteries and cards)

Power: 3 AAA Alkaline batteries
[batteries should last several months under normal usage]

Environmental:
Operating Temperature:
(with heater off) 32^{o} - 113^{o} F
Storage Temperature:-20^{o} - 160^{o} F

Hardware features:
Display: Liquid Crystal 8 line x 22 character
Keyboard: 49 key membrane actuator with tactile feedback

Software features:
Operating System: HP-48SX (256k)
Application: TDS-500 (128k)

Memory: 32k-byte or 128k-byte RAM required. (up to 750 or

3000 points depending on amount of raw data stored at each point)

Interfaces:
RS-232 (4 pin) port built in for communication with desktop computers and total stations
I/R port built in for wireless communication between units as well as to the HP 82240B Inftared Portable Printer.

**Specifications subject to change without prior notice*

APPENDIX B

How to connect the TDS-48 to your electronic total station.

1. Use the FC-48's Setup Screen to select the proper instrument and model.

2. Setup and level your gun.

3. Connect the TDS-48 to the gun with the proper cable.

4. Turn the gun ON.

5. To confirm that the gun is working properly, take a practice shot at a target.

6. Use the proper TDS-48 functions to trigger your gun and take the data.

Information specific to the use of the TDS-48 with various electronic total stations

TOPCON

Models supported - RS232 models

When fast mode is set, all shots will be taken in Coarse Mode.

There is no distance averaging mode available for Topcon instruments.

APPENDIX B

LIETZ

Models supported	Slope distance?	Zenith angle?	Horizontal angle?
SET 2 / 3 / 4	Yes	Yes	Yes
SDM3FR	Yes	Yes	No
SDM3F	Yes	No	No
SDM3ER	Yes	Yes	No
SDM3E	Yes	No	No
DT20E	Yes / No	Yes	Yes

The DT20E is an electronic theodolite. It can only provide angles. By using it with a top mounted EDM, you can get both angles and distances. For this configuration, choose the "SETs" as the Instrument Setup option in the TDS-48.

You do not have to push any keys on the gun to obtain readings from Lietz instruments. Requesting information and triggering are done automatically from the TDS-48. The data collector will prompt for the proper readings as required by the particular application being done.

Fast mode may be set by placing the gun in tracking mode directly. It will then be in effect whether or not the TDS-48 has been set for fast mode.

There is no distance averaging mode available for Lietz instruments.

Newer Lietz guns have both a theodolite and an CA (distance) mode. The user must select the CA mode on the gun manually for shooting both angles and distances. To shoot angles only, the gun may be in either mode but the gun will return angles much faster if it is in theodolite mode rather than CA mode.

WILD

Models supported - T1000
T1600
T2000

The selections in the Setup Screen are as follows:
T2000 + EDM
T1000 + EDM
T2000
T1000
You should initialize the gun whenever you turn its power on. this can be done by pressing the **[INIT]** "softkey" from either the Backsight or Device Setup Screens.

When using a T1600, you should place the T1600 in a mode that will communicate like a T2000. This can be done from the gun with the following key sequences:

SET MODE 74 RUN 1 RUN

Then choose the T2000 from the Instrument Setup Screen in the TDS-500.

The TDS-500 assumes that the Wild instruments are set to communicate at:
Baud rate - 2400
Parity - even
Data bits - 7
Stop bits - 1

The gun may be set to the communication settings given above with the following key sequences:

SET MODE 70 RUN 4 RUN (to set 2400 baud)
SET MODE 71 RUN 2 RUN (to set even parity)

APPENDIX B

These sequences only have to be keyed into the gun once. The instrument will remember these settings even if the battery is briefly removed.

Fast mode is available for all models. When using a T2000 or T1600, you need to set the gun tracking mode manually. This can be done by pressing the **[REP]** and **[DIST]** keys on the gun.

There is no distance averaging mode available for Wild instruments.

Troubleshooting tips:

1. Make sure that you have executed the **[INIT]** function from the TDS-48 each time that you turn the gun ON.
2. If the TDS-48 does not seem to be triggering the gun or if the TDS-48 does not get the distance reading from the gun, the problem is most likely in the software in you gun. contact your Wild dealer and request an upgrade in the data communication software in you gun.

NIKON

Models supported - TOP GUN

Fast mode is available for the TOP GUN.

When the gun is set up to average distance readings, set the "Measurement Mode" in the Device Setup Screen to "Multiple".

GEODIMETER

Models supported - 400s RS232

When used with the 400 series, you should set the gun for the RS232 interface (see below). When set this way, you must press the **[AIM]** key on the gun to take a shot.

Setting up the Geodimeter 400 Series total stations to communicate with the TDS-48.
[Note: This procedure needs to be done only once. The gun will remember the proper setting when turned "OFF".]

On the gun:
1. Press **[MNU]**.
2. Press **[4]**. The display will now show:
   Data com
   1 Select device
   2 Create table
3. Press **[1]**. The display will now show:
   1 Geodat
   2 Serial
   3 Xmem
4. Press **[2]**. The display will now show:
   Serial ON?
5. Press **[REG]** (for Yes). The display will now show:
   Serial

   COM=1.7.2.1200

These are the current settings of the communication parameters. If the current readings do not match those shown above, key in the numbers as shown from the digit keypad. The decimal point is the key next to the **[0]** key on the bottom row of the keypad.
6. Press **[ENT]**. The display will now show:
   U.D.S ?
7. Press **[AIM]** (for No). The display will now show:
   Table no=
8. Press **[ENT]** to select the default table number. The display will now show:
   Request?
9. Press **[REG]** (for Yes). The display will now show:
   HA:

VA:
SD:
The gun setting is now complete.

On the TDS-48:
1. From the Main Menu press **[H]**.
2. From the Setup Menu press **[H]**.
3. Move the scroll bar to the Instrument line and select >Geodimeter
4. Move the scroll bar to the Model line and select >400s-RS232

Fast Mode is available with the 400 series total stations.
Fast mode must be set in the gun manually.

ZEISS

Models supported - Elta /C, Old Elta

Zeiss has changed their communication commands during 1986 and 1987. If you have an Elta gun you should first try the "Elta /C" option. If this doesn't work, then try the "Old Elta" option.

There is no fast mode nor distance averaging mode available for Zeiss guns.

KERN

Models supported - E1, E2

The TDS-48 will only work with the models of the Kern E1 or E2 which are equipped with an EDM. Confirm that your Kern is so equipped before you attempt to use your TDS-48 with it.

APPENDIX C

File Format of TDS-48 Coordinate Files

Each file begins with a 20 byte header:

Bytes 1 - 13 is the file name in ASCII.
Byte 14 is the file type.
Bytes 15 - 17 is the file size.
Bytes 18 - 20 is the record pointer.

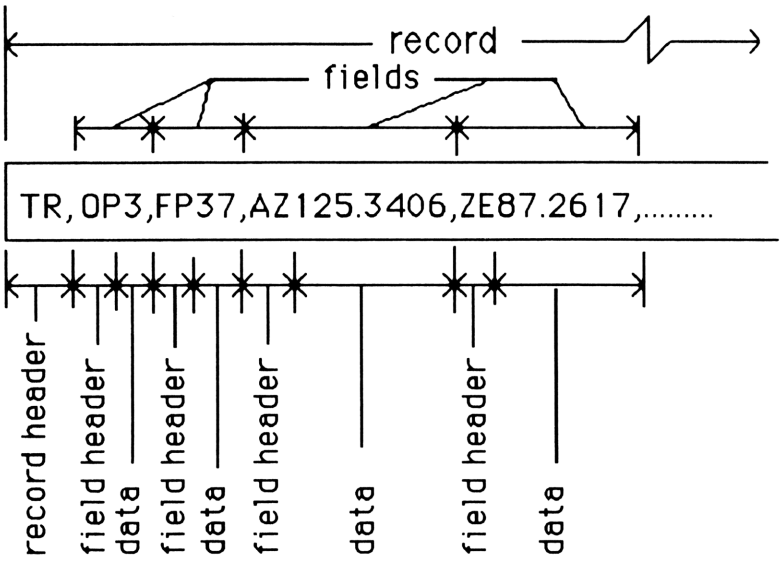
The header is followed by the point coordinate records which are each 41 bytes long:

Bytes 1 - 8 is the northing of the point.
Bytes 9 - 16 is the easting of the point .
Bytes 17 - 24 is the elevation of the point.
Bytes 24 - 41 is the point descriptor in ASCII.

APPENDIX D

Codes and symbols used in TDS-48 Raw Data Files

The Raw Data File is made up of a sequence of ASCII text records. Each record contains data for a complete field operation, such as a traverse or a side shot. A record may consist of multiple fields of data that describe the operation. Each record occupies a line in the screen when you select the Raw Data Screen from the Jobs Menu. The entire line may be viewed by moving the cursor to the appropriate line and pressing **[VIEW]**. These different fields are separated by commas in a record.



Each record is started with a two letter code and a comma to identify the type of the record. Each field is also preceded by a

two letter code as the field header. The value or data in a field follows directly after the field header.

A typical traverse record will look as follows:
TR,OP3,FP37,AZ125.3406,ZE87.2617,SD249.87,--FIRE HYDRANT

Meaning:

Type (TR):	Traverse
Occupy point (OP):	3
Foresight point (FP):	37
Azimuth (AZ):	125.3406
Zenith (ZE):	87.2617
Slope Distance (SD):	249.87
Note (--):	FIRE HYDRANT

Records are described in detail below:

Occupy Record
Record type : OC
Field headers:

PN:	Point number
N :	Northing (the header is N space)
E :	Easting (the header is E space)
EL:	Elevation
-- :	Note

Traverse / Sideshot Record
Record type: TR / SS (lower case tr/ss for reverse traverse or side shot)
Field headers:

OP:	Occupy Point
FP:	Foresight Point
(one of the following)	
AZ:	Azimuth
BR:	Bearing
AR:	Angle-Right
AL:	Angle-Left
DR:	Deflection-Right

DL: Deflection-Left
(one of the following)
ZE: Zenith
VA: Vertical angle
CE: Change Elevation
(one of the following)
SD: Slope Distance
HD: Horizontal Distance
-- : Note

Backsight Record
Record type: BK
Field headers:
OP: Occupy point
BP: Back Point
BS: Backsight
BC: Back Circle

Line of Sight Record
Record type: LS
Field headers:
HI: Height of Instrument
HR: Height of Rod

Off Center Shot Record
Record type: OF
Field headers:
AR: Angle right
SL: Side slope distance
DD: Delta Distance
ZE: Zenith (actual)
OL: Offset Length

TR/SS Repetition Record
Record type: AA (Accumulating Angle-right)
Field headers:
BC: Back Circle
AR: Angle-Right
ZE: Zenith

SD: Slope Distance

Record type: RD (Repeat Directional)
Field headers:

BD: Backsight Direct
FD: Foresight Direct
ZD: Zenith Direct
FV: Foresight Reverse
ZV: Zenith Reverse
BV: Backsight Reverse

Record type: MD (Multiple distances)
Field headers:

SD: Slope distance

Store Point Record
Record type: SP
Field headers:

PN: Point Number
N : Northing
E : Easting
EL: Elevation
-- : Note

Resection Record
Record type: RS
Field Headers:

PN: Point number
CR: Circular Reading
ZE: Zenith (or VA, CE)
SD: Slope Distance (or HD)

Note: A two point resection will be recorded as:
RS,PN,CR,ZE,SD
RS,PN,CR,ZE,SD (one reading for each point)

Note: A three point resection will be recorded as:
RS,PN,CR
RS,PN,CR

RS,PN,CR (one reading for each point)

Mode Setup Record
The mode setup will be recorded at the beginning of the raw data file and whenever it is changed.
Record type: MO
Field headers:

AD: Azimuth direction (0 for North, 1 for South)
UN: Distance unit (0 for feet, 1 for meter)
SF: Scale factor
EC: Earth Curvature (0 for off, 1 for on)
EO: EDM offset(inch)

Stake Out Record
Record type: SK
Field headers:

OP: Occupy Point
FP: Foresight point
AR: Angle right
ZE: Zenith
SD: Slope distance

Slope Stake Record
Record type: CP (catch point)
Field headers:

ST: Station (nn+nn.nn)
OD: Offset direction (0 for center, 1 for right, 2 for left)
OL: Offset length
EL: Elevation
GD: Grade (design)
-- : Note

Cut Sheet Record
Record type: CF (cut or fill)
Field headers:

For an offset stakeout cut sheet
ST: Station

OD: Offset direction (0 for center, 1 for right, 2 for left)
OL: Offset length
EL: Elevation
GD: Grade (design)
-- : note

For a point stakeout cut sheet
PN: Point number
EL: Elevation
GD: Grade
-- : note

The above record will be recorded only if the stake point is stored. A Side shot (or store point) record will also be recorded.

Sun Shot Record
Record type: SU
Field headers:

For a sunshot setup
GH: Greenwich hour angle (GHA 0 & GHA 24)
DE: Declination (DECL 0 & DECL 24)
SM: Semidiameter of Sun (in angle)
DT: Local date
TM: Local time

For the actual sunshot
BD: Backsight Direct
FD: Foresight Direct
FV: Foresight Reverse
BR: Backsight reverse
LA: Latitude
LO: Longitude
EG0: Left trailing edge sun position
EG1: Right trailing edge sun position
EG2: Center sun position

Job Record
Record type: JB
Field headers:

NM:	Job name
DT:	Date
TM:	Time

Remote Elevation Record
Record type: RE
Field headers:

OP:	Occupied point
FE:	Foresight elevation
AR:	(always 0)
ZE:	Zenith angle
SD:	Slope distance
-- :	(always "Remote elev")

Summary

Alphabetical listing of Record Types

AA:	Accumulating Angle-right
BK:	Backsight
CF:	Cut Sheet
CP:	Slope stake
JB:	Open a job
LS:	Line of sight
MD:	Multiple distances
MO:	Mode setup
OC:	Occupy
OF:	Off center shot
RD:	Repeat Directional
RE:	Remote Elevation
RS:	Resection
SK:	Stakeout a point
SP:	Store Point
SS:	Side shot
SU:	Sun Shot
TR:	Traverse

APPENDIX D

-- : Note record

Alphabetical listing of Field Headers

AD: Azimuth direction (0 for North, 1 for South)

AL: Angle-Left
AR: Angle-Right
AZ: Azimuth
BC: Back Circle
BD: Backsight Direct
BP: Back Point
BR: Bearing (this field will be recorded as N123.4500W)
BS: Backsight (when back point is not defined)
BV: Backsight Reverse
CA: Center horizontal angle
CE: Change Elevation
CR: Circular Reading
DD: Delta Distance
DE: Declination
DL: Deflection-Left
DR: Deflection-Right
DT: Local date (MM-DD-YYYY)
E : Easting (the header is E space)
EC: Earth Curvature (0 for off, 1 for on)
EG0: Left trailing edge sun position
EG1: Right trailing edge sun position
EG2: Center sun position
EL: Elevation
EO: EDM offset
FD: Foresight Direct
FE: Foresight Elevation
FP: Foresight Point
FV: Foresight Reverse
GD: Grade (design)
GH: Greenwich hour angle
HD: Horizontal Distance
HI: Height of Instrument
HR: Height of Rod

LA:	Latitude
LO:	Longitude
N :	Northing (the header is N space)
OC:	Occupy Point
OD:	Offset direction (0 for center, 1 for right, 2 for
OL:	Offset length
OP:	Occupy Point
OS:	EDM offset
PN:	Point number
SD:	Slope Distance
SF:	Scale factor
SL:	Side slope distance
SM:	Semi-diameter of Sun (in angle)
ST:	Station
TM:	Local time (HH:MM:SS)
UN:	Distance unit (0 for feet, 1 for meter)
VA:	Vertical angle
ZD:	Zenith Direct
ZE:	Zenith
ZV:	Zenith Reverse
-- :	Note

APPENDIX E

Transverse Mercator Zones

Central Meridians of State Plane Coordinates

E = East
W = West
C = Central

STATE	ZONE	C.M.	STATE	ZONE	C.M.
Alabama	E	85 50	Hawaii	1	155 30
	W	87 30		2	156 40
				3	158 00
Alaska	2	142 00		4	159 30
	3	146 00		5	160 10
	4	150 00			
	5	154 00	Idaho	E	112 10
	6	158 00		C	14 00
	7	162 00		W	115 45
	8	166 00			
	9	170 00	Illinois	E	88 20
Arizona	E	110 10		W	90 10
	C	111 55			
	W	113 45	Indiana	E	85 40
				W	87 05
Delaware		75 25			
Florida	E	81 00	Maine	E	68 30
	W	82 00		W	70 10
Georgia	E	82 10	Michigan	E	83 40
	W	84 10	(1934)	C	85 45
				W	88 45

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STATE	ZONE	C.M.
Mississippi	E	88 50
	W	90 20
Missouri	E	90 30
	C	92 30
	W	94 30
Nevada	E	115 35
	C	116 40
	W	118 35
New Hampshire		71 40
New Jersey		74 40
New Mexico	E	104 20
	C	106 15
	W	107 50
New York	E	74 20
	C	76 35
	W	107 50
Vermont		72 30
Wyoming	1	105 10
	2	107 20
	3	108 45
	4	110 05

APPENDIX F

Lambert Zones

Central Meridians and Zone Constants for State Plane Coordinates

N = North
S = South
C = Central
M = Mainland
NC = North Central
SC = South Central
I = Island
O = Offshore

STATE	ZONE	CENTRAL LONGITUDE	LATITUDINAL CONSTANT
Arkansas	N	92 00	0.581899
	S	92 00	0.559691
California	1	122 00	0.653884
	2	122 00	0.630468
	3	120 30	0.612232
	4	119 00	0.596587
	5	118 00	0.570012
	6	116 15	0.549518
	7	118 20	0.561243
Colorado	N	105 30	0.646133
	C	105 30	0.630690
	S	105 30	0.613378
Connecticut		72 45	0.663059
Florida	N	84 30	0.502526
Iowa	N	93 30	0.677745
	S	93 30	0.658701

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STATE	ZONE	CENTRAL LONGITUDE	LATITUDINAL CONSTANT
Kansas	N	98 00	0.632715
	S	98 30	0.614528
Kentucky	N	84 15	0.622067
	S	85 45	0.606462
Louisiana	N	92 30	0.528701
	S	91 20	0.500013
	O	91 20	0.454007
Maryland		77 00	0.627634
Massachusetts	M	71 30	0.671729
	I	70 30	0.661095
Michigan	N	87 00	0.722790
	C	84 20	0.706407
	S	84 20	0.680529
Minnesota	N	93 06	0.741220
	C	94 15	0.723388
	S	84 20	0.700928
Montana	N	109 30	0.746452
	C	109 30	0.733354
	S	109 30	0.714901
Nebraska	N	100 00	0.673451
	S	99 30	0.656076
New York (Long Island)		74 00	0.654082
North Carolina		79 00	0.577171
North Dakota	N	100 30	0.744133
	S	100 30	0.729383

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STATE	ZONE	CENTRAL LONGITUDE	LATITUDINAL CONSTANT
Ohio	N	82 30	0.656950
	S	82 30	0.634520
Oklahoma	N	98 00	0.590147
	S	98 00	0.567617
Oregon	N	120 30	0.709186
	S	120 30	0.684147
Pennsylvania	N	77 45	0.661540
	S	77 45	0.648793
South Carolina	N	81 00	0.564497
	S	81 00	0.544652
South Dakota	N	100 00	0.707738
	S	100 20	0.689852
Tennessee		86 00	0.585440
Texas	N	101 30	0.579536
	NC	97 30	0.545394
	C	100 20	0.515059
	SC	99 00	0.489913
	S	98 30	0.454007
Utah	N	111 30	0.659355
	C	111 30	0.640579
	S	111 30	0.612687
Virginia	N	78 30	0.624118
	S	78 30	0.606925
Washington	N	120 50	0.744520
	S	120 30	0.726396

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STATE	ZONE	CENTRAL LONGITUDE	LATITUDINAL CONSTANT
West Virginia	N	79 30	0.637773
	S	81 00	0.618195
Wisconsin	N	90 00	0.721371
	C	90 00	0.705577
	S	90 00	0.687103

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TDS

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