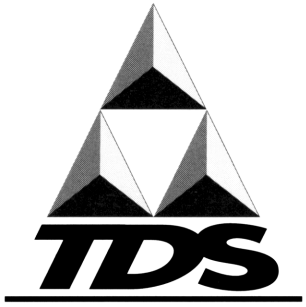

TRIPOD DATA
SYSTEMS, INC.

TDS-48GX

Survey Pro
User's Manual

SURVEY-PRO

Tutorial Manual

For use with the HP-48GX

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1. INTRODUCTION

In this chapter, you will become familiar with the SURVEY-PRO Card; you will install the card in your HP-48GX 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 SURVEY-PRO

SURVEY-PRO is an IC (Integrated Circuit) Card for the HP-48GX Scientific Expandable Handheld Calculator. The program is stored in Read Only Memory (ROM) and therefore has no need for a backup battery. With normal use, the user cannot delete, change or damage the program that is stored on this card.

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

1) SURVEY-PRO 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 SURVEY-PRO 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, you can use TDS's companion TFR software to upload and/or download your coordinates and raw data to or from an office PC. The TFR and TFR-Link™ programs also give you the ability to convert your coordinate data (TFR) and raw data (TFR-Link) into formats that can be used by a wide variety of CO-GO, CAD and other survey- related software.

SYSTEM CONFIGURATION

The minimum configuration required for SURVEY-PRO is the following:

1) 1 HP-48GX Scientific Expandable Calculator.

2) 1 SURVEY-PRO Card.

3) 1 SURVEY-PRO Keyboard Overlay.

4) One of the following:

- TDS 128k-byte GX RAM Card
- TDS 256k-byte GX RAM Card
- TDS 512k-byte GX RAM Card
- TDS 256k-byte Multi-Memory™ Card
- TDS 512k-byte Multi-Memory™ Card
- HP-82215A 128k-byte RAM Card

In addition, if you want to connect SURVEY-PRO to your office PC, you will need:

5) 1 TDS PC to HP-48 cable or HP-82208A opt.1AW Cable.

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

If you want to connect SURVEY-PRO to your electronic total station, you will need:

7) 1 TDS-48 Instrument Cable.

8) 1 TDS-48 Tripod Bracket.

The TDS TFR PC Program will provide for data communication between your PC and SURVEY-PRO. 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's EASY SURVEY Office Software.

INSTALLING THE SURVEY-PRO CARD

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

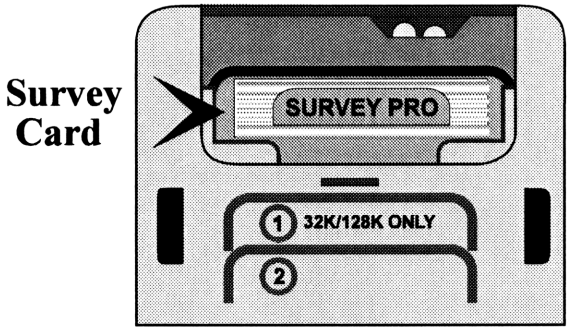
Be certain that you have three AAA alkaline battery cells properly installed in your HP-48GX before you begin the card installation process. If you have no cards plugged into your HP-48GX, you may go to step 3.

Step 1: Turn your HP-48GX OFF: [ON]

Step 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.**

Step 3: Turn your HP-48GX [ON] and then OFF again: [ON].

Step 4: Insert the **SURVEY-PRO Card** into **Port 2** of your HP-48GX. Ports 1 & 2 may be identified by the graphic on the back of the HP-48GX. Cards are installed with the card graphics facing up when the 48 is inverted (keyboard down).

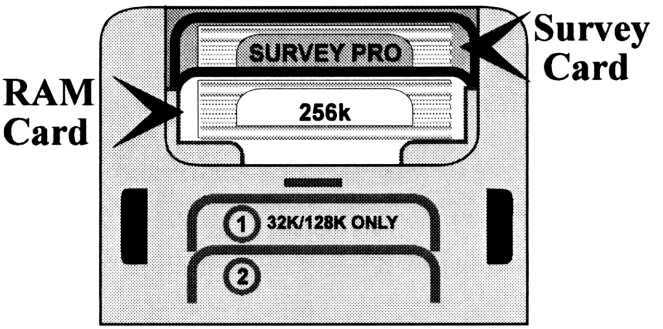


Step 5: Turn the 48 **|ON|** & enter α α **T D S 4 8 |Enter|**.

Step 6: The following messages will appear on the display as the installation is taking place:

"Installing Library"
"Completed"
"Now insert RAM card"

Step 7: When prompted to insert your RAM Card, turn your HP-48GX **OFF** and remove the Surveying Card from Port 2. Insert the **Surveying Card** in port 1 and the **RAM card** in port 2. You should now have the SURVEY-PRO survey card in port 1 and a RAM card in port 2. Turn your 48 **|ON|**.



Step 8: Re-enter α α **T D S 4 8 [Enter]**. SURVEY-PRO should now be properly configured and running.

Step 9: Place the SURVEY-PRO Keyboard Overlay on the HP-48GX's keyboard. The small tabs on the edges of the overlay fit into slots on the keyboard.

You will need to repeat this installation procedure whenever your HP-48GX experiences a memory loss. Perform steps 3 through 8.

Step 10: The first time that you install a RAM card which has not been used previously with SURVEY-PRO, 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 any information. All data stored on this card will be lost when you press **[Y]**. In order for the program to continue you must enter **[Y]**.

Step 11: When you insert a RAM card for the first time, you *may* get a "**WARNING Invalid Card Data**" error message. This is normal. Ignore this error message and proceed with running SURVEY-PRO. 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.

For the remainder of this manual, we will adopt the convention of using the term SURVEY-PRO to refer to the combination of a SURVEY-PRO Card installed in an HP-48GX with a RAM Card.

INTRODUCTION

USE OF SURVEY-PRO CARD WITH TDS MULTI-MEMORY™ RAM CARDS

Hewlett-Packard makes available RAM cards for the 48GX in two sizes, 128k-bytes and 1M-bytes. In addition, TDS has 128k, 256kand 512k RAM Cards. With SURVEY-PRO, you can also use Multi-Memory™ RAM cards from Tripod Data Systems that are made for the HP-48SX. 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.

When used with SURVEY-PRO software, the Multi-Memory™ RAM Cards are the same as other RAM cards. When prompted to insert a RAM card, simply install the Multi-Memory™ RAM Card in port 2 of your HP-48GX. 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.*** For users who have both an HP-48SX and an HP-48GX there is another advantage to the Multi-Memory™ RAM Cards. They can be swapped between the 48GX and the 48SX with full use of the data in both systems. This applies only to the Multi-Memory™ RAM Card and not SURVEY-PRO program ROM cards. The ROM cards can only be used in the 48 for which they were programmed. The following table will help in determining compatible memory cards:

TYPES OF RAM CARDS:	**COMPATIBLE SYSTEMS: (when using the TDS surveying software)**	
128k RAM cards (all manufactures)	**HP-48GX**	**HP-48SX**
256k and 512k Multi-Memory™ RAM cards (TDS)	**HP-48GX**	**HP-48SX**
256K and 512k GX RAM cards (TDS)	**HP-48GX**	

NOTE:

The HP-48SX Multi-Memory™ Card **cannot** be used in the HP-48GX with software other than a TDS program. **The HP-48GX system is only aware of 128k of a Multi-Memory™ RAM Card at any one time.**

**** Caution ****

Any memory card that has data stored on it, from a TDS program, should not be used by any other non TDS HP-48 software. **This will delete all TDS data from the card**. In addition, if you store anything from the HP-48GX system, to a Memory Card that has data stored by the SURVEY-PRO software, **it will clear all TDS data from the card**.

RUNNING SURVEY-PRO

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

When SURVEY-PRO 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-48GX, 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.

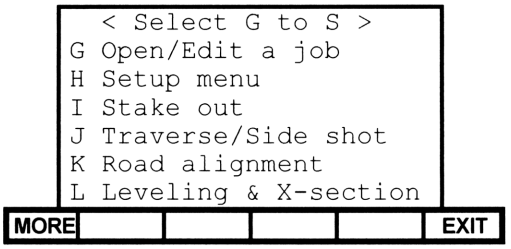
NOTE:

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 *purple* left shift key and is depicted in this manual as it is on the keyboard as |α|. In the standard HP-48GX, 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 HP-48GX in the next chapter: Getting Started.

INTRODUCTION

Now, in alpha mode, type **|T| |D| |S| |4| |8| |ENTER|**.
Use of the **|ENTER|** key will clear alpha mode.

You should now see the Main Menu of SURVEY-PRO.



Once you have activated the SURVEY-PRO software, it will remain in control of the system until you intentionally return to the standard HP-48GX 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 SURVEY-PRO

If you wish to exit from SURVEY-PRO and return control of the system to the standard HP-48GX operating system, press the **|EXIT|** softkey, from the Main Menu. You will be asked "**Exit program? |Y/N|**". Pressing the **|Y|** key will return you the HP-48GX stack; entering **|N|** will return you to SURVEY-PRO's main menu. If you exit the program, you may return by repeating the instructions on running SURVEY-PRO, given in the previous section.

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

MAJOR FUNCTIONS OF THE SURVEY-PRO

INTRODUCTION

In SURVEY-PRO, a number of new functions have been added. The following is a list of the major types of functions in the program:

Job and File Routines:	These are routines that let you create, select and modify the different jobs and support files that are used by the SURVEY-PRO program. They are described in Chapter #2.
Setup or Configuration:	The routines in this section let you change the way the program reacts to your input and the peripherals that it will communicate with. These are described in Chapter #2.
Traverse / Sideshot:	This routine is designed to collect points from the real world as coordinate in the SURVEY-PRO program. Traverse / Sideshot is covered in Chapter #3.
CO-GO, Curve & Triangle:	The Coordinate Geometry and Curve routines let solve for different parameter and properties in the design and laying out of your work. They are illustrated in Chapter #5.
Stakeout:	These routines allow you to position designed coordinates to the real world. Included are a point or radial stakeout routine, a offset to a center line routine, a slope staking routine, a leveling stakeout routine and an X, Y, Z building pad stake routine. They are described in Chapters #6 and #7.
Road Alignment:	This section lets you enter the description of a roadway from the data provided in construction drawings. The Horizontal, Vertical and Cross-sectional profiles are each independently defined. It is described in Chapters #6
Leveling: Building Pad: Cross-Section:	These routines let you: • determine the elevations of real world points. • collect and set points in a simple coordinate system. • collect profile data alone perpendicular cross-sections. They are illustrated in Chapter #7.
Adjustments:	These routines let you Change Scale, Translate, Rotate and perform Closure Adjustments, as described in Chapter #4.
Sun Shot:	This routine lets you determine a bearing from solar observations. It is covered in Chapter #3.

HOW TO LEARN THE SYSTEM AND HOW TO USE THIS MANUAL

The best way to learn SURVEY-PRO System is 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 SURVEY-PRO which has been widely accepted within the surveying community. SURVEY-PRO utilizes a combined "Menu"-and-"Screen" user interface. The user interface makes use of the HP-48GX's "softkeys". These six keys across the top of the keyboard are defined as needed for each job. A one word explanation of each key is always shown on 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 SURVEY-PRO is to go ahead and press some keys. See what happens. You can't hurt the TDS-48GX.

This User's Manual is organized into two major sections. The Tutorial consists of introductory material and a series of examples which teach the various features of SURVEY-PRO system in a step-by-step fashion. The second section consists of a detailed Reference Manual which describes all of the functions of SURVEY-PRO. It is organized by class of function. Having mastered the basic operation of SURVEY-PRO 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.

The Tutorial is designed with three types of users in mind: the user who is already familiar with a TDS data collector product and simply wishes to learn the new features of SURVEY-PRO; the user who wants to spend a limited time learning only the data collection functions and get into the field to use his new tool. This person, of course, is committed to spending his evenings to cover the rest of the field computer features. And, the user who has a desire to be familiar with the entire capability and power of SURVEY-PRO.

Let's address each of these: first the experienced TDS user who has just received his SURVEY-PRO card. You could use SURVEY-PRO just as you used your other TDS data collector but you would miss out on several powerful features that have been added to this new software. Go back to the section in this chapter on the Major Features of the SURVEY-PRO and look at the reference listed for each feature that you are not already familiar with.

For those who need to get out in the field immediately, Study chapters 1,2 and 3 to get an overview of the layout of TDS's software and a introduction to field work. It is strongly recommended that you take the time to complete the remainder of the tutorial as soon as possible so you will be familiar with all the capabilities of your new tool. If you are not aware of all of SURVEY-PRO's capabilities, you will be less likely to use them when the need arises. In addition, if you wait until you are in need of a feature before learning about its function, you are less likely to have the time to learn it.

Lastly, for you who want to learn the whole system, simply run through the entire tutorial. We strongly recommend this approach. The tutorial is set up to be most efficient when used in order from chapter one to the end. However, after the first three chapters, the remainder of the tutorial can be used by chapter in any order you wish.

The tutorial will not cover every screen or routine in SURVEY-PRO; however, it will explain in detail each type of procedure. It will have several examples of CO-GO and curve routines. TDS software products are all very consistent in their layout and use. If you learn one CO-GO calculation, you have a good idea how to use them all. The more you use a part of your product the more familiar you are with that product as a whole. If you are familiar with a routine in one product, you already know how to use that routine in an other product. So dig in and get dirty. Using SURVEY-PRO is the best way to learn it.

For SURVEY-PRO users who find that they would like to maximize the use of their data collector by using a companion software in a PC, Tripod Data Systems offers **Easy Survey**. **Easy Survey** looks and acts as your SURVEY-PRO program would if it ran on a PC. Many of the menus and screens with which you are familiar, are used throughout Easy Survey.

Other new and more powerful functions like automated mapping and contouring, use a menu and screen user interface, which you are already familiar and will find to be instinctively comfortable. You can take a notebook PC to the job site and **see** your work before you leave.

Easy Survey provides real time graphics throughout. When you perform an inverse on two points, a line connecting the two points is drawn on the screen. Perform an area solution and a boundary appears defining the property. If you use automated mapping, the descriptor codes you used when locating points on curb lines, center lines, easements, etc. are automatically drawn as lines, arcs, points, symbols, annotation, etc., by Easy Survey. You can overlay a contour map; perform a Least Squares adjustment; export your graphic map from the display of your monitor as an Autocad DXF drawing file or a MicroStation DGN file; or use your printer or plotter to make a fast and easy hard copy.

If you like the way your SURVEY-PRO card works, you'll find TDS **Easy Survey** is the perfect match on your PC.

2. GETTING STARTED

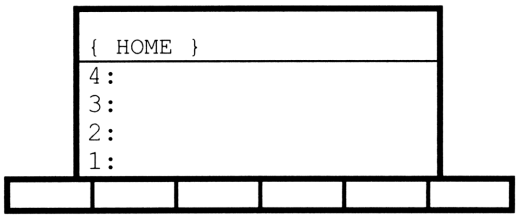
In this chapter, you will start to use your TDS SURVEY PRO. You will initialize the unit by setting the correct time and date and by selecting the various devices with which your SURVEY PRO will communicate. You will learn how the features and functions in the SURVEY PRO are organized and how the various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

BEFORE YOU START

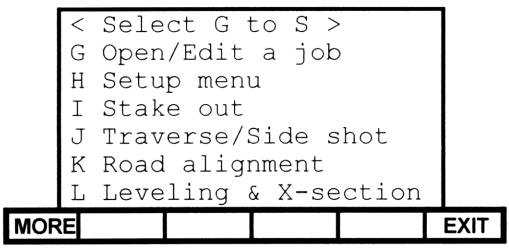
Before you start, you should be certain that you have installed in your HP-48GX your batteries and your SURVEY PRO Card; have initialized the libraries; and, have installed a RAM Card. For installation instructions see Chapter 1 - Introduction.

RUNNING YOUR SURVEY PRO

Now, press the **|ON|** key. You will see the operational stack of the standard HP-48GX operating system displayed as:



Now press **|α| |α| |T| |D| |S| |4| |8| |ENTER|**. The **SURVEY PRO** Card has now taken over control of the machine. You will see the MAIN MENU of the system which looks like:



GETTING STARTED

To turn off the unit, press the  and **|ON|** keys. 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 HP-48GX 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 SURVEY PRO is an intuitive-use software. 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.

MENUS

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. See Main Menu above Except for the **|EXIT|** and **|MORE|** keys, MENUS do not use active "soft" keys. The **|EXIT|** key is always displayed above the **|F|** key on the right. The **|MORE|** key will be labeled above the **|A|** key if there are more menu choices than will fit on one display. 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 SURVEY PRO 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).

If a menu has **|MORE|** displayed above the **|A|** key, there are other choices that can be made from this menu. Pressing the **|MORE|** key will display the remaining options. The **|EXIT|** key will then return you to the original set of options.

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 **|MORE|** from the MAIN MENU and viewing the choices M through S. As you become familiar with the SURVEY PRO, you will learn the frequently used letters in the MAIN MENU. You can 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 SURVEY PRO returns to the previous MENU in the MENU "tree". Finally, you arrive back at the first display of the MAIN MENU.

NOTE:

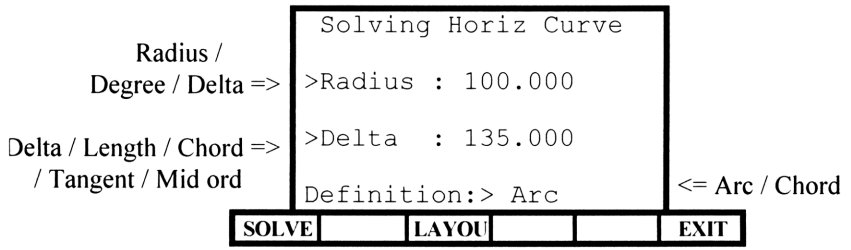
In the HP-48GX, the top row of keys are used for the alpha keys A - F, as well as for the softkeys. For this reason, all Menu labels in SURVEY PRO will begin with the letter **|G|**. Since there is no ambiguity in MENUS between menu selection keys and softkeys, it is *not* necessary to press the **|**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

GETTING STARTED

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. They also have a variety of "soft" key labels at the bottom. These "soft" keys give you choices of one or more functions to perform. **It is in the SCREENS where you will enter your data and solve your surveying problems.** *You don't solve problems* in the MENUS. The MENUS are an aid to help you navigate the various Screens. 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.

The Horizontal Curve Screen appears as:



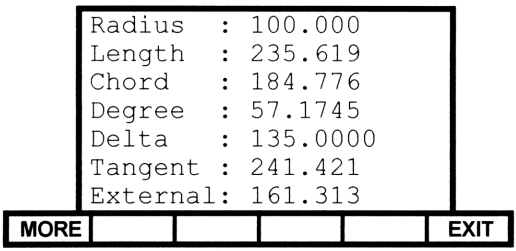
You will use this screen to solve your first problem and, at the same time, learn some very important concepts or *Rules of the Road.* The first has to do with the uses of the vertical cursor keys **|↑|** and **|↓|**. When you first enter this screen, the value of the radius is highlighted by a *scroll 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 **|↓|** key moves the scroll bar down in the screen. When the arrow key moves to the bottom of a screen, scrolling again will wrap to the top of that screen (or from the top to the bottom). 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 screen 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 the curve parameters (solve the curve) for a horizontal curve of 100 ft. radius and a delta angle of 135°.

Step 1: With the scroll bar at the radius line, key in 100. Then, press **|↓|**. (The **|ENTER|** key will also move the scroll bar to the "next" data entry line.)

Step 2: Now, key in 135 at the Delta prompt.

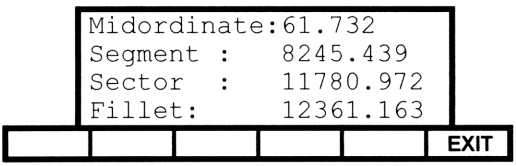
Step 3: Leaving the curve definition as Arc press **|SOLVE|** (softkey **|A|**). The screen will now display the solution curve parameters for the curve you have solved.



NOTE:

All angles in SURVEY PRO 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 **|MORE|** will display the remaining curve parameters:



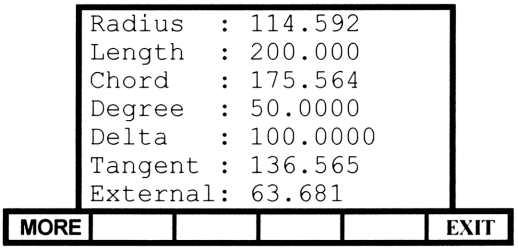
Press **|EXIT|** again to return to the Solving Horizontal Curve Screen.

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 **|→|**.

Step 1: With the scroll bar on the Radius input line, press the **[➔]** key. The prompt will change to "Degree". Key in 50 and press **[↓]** (or **[ENTER]**).

Step 2: Now press **[➔]** multiple times to see the selections for the second curve parameter. With the label on "Length", key in 200. Leave the Definition field as "Arc".

Step 3: Press **[SOLVE]**. The solution screen will display the parameters of this new curve.



Again, pressing **[MORE]** will show you the remaining computed curve parameters:

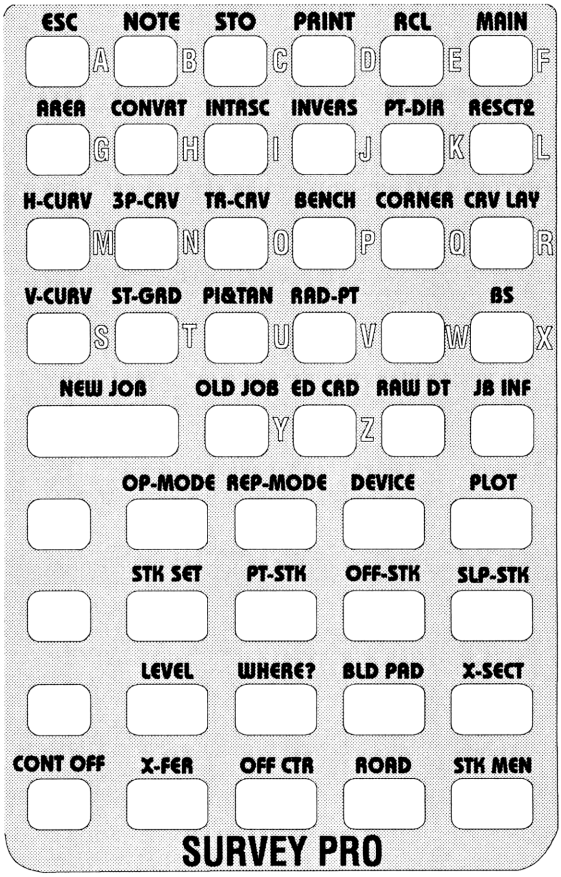
NOTE:

A ">" character in front of any prompt in a CONTRACTOR screen allows you to change the prompt to another option by scrolling through options with the horizontal cursor keys.

THE KEYBOARD OVERLAY

Your SURVEY PRO Card comes with an overlay which you may install on your HP-48GX'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 SURVEY PRO. The overlay also displays the shifted function of each key (in purple) for direct access to many of SURVEY PRO's most-used routines. The overlay appears as shown:

Overlay for SURVEY PRO:



GETTING STARTED

Note that the alpha keys, printed in white, are positioned to the right of the associated key. The **|CONT|** and **|OFF|** functions, printed in purple and green respectively, are positioned above the **|ON|** key with which they are associated. All functions on the overlay can be accessed by pressing the purple or green shift key, and then the appropriate function key. The Top-Row of shifted keys perform a function and return to where you left off. The remainder of the shifted function keys send you to a screen or menu within SURVEY PRO's tree structure. When you **|EXIT|** from that screen, you will return to the screen from which you pressed the direct access key. With the exception of the top row keys, all direct access functions can be accessed from the menu tree in the normal manner. Below is a table listing each Direct Access key used by SURVEY PRO and a simple description of what each does:

Key	Function	Description
A	**ESC**	Escape temporarily from the **SURVEY-PRO** program and return to the main operating system of the HP-48GX. See the **ON** or **CONT** key to return to the SURVEY-PRO
B	**NOTE**	Enter a NOTE in the Raw Data file.
C	**STORE**	Store a value to the Clipboard register.
D	**PRINT**	Print the current screen to an Infrared Printer.
E	**RECALL**	Recall a value from the Clipboard.
F	**MAIN**	Return to the Main Menu from wherever you are in SURVEY-PRO.
G	**AREA**	Compute the area of a parcel of land.
H	**CONVRT**	Convert Azimuths to Bearings or Vertical angle and Slope distance to Horiz. distance and change in elevation.
I	**INTRSC**	Find a point at the intersection of two lines.
J	**INVERS**	Compute the Inverse between two points or a point and a line.
K	**PT-DIR**	Compute the coordinates of a new point by specifying a known point, a direction and distance.
L	**RESCT2**	Determine the coordinates of an unknown occupied point by field measurements (angles and distances) to two known points.
M	**H-CURV**	Solve for the properties of a horizontal curve.
N	**3P-CRV**	Solve for a curve that will pass through three known pts.
O	**TR-CRV**	Include a horizontal curve in a traverse.

P	BENCH	Compute the elevation of the occupied point given the known elevation of the foresight.
Q	CORNER	Compute the angle made by two lines that meet at a common (corner) point.
R	CRV LAY	Will bring up the Curve Layout Menu where you can select the PC & PI Deflections, Tangent & Cord Offsets.
S	V-CURV	Compute the elevations at various stations along a vertical curve.
T	ST-GRD	Solve for the elevation at various stations along a straight grade.
U	PI&TAN	Solve for the PC and PT with known PI, tangents and radius.
V	RAD-PT	Calculate the radius point of a curve with two points and one other parameter known.
W		
X	BS	Modify the backsight angle and circle angle setting.
Y	OLDJOB	Allow you to select an existing job to be opened.
Z	ED CRD	Provide a way to review and edit coordinate data.
ENTER	NEW JOB	Allow for the creation of a new job file.
DEL	RAW DT	Provide a mechanism for reviewing the raw data file.
←	JB INF	Provide for a way of reviewing many of the important parameters of the currently active job.
9	DEVICE	Establish manual input or communication with an electronic total station.
8	REP-MODE	Establish the technique to be used in acquiring angles and distances in your survey.
7	OP-MODE	Set the operating modes.
6	OFF-STK	Stakeout a right-of-way by specifying the station on the center line and offset distance from the center line.
5	PT-STK	Interact with your gun and your rod man to performing a radial stakeout.
4	STK SET	Establish the setup parameters of the offset stakeout.
3	BLD PAD	Will bring up the Building Pad Menu where you can Setup, Survey and Stakeout a building pad.
2	WHERE?	Help the rod man to find the next point relative to his own point of view during a stakeout by point number.

1	LEVEL	Will bring up the Leveling Menu where you can select the Trig., Differential or Stakeout leveling routines.
0	XFER	Transfer your data to or from a PC or Data Collector.
÷	PLOT	View a plot of a block of points in SURVEY-PRO's screen display.
*	SLP-STK	Slope stake a road.
-	X-SECT	Will let you setup and shoot Cross-Sections.
+	STK MEN	Will bring up the Stakeout Menu.
ON	CONT	Return to the SURVEY-PRO program after ESC to the operating system of the HP-48GX.
.	OFF CTR	Will transfer you to the Off Center Shot Menu.
SPC	ROAD	Will bring up the Road Alignment Menu.

TOP-ROW SHIFTED FUNCTION KEYS

The six direct access keys on the top row are in some ways different from the rest of the direct access keys. They perform a specific function rather than bring up a screen or menu. The functions they perform are **[ESC]**, **[NOTE]**, **[STORE]**, **[PRINT]**, **[RECALL]** and **[MAIN]** respectively. These functions are described in more detail below:

[ESC] - ◀ **[A]** The **[ESC]**, Escape, function allows you to escape temporarily from the SURVEY PRO program and return to the main operating system of the HP-48GX. This function will also "bring with it" the value of the field at the current cursor location and loads this value into the HP-48GX 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 SURVEY PRO, 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 required to execute the Escape function are ◀ **[A]**. The details of the operation of 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 SURVEY PRO to the operating system of the 48GX. In addition, the numerical value in the screen at the current 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 SURVEY PRO, press **|CONT|** or ↩ **|ON|**. **|CONT|** is the purple 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:

If you find yourself at the HP-48GX system stack and do not know why or how you got there, you may have inadvertently pressed the **|ESC|** key. Check and see if **HALT** is displayed on the top of the screen. If it is, then press the **|CONT|** or ↩ **|ON|** keys. If **HALT** is not displayed, you must have accidentally **|EXIT**ed| the program; Rerun SURVEY PRO program by entering α α T D S 4 8 and press **|ENTER|**.

|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 date, names of your crew or any other pertinent information, press ↩ **|B|**. You will then be able to key in text information which will be stored in the raw data file as a note.

|STORE| - ↩ **|C|** The **|STORE|** key will take any numeric value from an input field and store it to a temporary register. To save a numeric value, first highlight the field that you want stored and then press the ↩ and **|STORE|** or **|C|** keys. The value can be moved to another field using the **|RECALL|** key (see below). This function is useful in transferring data from one screen to another. However, some values in a screen are display only and therefore you cannot highlight them with the cursor. thus you can't store them to the **|STORE|** register.

|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 SURVEY Pro at any time that you want a hard copy of your work.

|RECALL| -  **|E|** The **|RECALL|** key will copy the numeric value from the register to the currently highlighted input field. To copy a numeric value, first, highlight the field that you want to move it to, then, press the and **|RECALL|** or **|E|** keys.

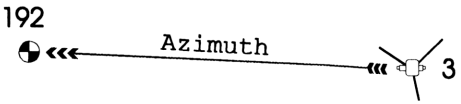
|MAIN| -  **|F|** The **|MAIN|** function will allow you to return to the MAIN MENU from any other menu or screen in SURVEY Pro. It is a shortcut method of returning to the Main Menu "home base" without pressing **|EXIT|** repeatedly as described above.

If you would like to see the complete MENU "tree" for SURVEY Pro and identify the kinds of surveying problems that can be solved with SURVEY Pro, 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.

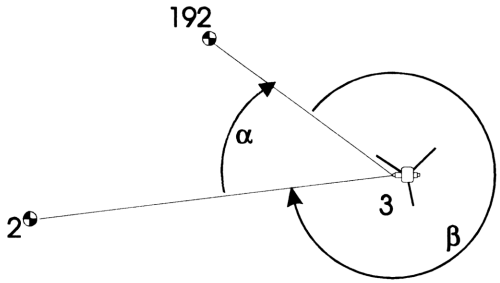
DATA ENTRY TIPS

Throughout the CONTRACTOR program you can use a short-cut method for entering Directions, Angles or Distances. If the highlighted input field is expecting a Direction, Angle or Distance and the desired value is defined by points in your current job, you can enter those points separated by a "-". If in the previous Horizontal Curve Solution example, the radius desired was defined by points 53 and 147 and the delta was defined by 147, 53 and 204 then you could enter "53-147" in the Radius field and "147-53-204" in the Delta field. The CONTRACTOR program will calculate the distance of the radius and the angle of the delta for you.

As an other example, if you need to enter a *slope distance* in the Traverse / Sideshot screen you can either enter the actual value or you can type in the end-points of a line with the desired distance. e.g. 3-192 **[ENTER]**. The program will then compute the slope distance from point 3 to point 192 and enter the value for you. Note that the program is 'smart' enough to know what kind of data is currently needed and will compute that value. If you enter 3-192 in the '*Angle Right*' field, the program will calculate the azimuth from point 3 to point 192 instead of the slope distance.

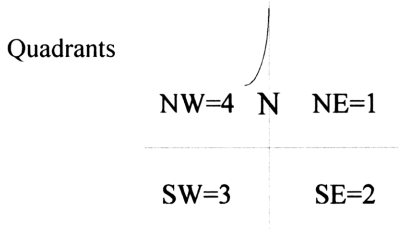


Moreover, when entering angles you can enter 2-3-192. The program will then compute the corner angle right:



α is the angle right with Occupy point 3, Backsight point 2, foresight to point 192. α should be entered as 2-3-192 and 192-3-2 will calculate β.

When entering a bearing, you can press [α] to put the HP-48 in the alpha mode; then, type "N" or "S", the bearing and an "E" or "W". A faster way to enter this is to use quadrants. Type the quadrant number followed by the bearing.



As an example, if you had a bearing of S47.3627W it could be entered as 347.3627; and N47.3627E it could be entered as 147.3627.

When you are prompted for a descriptor you can edit the text interactively. When the prompt first appears, the cursor sits on the first character of the field, and the HP-48 will be in the alpha mode. If you enter text while the cursor is on the first character, the existing descriptor, if there is one, will be removed and the text you enter will be all that is left. On the other hand, if you press the alpha key to take the HP-48 out of alpha mode and then press the [←] or [→] arrow keys, you can scroll within the field. At this point, the text in the descriptor field is fixed. If you scroll to the middle of a descriptor and put the HP-48 back in alpha mode, as you enter a character it will be inserted at that point. All characters to the right will be move one place to the right. You can switch in and out of alpha mode to enter text or use the cursor keys as often as you like.

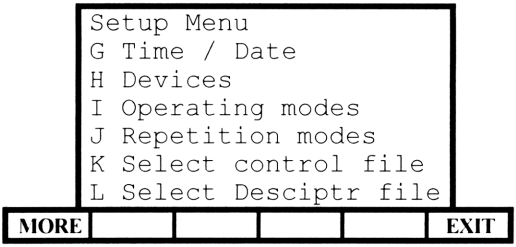
Each of these entry tips will be explained in greater detail via the example in the chapters that follow.

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-48GX is to set up the data collector 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 SURVEY Pro as soon as possible. The present section of the manual will illustrate the use of the menus and screens by taking you through some of the common setup routines. 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 familiar with the way menus and screens in SURVEY Pro interact.

Path:	From the Main Menu, press **[H]** to access the Setup Menu.

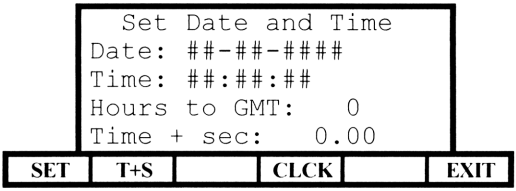
You should now see the Setup Menu which appears as:



SET THE TIME AND DATE

Sooner or later you will need to set the time and date in the machine.

Path:	Press **[G]** and see the Time and Date Screen:

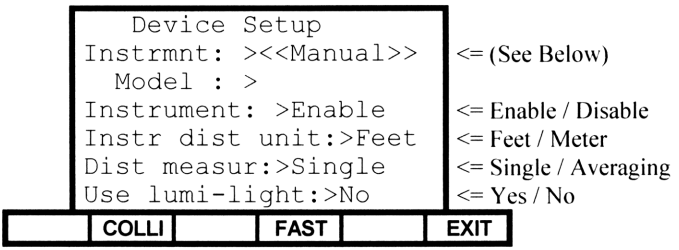


GETTING STARTED

DEVICE SETUP

This is the menu from which you will establish the brand and model of the instrument to which SURVEY Pro will be connected. You can also establish the units used by the total station and measurement mode of the gun; single shot or averaging mode.

Path: From the Setup Menu, press **|H|** and you'll see:



<= (See Below)
<= Enable / Disable
<= Feet / Meter
<= Single / Averaging
<= Yes / No

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 manufacturers that are available. As you scroll the Instrmnt prompt, the model options are also changed. The Model line will be restricted to those particular models that go with the displayed brand of instrument.

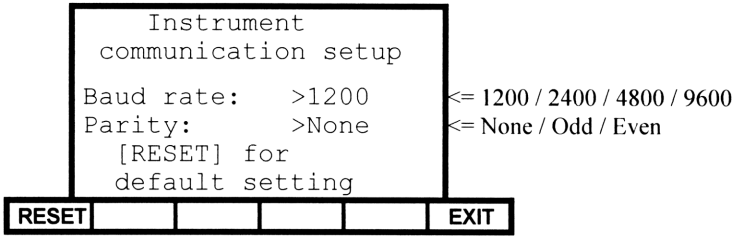
Step 1: With the scroll bar at the instrument line, press **|➔|** repeatedly to see the selections. When you have the proper brand name of total station in the display, press **|🡻|** or **|ENTER|** to move to the Model line.

Step 2: You may now scroll and select the proper model of your brand of total station.

The other lines are for setting the way we interact with your instrument. The Instrument: Enable/Disable lets you switch between the manual mode and an instrument, without losing the instruments settings. The Instr dist unit field will let select the distance units that the CONTRACTOR is expecting from the instrument; either Feet or Meter. The Dist measure set the instrument to either take a Single distance measurement or average several measurements. The Use lumi-light turn

the lumi-light on or off in supported be your instrument. For more information on setting up your instrument see the Reference Manual and Appendix B.

As you press **[EXIT]** to return to the Setup Menu, if you have selected an instrument, the following screen will be displayed:



This screen will let you set the communication parameters for that instrument. The Baud rate is the speed at which the instrument will communication with the data collector, expressed in bytes per second. The Parity is a communication error check that can be set to even, odd, or none. The **[RESET]** key will set the baud rate and parity to there default or factory settings These settings should work with the selected instrument unless the baud rate and/or parity have been changed in the instrument its self..

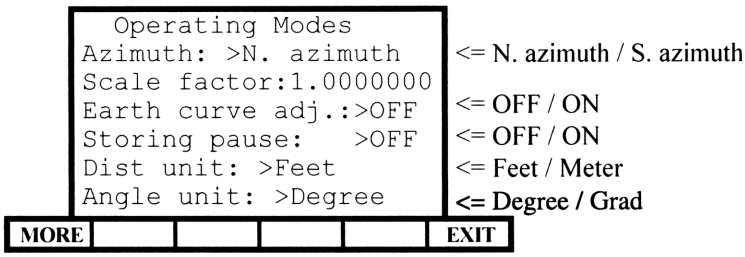
For all the examples in this tutorial you will want the Device Setup to be in the Manual Mode and the Instr dist unit to Feet. After you have returned the Device Setup Screen to these setting, press **[EXIT]** to return to the Setup Menu.

GETTING STARTED

OPERATING MODES

The operating modes screen is used to allow you to establish different conditions that are used in the management of the TDS-48.

Path: From the Setup Menu, press **[I]** and you'll see:



Step 1: Set the Azimuth: This indicates the assumed direction of a zero azimuth, either North or South.

Step 2: In this screen, you can set a Scale factor which is the factor by which all distances entered in the field will be multiplied before coordinate values are computed.

Step 3: Earth curve adjust, when set ON, will include calculations to compensate for earth curvature and refraction in the computation of coordinates.

Step 4: Storing pause, when set ON, will pause and display the computed coordinates as each point is shot.

Step 5: The Distance unit and Angle unit set the units that the internal calculations will use. These can be Feet or Meters and Degrees or Grads. These settings differ from the unit settings in the Device Setup screen in that there they set the unit that the data is collected in. You can set the data collector to any combination you need. e.g. your gun reads in feet but you want it stored in meters.

Step 6: Pressing **[MORE]** will bring up the following screen. Here you can turn your beep on or off; set a switch that determines whether the data collector will prompt you for a rod height after each shot; whether it will prompt you for a descriptor after sideshots; whether a code will be used in selecting a

descriptor form the Descriptor table or whether you will be prompted for occupy and backsight points after opening a new job. We will demonstrate several of these in later examples so set each as in the display below.

```
  OP Modes (cont.)
Beeper:> ON                <= ON / OFF
Prompt for rod Ht:>Yes     <= Yes / No
Prompt for desc.: >Yes     <= Yes / No
Code is used in the
 Descriptor table:>Yes     <= Yes / No
Prompt for setup: >Yes     <= Yes / No
PREV                                EXIT
```

REPETITION MODES

After you have completed the Operating Modes Screen, press **[EXIT]** to return to the Setup Menu. The next screen is the Repetition Modes screen which allows you to set the sequence to be used in acquiring angles and distances in your survey.

Path:	From the Setup Menu, press **[J]** for the Repetition Modes Screen. You can access also this screen from the Traverse/ Side Shot Screen by pressing **[REP]** Repetition Modes Menu and then **[K]**. The following screen is displayed:

```
Horiz angle mode:          Single / Directional /
       >Single             <= Accumulation
Vert angle: >Single        <= Single / Multiple
Dist mode:  >Single        <= Single / Multiple
Number of sets:  0
Angle tol(sec):   0.00
Dist tol(ft)   :   0.00
MORE                                EXIT
```

Step 1: Horizontal angle mode can be set to one of three modes:

- *Single* - a single horizontal angle shot will be taken.
- *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 reading is used as the circle angle for the next backsight; thus, accumulating the readings.

Step 2: Vertical angle may be set as either single or multiple readings to be averaged to determine the vertical or zenith angle for each point.

Step 3: Distance mode may be set to take either single or multiple distances to be averaged in the TDS-48 for each point.

Step 4: 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. If you want to switch to single mode you need only set the number of sets to 0.

Step 5: Angle tol (sec) and Dist. tol (Ft) lets you specify the error among multiple shots that will be tolerated before you are alerted by SURVEY Pro 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.

Step 6: Pressing **[MORE]** will allow you to set the order of the directional repetition shots. The sequence start with a direct to the Backsight then direct to the Foresight. You can select between taking a reverse to the Backsight then to the Foresight or taking a reverse to the Foresight then the Backsight second.

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.

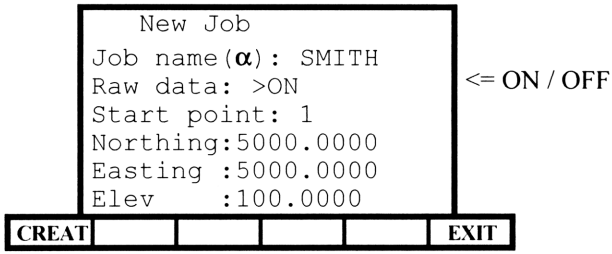
Once your TDS-48GX has been set up, it is not necessary to set it up again unless you want to change one or more of the settings. You may change any of the settings at any time, even in the middle of a surveying job. TO RESET: locate the proper Setup Screen. Change the appropriate setup options. Proceed with the job in progress.

CREATING YOUR FIRST JOB

SURVEY Pro 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. Since you have not established a job in the machine, you must begin by creating a Job.

Path:	Press **[G]** to see the Open/Edit a Job Menu, then press **[G]** again for the New Job Screen.

This will present the New Job screen:



Step 1: The scroll bar is highlighting the Job name field. To enter the Job Name, press the **[α]** once and key in the name of your job. In this example, enter **[S] [M] [I] [T] [H]**. The name may be any combination of up to *eight* alpha, numeric or special characters.

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 HP-48GX into alpha mode. Pressing **[α]** once will lock the keyboard into alpha mode and pressing the purple 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.

You should also realize that you may key in alpha characters in either upper or lower case. SURVEY Pro *will* maintain a distinction between them. For example, if you name this job **SMITH**, SURVEY Pro will treat it as distinct from a job named **Smith**. Care should be taken when using jobs with the same name and only upper or lower case differences. If both files are down-loaded to a PC, they will no longer be unique. *Only* the second one down loaded will exist on the PC.

Step 2: As you work in the field, SURVEY Pro 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 SURVEY Pro under the job name you have set up; in this case, SMITH. However, you also have the option of having your TDS-48GX record your raw data. If you would like SURVEY Pro to record your raw data, just move the scroll bar past the raw data line of the display, leaving it as **ON**. If you don't want 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**.

The coordinates and the raw data are actually stored in different parts of the HP-48GX'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 edited or modified in the field (only **deleted** *in full* if **RAW DATA** is turned **OFF**). Once a field measurement is taken, the raw data record is updated with the measurement. It may not be altered in the HP-48GX.

Because of this, it is 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.

Step 3: 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 positive integer. This number will also become the smallest point number that SURVEY Pro 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 smallest point number in this field.**

Step 4: 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.

Step 5: When a coordinate point is stored, a descriptor or note of up to sixteen characters may be saved with it. The default descriptor for the starting point is "START".

Step 6: Once you have the New Job screen properly configured, press **|CREAT|**. This command instructs SURVEY Pro to create the SMITH job as you have specified it in the screen.

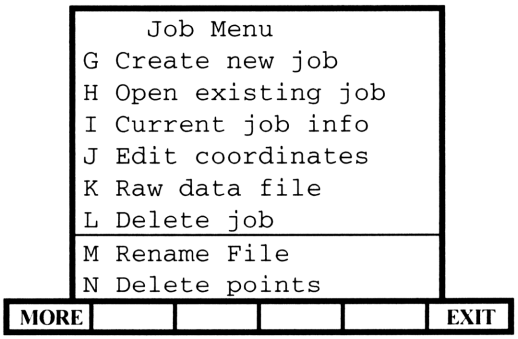
This is another general *"rule of the road"* . While you are moving the scroll bar around the screen keying in information in response to prompts, SURVEY Pro does not take any direct action. If you make a mistake, you may reposition the scroll bar over the erroneous entry and key in the correct information. SURVEY Pro 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|**, SURVEY Pro will establish the job SMITH. SURVEY Pro will display the Current Job Info Screen so that you may review the status of the current job. When you setup the Operating Modes there was a setting called "Prompt for setup". If this setting was set to **Yes**, then as you press **|EXIT|** from this screen you will be asked if "you wish to step through all setups?" We have already covered these parameters or will discuss then in a later chapter so press **|NO|** or **|F|** to return to the Jobs Menu.

If you have set the Operating Modes field, Prompt for Setup, to yes then as you **[EXIT]** the Current Job screen you will be asked if "you wish to step through all setups?" If you select YES the Operating Mode, Device Setup, and Backsight Setup Screen will be displayed for changing any parameters including the Occupy and Backsight points and HI. When you have entered a Backsight, Occupy Pt and HI and pressed **[SOLVE]** you are ready to traverse.

OTHER JOB RELATED FUNCTIONS

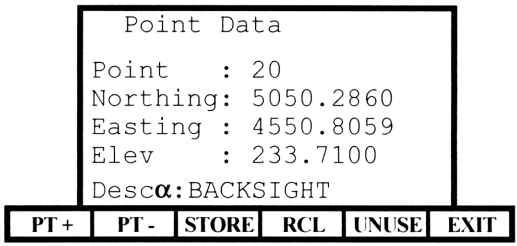
Within the Job Menu there is the ability to handle a number of other job file related tasks.



The number of jobs that you can store in your TDS-48GX 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] Open existing job** key from the Jobs Menu.

You have seen the **Current job info** screen already, after you created the Smith job. By pressing **[I] Current job info** you can recall this screen to view information about the current job.

At this time, let us enter a second set of coordinates for practice. Press **|J| Edit coordinates** from the Jobs Menu. You will see the coordinates for point 1 of the SMITH job that you established earlier. Lets create a point 20:



Enter "20" in the Point: field for point number 20 and press **|ENTER|**. Now input "5050.2860" as the Northing; "4550.8059" as the Easting and "233.71" as the Elevation, pressing **|ENTER|** between each field entry. Enter "BACKSIGHT" as a descriptor. The screen should be filled out as displayed above. Now, press **|STORE|** to generate point 20 in our SMITH job. A warning is displayed:

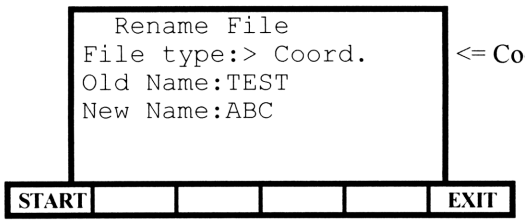
```
11pts passed EOF
Expand File?
```

Press **|YES|** or **|A|** to allow space for point between 1 and 20.

The **|K| Raw data file** option brings up a menu that allows you to view Raw Data and create (turn on) or delete (turn off) Raw Data.

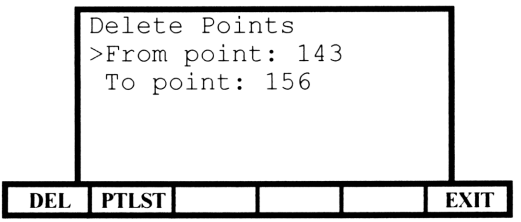
The **|L| Delete job** lets you select the file to delete.

The **[M] Rename File** selection lets you rename a file. The first line prompts for the type of file. When a CR5 file type is selected, rename will change the file name of both the CR5 (coordinate file) and RW5 (raw data file), if there is one, for the job named. The next two lines prompt for, the job to be renamed and the name it is to be changed to (See below).



<= Coord / PtLst / Text

The **[N] Delete points,** lets you delete a group of points. The array of points can either be a range of sequential points entered with a starting and an ending point (see Below) or you can define a set of non-sequential points using a Point List. A Point List is a special file where you enter a list of points to be used by one of TDS-48's functions. We will discuss the use of Point Lists more in a later chapter.



The **[O] Descriptor File** menu**,** allows you to select, view, create, deselect or delete a descriptor file.

The **[P] Show Directory,** lets you display all files stored in the SURVEY-PRO.

3. SURVEY FIELD WORK

The first section of this chapter is designed to introduce you to the use of SURVEY-PRO as a data collector. We will discuss in a general way how to collect data using SURVEY-PRO. Then, you will survey the SMITH job in several ways using manual input. You will perform a boundary survey with single and repetitively observed points. You will learn how to do resections in the field. You will see how a topographic survey can be done with SURVEY-PRO. This chapter also covers the field use of SURVEY-PRO in doing sunshots.

INTRODUCTION

This chapter is designed as a introduction to the field use of SURVEY-PRO. It assumes that you understand and have a working knowledge of your particular total station. This Manual will cover how to use SURVEY-PRO to collect data from a total station in a general way. The specific button to press on your total station to perform an operation, like zeroing the circle, is left up to you to determine. We will try to mention any difficulties or special differences a total station may have, but you should be familiar with the operation of you instrument. (See Appendix B)

In this first section, we will discuss field work with a data collector, in a general way. Without going into detail we will look at collecting data for a topo or traverse and radial stakeout for setting design points. Then, in the sections that follow we will review in greater detail, examples of each of the above. Due to the inability to perform different field exercises and still have uniform data, the examples in this section will be entered manually. We will try to tell you how manual entry will differ from the actual field work, but the data entry for the examples is designed to be done in the office.

This chapter is also a first introduction to field work. When you are familiar with the functions covered in this chapter, there are advanced field work chapters which cover auto linework and the stakeout routines. For your convenience, the chapters that follow this introduction to field work are designed to be stand-alone tutorials. They are used most efficiently when carried out in order, but you can review those that are of interest in any order. We recommend that you examine all the chapters in this Manual so you become familiar with all the capabilities of the SURVEY-PRO field computer.

QUICK START: an Overview of FIELD WORK

There are a couple of concepts related to the use of SURVEY-PRO that you should be aware of. First, SURVEY-PRO is a 3-dimensional, coordinate geometry field computer with data collection capabilities. It has the option of storing or not storing Raw Data, but it always stores the coordinate data. This gives you the ability to perform various calculations and layout design in the field. This is important to understand: you can turn off raw data, but you cannot turn off coordinate data. In addition, you cannot turn off elevations.

Second, when entering field data manually you have a number of optional formats in which the data can be entered; e.g. Angle right or left; Azimuth or Bearing; Deflection right or left;. Zenith or Vertical angle and Slope distance or Horizontal distance and Change in elevation. But, when gathering data from a total station, the instrument must be sending and the data collector set to receive, Horizontal angle, Zenith angle and Slope distance. With modern surveying equipment, this is the form that the field data is originally observed in and is manipulated from there. Collecting this data gives the data collector the greatest accuracy and flexibility.

Data Collection

When beginning a traverse, topo or any field data collection the setup is the same. The first thing we need to establish is an occupied point. The coordinates for this point must be in the current job of the data collector. They can be assumed coordinates, a bench mark, calculated from an adjacent job or arrived at from any other source you may have. SURVEY-PRO will support a control file which contains reference points that can be occupied or back-sighted. We will discuss more about this toward the end of this chapter. If the point you wish to occupy is not in the current job, you need to go to the Edit coordinate screen; **|ED CRD|** or  & **|Z|**; and enter it. Any point in the current job can be an occupied point.

If you have two or more points in your job file but you do not want to occupy any of them, you can set up your instrument on a convenient point and determine the coordinates of your occupied point using the 2-pt or-3 pt resection routine (**|RESCT2| |L|** or **|RESCT3| |R|**).

Also, if you have assumed an elevation for your occupied point and have a bench mark or other known elevation in sight, you can use the Benchmark routine **|BENCH|** or ↵ & **|P|** to adjust the elevation of your currently occupied point. We will discuss each of these in detail later in this chapter.

The second reference we need is a backsight direction. This can be in the form of an azimuth, bearing or a second point stored in the job file. Due to the fact that SURVEY-PRO collects a relative angle in the horizontal plane, angle right, you must specify a backsight direction. You can approximate or assume a backsight direction or you can use the sun shot routine to establish an accurate backsight. In the scenarios below, we will describe three different possibilities for defining a backsight.

Scenario:	**Solution:**
You have found two points on your lot and know the azimuth between them. But, you do not have coordinates for either.	Occupy one of them with assumed coordinates. Enter the azimuth between them as the backsight. Sight the other point and zero your instrument. Frequently, you may want to shoot the backsight point as your first foresight point so that you have coordinates for it. Simply proceed as explained above and take a shot at the backsight as the first foresight. The Angle right will be zero.
You have one point established on your lot but you know the azimuth to an observable reference.	Again, simply occupy your known point and enter the azimuth in the backsight. Sight the reference and zero your instrument. At this point you turn to your foresight and you are ready to shoot.

Scenario:	Solution:
You have only one known point on this job.	Here you have several options. One, you can simply assume an azimuth for the backsight and rotate the job at a later time when you have determined its orientation. Secondly, you could approximate a backsight and again rotate later. Or you can use the sun shot routine to determine an azimuth.

The foresight simply needs a point number under which it will be stored for future reference. At this point, you should also enter the height of instrument. The height of rod and descriptor can be entered now or after you fire the instrument depending on how you set up your data collector.

Now, with this overview, typically you would set up on the occupied point and sight your backsight. Enter your backsight; then, zero your instrument on the backsight; and, turn to the foresight. With your instrument sighted on your foresight, you simply press **[SIDES]** (the **[A]** key) or **[TRAV]** (**[D]**) to fire your instrument and download your data to SURVEY-PRO. (Some instruments require a key to be pressed on the total station. If this is the case with your instrument, you will be prompted to press a key on your instrument. Simply follow the prompts.)

The **[TRAV]** key expects that you will be occupying your present foresight before taking another shot. It will set the OC, FS and BS point numbers accordingly. The **[SIDES]** key, on the other hand, will only increment the foresight. As you traverse, if you use your immediately preceding occupied point as a backsight, the data collector will calculate the backsight direction for you.

If you cannot easily zero your instrument on the backsight or if you want to orient your instrument to a true azimuth, you need to enter a backsight circle before turning to your foresight. Press **|BACK|** or **|C|** to move to the backsight screen and enter the backsight direction or point number as you normally would. Then, while pointing at your backsight, enter the circle reading of the instrument or press **|CIRCL|** or **|E|** to electronically download the circle reading from the instrument. You then, proceed with the process of taking a foresight as you would normally. When a shot is taken, SURVEY-PRO will subtract the BS circle from the circle reading sent by the instrument, resulting in an angle right.

SURVEY-PRO has the ability to adapt to the way you do surveying in several modes. The device setup, lets you specify your particular instrument and its distance and angle units. The operation modes setup allows you to specify the distance and angle units to be used in the data collector and several other parameters modifying the interaction between you and the data collector. The Repetition Modes screen and **|REP|** or **|B|** key in the Traverse/Sideshot screen let you set the type and number of repetitions you wish to take in obtaining a foresight. In the Traverse/Sideshot screen, the **|OFFCT|** or **|E|** key lets you pick from a selection of Off Center routines. These routines permit you to take foresight shots to point where you cannot set a rod.

Stakeout

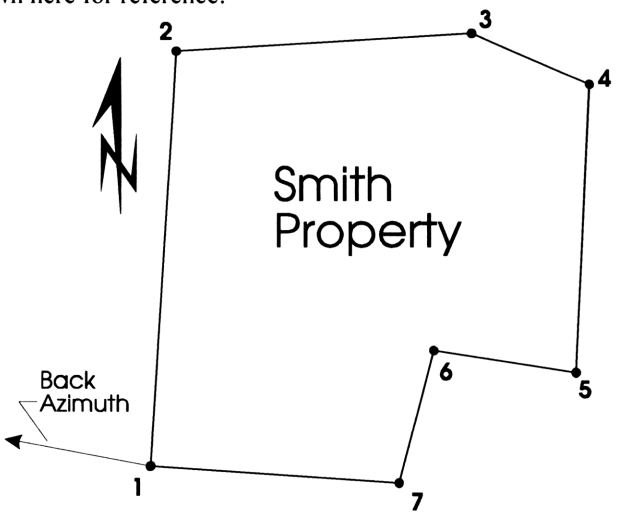
When setting up for a stakeout, the requirements are nearly the same as for data collection. You need an occupied point, a backsight direction (or point), and a foresight point number. The only real setup difference is that you need coordinates for each foresight stored in the current job. With stakeout, you setup on the occupied point; turn to the backsight; and, zero your instrument. At this point, SURVEY-PRO will tell you the circle angle to turn to and how far out your rod man should go. With the rod placed at an approximation of this point you can shoot this point as many times as necessary to close in on the exact point. Between each shot, you are given a come or go distance that the rod man needs to move in order to zero in on the point to be staked.

TRAVERSING THE BOUNDARY OF THE SMITH PROPERTY

The remainder of this chapter covers several examples of the use of SURVEY-PRO in the field. As with other sections of this Manual, the general approach is to cover some basic material and deal with both the theory of the operation of SURVEY-PRO and its practice. It is presumed 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 actual use of SURVEY-PRO in the field, you would collect angle and distance data automatically from your electronic total station. Where appropriate, differences in procedure are presented in this chapter.

You are now somewhat familiar with SURVEY-PRO. You have the unit set up for your equipment and methods of surveying. It's time to get started by working 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.

Your first task is to perform a boundary survey of the Smith property, a plot that you will work with throughout this Manual. A sketch of the property is shown here for reference:



You begin by setting your instrument 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: (You will traverse the last three points using multiple horizontal angles.)

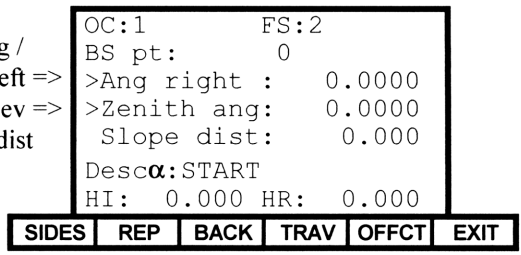
Back Sight [BS]	Occupied Point [OC]	Fore Sight [FS]	Height of Instru. [HI]	Height of Rod [HR]	Horizontal Angle (angle right) [HA]	Zenith Angle [ZA]	Slope Dist. [SD]	Note
0*	1	2	5.32	6.0	86.5412	89.4050	711.42	PT 2
1	2	3	5.43	6.0	262.5448	89.3236	457.76	PT 3
2	3	4	5.40	6.0	208.5710	89.1803	201.31	PT 4
3	4	5	5.39	6.0	247.1657	88.5235	497.13	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.

Path:	From the Main Menu, press **[J] Traverse/Sideshot** Screen.

Ang right / Azimuth / Bearing /
Ang left / Def right /Def left =>
Zenith ang / Vert ang / Chng elev =>
Slope dist / Slope dist / Horiz dist



This screen is designed for you to key in your data directly from your field notes or collect data from an instrument.

NOTE:

If you have your TDS-48 set up to communicate with a total station, you should disable this automatic mode by selecting **|DEVICE|** or **|9|** for the Device setup screen; then use the horizontal cursor keys to adjust the Instrument scrolling prompt to **<<MANUAL>>**. This will allow you to enter your field data manually.

Step 1: To begin: from the Traverse/Sideshot Screen, set the occupied point (OC) as 1; the foresight point (FS) as 2; and press the **|BACK|** key. This will allow you to set the back azimuth for your first shot. Fill out the Backsight azimuth with 276.2315 and press **|SOLVE|.** You will be prompted for a new HI and the Screen will appear as:

BS point / BS azm / BS brg =>

```
   Backsight
>BS azm:  276.2315
 BS Circle reading
  of gun:  0.0000
Occupy pt:  1
HI:  0.000
BS Azm:   276.2315
```

SOLVE	CHECK		FAST	CIRCLE	EXIT

The HI (height of instrument) and Occupy point can be entered in either this or the Traverse / Sideshot screens)

NOTE:

Remember to use the **|←|** or **|→|** key to change the first line prompt to "BS azm" before keying in the back azimuth. The BS Circle field, is the horizontal circle (angle) reading in the instrument while sighting on the backsight. This is customarily zero, but may be any value. **In this example, it should always be 0.**

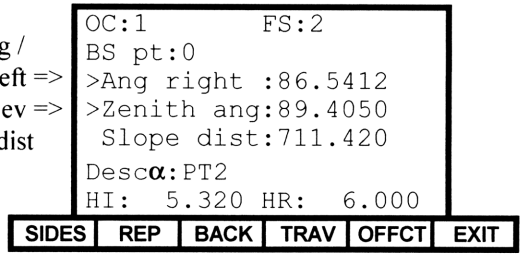
Step 2: Pressing **|EXIT|** will return you to the Traverse / Sideshot Screen. Finish filling out this screen with:

- **Angle Right: 86.5412**
- **Zenith Angle: 89.4050**
- **Slope Distance: 711.420**
- **Desc: PT2**
- **HI: 5.320**
- **HR: 6.000**

taken from the table above.

The screen should be filled out as show below:

Ang right / Azimuth / Bearing /
Ang left / Def right /Def left =>
Zenith ang / Vert ang / Chng elev =>
Slope dist / Slope dist / Horiz dist



Step 3: Press **|TRAV|** to take this shot.

If you were collecting data electronically, you would be prompted for a descriptor. At this prompt, suppose "START" is in the display. If you simply enter "PT2", "START" would first be removed and you would be left with only "PT2".

If you have set the Prompt for HR to ON (in Operating mode screen) you would also be prompted for the rod height.

When you press **|TRAV|** key, the SURVEY-PRO does several things. First, it computes the coordinates of your foresight point; in this case, point 2. If you have the "storing pause" set to "ON" in the Operating Modes Screen of the Setup Menu, the SURVEY-PRO will also display the coordinates for you.

Next, SURVEY-PRO 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 increment the occupied point and foresight point and set the backsight point to be the old occupied point. The result: OC=2; FS=3 and BS=1. 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 **|BACK|** key. You need to use the **|BACK|** 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. SURVEY-PRO assumes that this is the continuing 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 instrument selected in the Setup Screen, SURVEY-PRO will collect the angles and distance before computing the coordinates and doing the other functions listed above. In this mode, SURVEY-PRO will prompt you to key in the point descriptor after the instrument has taken the shot, but before the coordinates are computed and stored. Depending on the settings in your data collector, SURVEY-PRO can prompt for the rod height as well.

Step 4: Fill out the Traverse \ Sideshot screen for the next point. The data for point 3 should appear as shown below prior to pressing **|TRAV|**. Again you will be prompted for the HI.

```
OC:2          FS:3
BS pt:1
>Ang right  :262.5448
>Zenith ang:89.3236
 Slope dist:457.760
Descα:PT3
HI:5.43      HR:6.000
```

SIDES	REP	BACK	TRAV	OFFCT	EXIT

NOTE:

From the standpoint of SURVEY-PRO, 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.

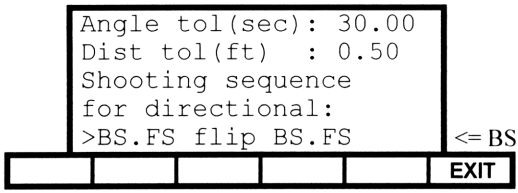
Step 5: In the same manner, you should enter the data from the table for the next two corners into the SMITH job file. This will complete FS points 2 to 5. The last three traverse points will be entered using multiple readings.

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. SURVEY-PRO will automatically do this for you, using one of the several averaging techniques. The techniques supported include averaging direct and reversed horizontal angles (Directional); accumulated horizontal angles or windings (Accumulation); direct and reversed zenith angles; and multiple distances. These techniques may be used in combination with each other. If you are connected to an electronic total station in the field, SURVEY-PRO will prompt you with the proper field procedure. It will also trigger the instrument to take the appropriate readings at the proper time. To illustrate the techniques for taking multiple readings, let's finish the Smith job using directional multiple readings.

Step 1: Before taking repetitive shots there is some set up that should be done. You can use the Repetition Mode Screen accessed from the Setup Menu but let us go to the Traverse / Sideshot screen, then press [REP] or [B] key and then [I] Set Rep. mode. This screen is used to set the tolerance and order of your repetitive shots. You will employ a 30-second tolerance between angle readings. The distance error (tolerance) is immaterial because you will only use one distance reading for each point.

The Shooting sequence lets you set the order that the directional horizontal angle shots will be taken. With both settings you take a backsight direct, then the foresight direct and flop the scope. As you take the reverse shots, you can select between taking the backsight first or the foresight first. So the options are: BS direct, FS direct, flop the scope and then BS reverse, FS reverse; or BS direct, FS direct, flop the scope and then FS reverse, BS reverse. The screen should now appear as:



Step 2: **[EXIT]** back to the TR/SS Repetition menu. To setup the directional method of recording horizontal angles press **[G] Repetition Shots**. You will be taking a direct shot at the backsight then the foresight, and then a reverse shot at the backsight then the foresight. Altogether these shots constitute one set. Therefore, enter "1" in the Number of Sets field. Next set the Horiz field to read "Directional" and not "Single" or "Accumulation". The last two lines should read "Single". The screen should now appear as:

```
   Repetition Shots
Number of sets: 1
OC:5        FS:6
HI:5.35     HR:6.000
Horiz: >Directional   <= Single / Directional / Accumulation
Vert angle: >Single   <= Single / Multiple
Dist mode:  >Single   <= Single / Multiple
```

SIDES	HA	ZE	TRAV	SD	EXIT

The last half of the field observations with multiple angles is shown in the table below. Let us take the rest of the traverse shots from this table in order to understand how SURVEY-PRO works with multiple readings.

Back Sight Obser. [BS]	Occu -pied Point [OC]	Fore Sight [FS]	Height of Instru. [HI]	Height of Rod [HR]	Horizontal Angle (angle right) [HA]	Zenith Angle [ZA]	Slope Dist. [SD]	Note
0	5	6	5.35	6.0	277.4835	90.2926	223.98	PT 6
180.0012					97.4854			
0	6	7	5.40	6.0	92.4143	90.2746	233.88	PT 7
180.0009					272.4144			
0	7	8	5.42	6.0	261.2756	91.4405	387.25	Close
179.5946					81.2748			to PT 1

Step 2: Now, you are ready to take point 6. Before pressing **[TRAV]**, for each shot, you only need to enter the OC, FS points and the HR. The multiple reading routine will prompt you for the Angle right, Zenith angle, Slope Distance and HI in the proper sequence. Now, press **[TRAV]** and enter the data as you are prompted.

The sequence is important. In the field and using your total station to gather the data automatically, the instrument has to be turned and/or flopped during the gathering of multiple data. Key in the required information in response to the prompts.

Step 3: You are first prompted for the direct backsight:

BS DIR 1:

Enter "0".

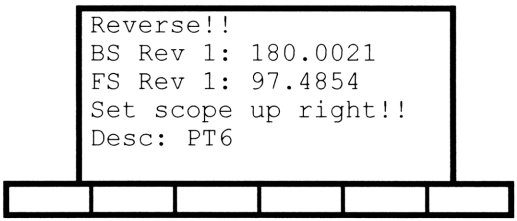
Step 4: Next, you enter the three foresight measurements in the direct orientation:

BS DIR 1: 0
FS DIR 1:
Hit a key when ready.
Slope dist: 223.98 [ENTER]
Horiz ang: 277.4835 [ENTER]
Zenith ang: 90.2926 [ENTER]

Step 5: The screen will clear and you enter the reverse orientation measurements:

Reverse!!
BS Rev 1: 180.0012 [ENTER]
FS Rev 1:
Horiz ang: 97.4854 [ENTER]

Step 6: At this time, you will be prompted for a descriptor and a default of "PT5" is displayed. Let us edit this default descriptor. Press the **|α|** key to turn off the alpha mode; use the **|➔|** to scroll to the "5". Now, press **|α|** to return to alpha and enter "6" and the **|Del|** key to remove the "5". You have edited the descriptor.



Step 7: Prior to pressing **|ENTER|** after the descriptor, the screen should appear as shown above. At this point, the two angle-rights are averaged and point 6 is stored.

NOTE:

If you were connected to an electronic total station, the multiple angles and distances would again be collected automatically. However, the prompts are similar to the above example in order to inform you as to when to flip your scope.

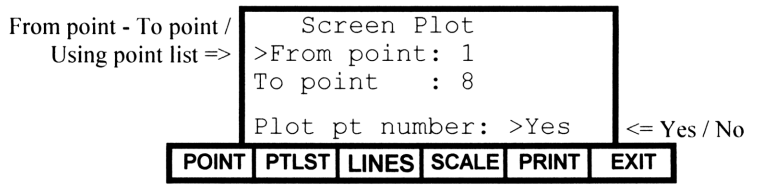
FIELD WORK

Step 8: Continue entering the remaining two shots. The repetition routine will prompt you for all the data that is needed. You will not need to enter anything in the Traverse / Sideshot screen. When you come to the last (closing) shot, SURVEY-PRO 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 SURVEY-PRO 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.

SCREEN GRAPHICS

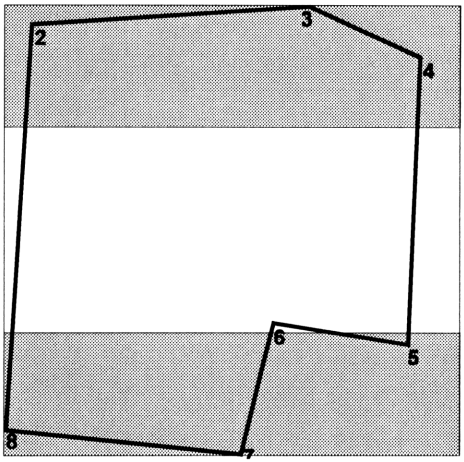
At this point, you may wonder if those coordinates resemble the SMITH property. One way to tell is to look at these coordinates and try to figure out where they are in relation to the corners of the Smith property. However, there's an easier and faster way. You can use the Screen Plot capability of SURVEY-PRO to show the points of the SMITH job graphically in the display.

Path: From where you are, press **[PLOT]** or ↩ **[÷]** for the Screen Plot Screen. It is shown below:



Step 1: Specify points from point 1 to point 8.

Step 2: Then press **[LINES]**.



Use the **|↑|** and **|↓|** keys to scroll to the "hidden" portions of the plot.

Step 3: You should now see a partial plot of the SMITH job in the display. Use the **|↓|** and **|↑|** keys to view the rest of the plot.

Step 4: Press the **[ON]** key to return to the Screen Plot Screen.

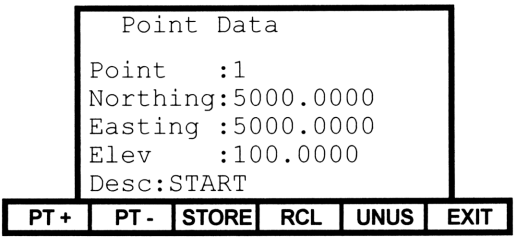
The Plot pt number field allows you to turn ON or OFF, the plotting of point numbers . You may also want to see what happens when you press **[POINT]**.

NOTE:

The first time that you do a screen plot after you have opened a job, SURVEY-PRO will automatically set the scale for all screen plots for that job. SURVEY-PRO 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. If you subsequently add new points that enlarge the area of your plot, 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 re-compute the scale and location of the plotted points based upon the *new* group of selected points.

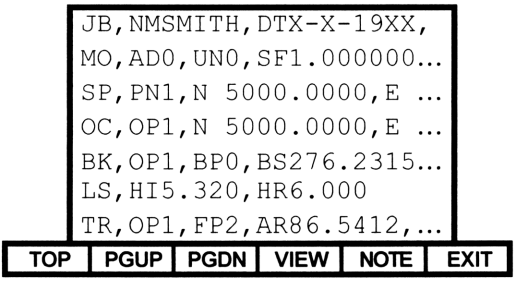
VIEW COORDINATE AND RAW DATA

As you learned, in Chapter 2, you can view your coordinates in the Edit coordinate screen ([ED CRD] or [↵] [Z]). The screen for point 1 is displayed below:



You can use the **|PT +|** and **|PT -|** keys to review coordinates.

At this time, you may wish to see how SURVEY-PRO has stored your raw data. Press **|RAW DT|** [↵] **|DEL|** and then **|G| View R. 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 removed, 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 from Tripod Data Systems, the codes will be decoded automatically. The raw data printout will then be much less cryptic.

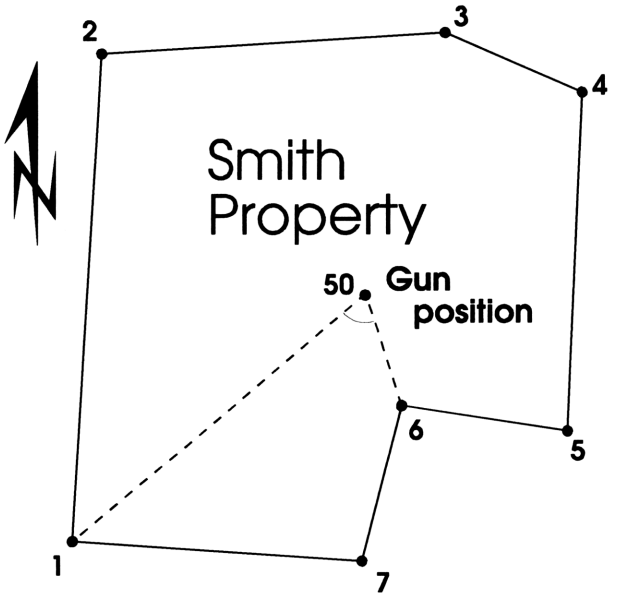
If you would like to add arbitrary text information to your raw data file in the form of a note, press **[NOTE]**. You may also add notes to the raw data file from any other screen in SURVEY-PRO by pressing the global note function **[NOTE]** or  **[B]**. The raw data file is a sequentially stored file. When any data, including a Note, is added, it is appended to the end. You cannot insert a note into the middle of a raw data file.

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 instrument to a position near the center of the property from which you have a good line of sight to the rest of the parcel. In this section, you will learn to establish the coordinates of the new instrument position using a two-point resection technique. To learn about the Three-Point Resection screen, consult the appropriate section in the Reference Manual.

Let us call this new (unknown) instrument position *point 50.* The two point resection requires the rod man to move to two appropriate points that have known coordinates in the SMITH 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, SURVEY-PRO can determine the coordinates of the instrument position and store this information in the SMITH coordinate file. The figure below depicts the situation.

FIELD WORK



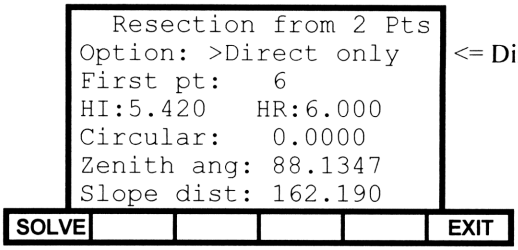
The field notes for this resection problem are shown in the table below:

Back Sight [BS]	Occupied Point [OC]	Fore Sight [FS]	Height of Instru. [HI]	Height of Rod [HR]	Horizontal Angle (circular) [HA]	Zenith Angle [ZA]	Slope Dist. [SD]	Note
6	50	6	5.42	6.0	0.0000	88.1347	162.19	PT 6
6	50	1	5.42	6.0	74.1810	91.0713	498.91	PT 1

This data is entered in the Two-Point Resection screen.

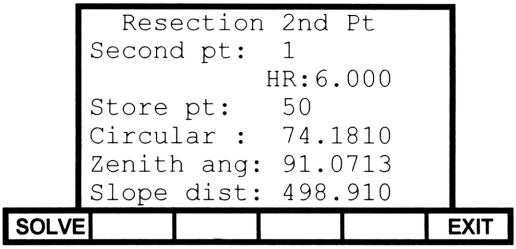
Path:	Press the direct access key **|RESCT2|** or ↵ **|L|**. As with all direct access keys, it can also be found from the Main Menu; then **|M| CO-GO menu;** and, then **|L| Resect (2P)**.

Step 1: Enter the data for this example as shown in the screen below:



<= Direct & Rev / Direct only

Step 2: Press **[SOLVE]** and SURVEY-PRO will go on to the second point. The next screen will appear. Fill it out as shown below:



Step 3: Again, press **[SOLVE]** from this screen. SURVEY-PRO will compute the coordinates of the new instrument position: point 50. It will also compute the horizontal distance between the two known points calculated in this resection. It will compare this distance with the distance between these points as determined from the known coordinates of these points stored in the SMITH coordinate file: points 6 and 1. This measurement is expressed as a precision number for the resection. In this example, the precision of the resection to establish point 50 is reported as 191,199, which is approximately 1 in 191,199. You are prompted for a descriptor for the new point.

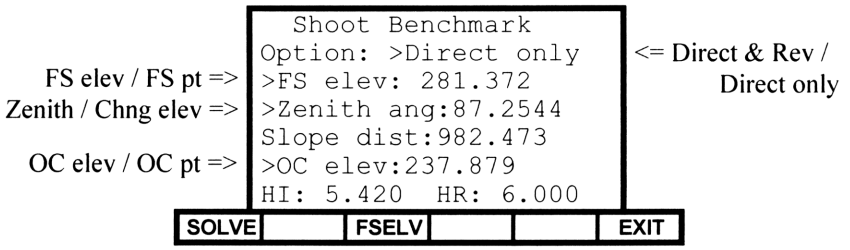
NOTE:

As in the Traverse/Sideshot Screen, if you are connected to an electronic total station, pressing **[SHOT]** from each Resection Screen will trigger the total station to take the measurements. The data will be automatically loaded into the SURVEY-PRO.

BENCHMARK

Since doing the boundary traverse, you have found a benchmark from which we can establish our true elevation. Before you begin the topo, you will want to have an accurate elevation for your occupied point. The Benchmark routine allows us to compute the elevation of an occupied point from the elevation of a foresighted point.

Path: Press the direct access key, **[BENCH]** or ↵ **[P]**. Or, from the Main Menu; press **[M] CO-GO;** then, **[O] Benchmark.**



Step 1: Fill out the screen with the field data as shown above and press **[SOLVE]**. The OC elev: is 237.88. The elevation determined by the 2-Pt resection was 110.35 with a difference of 127.53. This will be used later in Chapter 4.

Step 2: Now, change the OC elev: to OC pt: and enter "50". Press **[SOLVE]** and then **[ENTER]**. This time you will be asked if you want to overwrite point 50. Answer "Y" for yes. The elevation of point 50 is now adjusted relative to the foresighted benchmark.

NOTE: If the **OC pt** is selected, the Benchmark routine will replace the existing elevation of the occupied point with the elevation, calculated from the foresight. When the **OC elev** prompt is chosen, this routine will only display the calculated elevation.

TOPOGRAPHIC SURVEY OF THE SMITH JOB

From your position 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 interest of brevity, the data for this example 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 Instru. [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|**.

NOTE:

Be sure to set the repetition mode off before pressing **|SIDES|** or you will be prompted for multiple horizontal angles. Press **|REP| |B|** to bring up the Repetition menu, then **|L|** Set Rep. mode to display the Rep Mode screen. Enter "0" in the number of sets field and the repetition mode is turned off. You do not need to set the Horiz angle mode to single, 0 set means there is no repetition.

Step 1: The Traverse/Sideshot Screen, as shown below, is properly filled out for the first shot prior to pressing **|SIDES|**. After pressing **|SIDES|** the message

```
You have changed to a new occupied point use
next Screen to set up backsight & height of
instrument. Backsight can be a point or azimuth.
```

This data can be entered in the Traverse / Sideshot screen, so for this example, skip these screens.

Ang right / Azimuth / Bearing /
Ang left / Def right /Def left =>
Zenith ang / Vert ang / Chng elev =>
Slope dist / Slope dist / Horiz dist

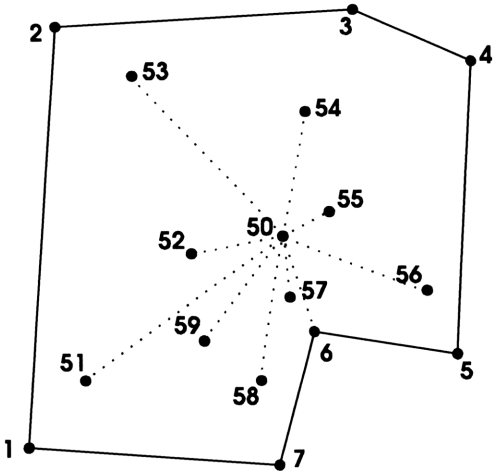
```
OC:50        FS:51
BS pt:6
>Ang right  :77.2701
>Zenith ang:91.0638
 Slope dist:350.430
Descα:PT51
HI:5.420    HR:6.000
```

SIDES	REP	BACK	TRAV	OFFCT	EXIT

Step 2: 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.

NOTE:

Traverse shots and sideshots can be taken intermixed. There is not a limit to the number of sideshots that can be taken from any one occupied point. Be mindful, if you use the **[TRAV]** key, that the point to be occupied next is shot last on each setup. When the **[TRAV]** key is pressed, the foresight point will be used to replace the occupy pt. If your next occupied point is not to be your last shot from this setup, then use the **[SIDES]** key and manually change the occupied point field when you move ahead.



SUNSHOTS

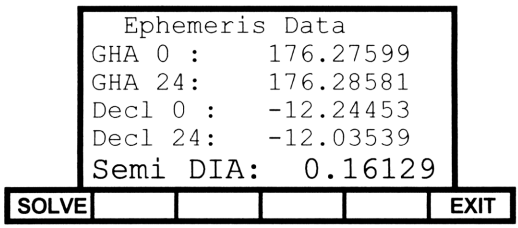
The next section in this chapter on Field Work will cover the use of SURVEY-PRO in helping you determine the true azimuth of a backsight in the field by solar observations. SURVEY-PRO has two methods built into its software. The first is called the *Ephemeris* method. It assumes that you have an ephemeris with you and will prompt you to key in the appropriate values from it. The other method is called the *Almanac* method. In it, SURVEY-PRO 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. The ephemeris method is capable of being more accurate in determining the azimuth.

****Warning****

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.

Path: From the Main Menu, press **|O| Sunshots** then **|G| Ephemeris Method**. The Ephemeris Data Screen is shown Below:

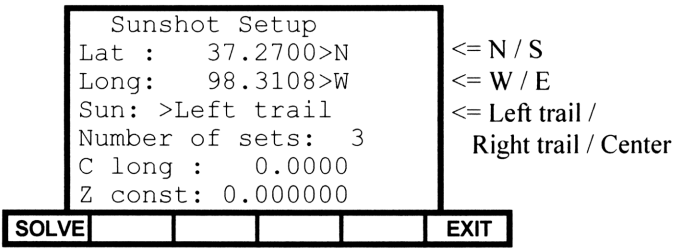


Step 1: The GHA 0 represents the Greenwich Hour Angle of the sun at zero hour Universal Time, Greenwich, on the current date. GHA 24 represents the Greenwich Hour Angle of the sun at zero hour Universal time, Greenwich, on the next date (24 hours later).

Step 2: 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 requested.

Step 3: The screen should be filled out as displayed above. Now press **[SOLVE]**. You will see the Sun Shot Setup Screen as:



Step 4: Lat and Long represent the latitude and longitude of the instrument position which may be scaled from a map such as a U.S.G.S. 7.5 minute quadrangle sheet.

Step 5: The Sun prompt indicates which part of the sun will be sighted at the vertical cross hair. Our example will use the Left trailing edge. (The Right trailing edge is for the southern hemisphere.) The Center setting can be used in either hemisphere or for star shots.

Step 6: 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. (At the time you are prompted to flip the scope, you can cancel the reverse observations.) A complete sun shot 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.

Step 7: 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.

Step 8: When this screen has been filled out as displayed above, press **[SOLVE]**.

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

A table of the solar observations and resulting azimuths is displayed below:

	Time	Angle	Computed Line Azimuth	
Direct	Backsight	0.0000		
Direct	15.12253	241.4352	241.12304	
Direct	15.13071	241.5118	241.12598	
Direct	15.13392	241.5736	241.12475	
Reverse	15.16217	62.4852	240.52367	
Reverse	15.16582	62.3548	241.12405	
Reverse	15.17410	62.4405	241.12368	
Reverse	Backsight	180.0005	Average	241.1237

After pressing **[SOLVE]**, the sun shot routine 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, SURVEY-PRO will take all readings automatically, including the time, as you trigger the machine.

Step 9: Enter the data for the prompts as follows:

Local date:	2.121989
BS dir cir:	0
Dir Time 1:	15.12253
Dir Cir 1:	241.4352
Dir Time 2:	15.13071
Dir Cir 2:	241.5118
Dir Time 3:	15.13392
Dir Cir 3:	241.5736

Step 10: You will then be asked:

Do you wish to take
reverse shots?[Y/N]_

Answer "Y" and enter the reverse observations as prompted:

Reverse!!
Rev Time 1: 15.16217
Rev Cir 1: 62.4852
Rev Time 2: 15.16582
Rev Cir 2: 62.3548
Rev Time 3: 15.17410
Rev Cir 3: 62.4405

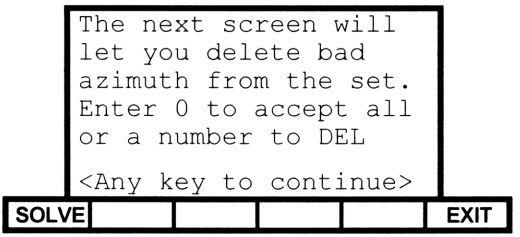
Finally observe the backsight with the scope reversed:

BS Rev Cir: 180.0005

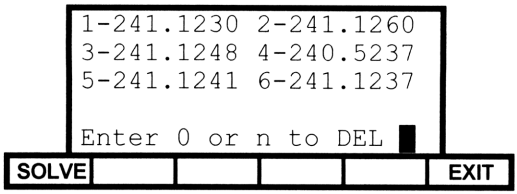
Step 11: After the last data has been entered, SURVEY-PRO will compute and display the individual back azimuths from each reading.

Line Az 1: 241.12304
Line Az 2: 241.12598
Line Az 3: 241.12475
Line Az 4: 240.52367
Line Az 5: 241.12405
Line Az 6: 241.12368

Pressing a key one more time will display the following message:



Again hit a key and you can delete any shot from the set. As you can see shot number 4 is out of the grouping and therefore would appear to be somewhat less accurate that the rest. To delete it from the average type "4" and [ENTER]. Now there are only five sets.



The default entry is always 0 and therefore you may simply press [ENTER] to accept the remaining shots. The average will then be displayed.

Avg Line Az = 241.12430

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

Frequently on a job, you might like to differentiate between control points and survey points. One way to do this is by point numbering; i.e. control points numbered below one hundred, and survey points numbered from three hundred and above. However, SURVEY-PRO will allot memory for all of the unused point numbers between the highest numbered control point and the lowest-numbered survey point. This restricts the number of points that can be surveyed within a given job. Perhaps more importantly, if you divided a project into more than one job file and want to use the same control points, the points must be copied into each job. By separating control points into a Control File, we resolve these problems.

The concept is quite simple. The control points can be stored in a separate job file with a distinct name. Then, any job that needs access to these points can select this as its control file from the Setup Menu. During operation of SURVEY-PRO, whenever a point is referenced by point number, SURVEY-PRO will *first search* for a point with that number in the *main job file.* If there is one, that point will be used. However, if the point number specified is less than the smallest point in the main job file, then SURVEY-PRO will search for that point in the selected control file. If a point exists there, then that point is used. If the specified point number does not occur in either file, then an error message is displayed.

Care needs to be taken in designing projects that will use control files. SURVEY-PRO will only look for control points that are less than the smallest point possible in the main job file. Therefore, the control points should be low numbers. **The main job must be created with a starting point that is larger than the largest control point you wish to access.** If your control points were numbered between one and one hundred, then your main job file must be created with a starting point greater than one hundred.

Control point numbers may be used in any screen location in which read only 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. They cannot be used where a point will be created or modified. They cannot be used as a Foresight Point or as the Store pt: in Intersection or Pt-in-Dir. For example, you may want to inverse between a point in the main job and one of your control points. Go to the inverse screen and use it as you would for any other inverse, specifying the point numbers where required.

The Setup Menu has two choices that relate to control files: **|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 **|SELECT|**. To deselect the control file, merely press **|L|** from the Setup Menu.

DESCRIPTOR CODE TABLES

One of the best ways of improving the productivity of data collecting is to speed up the process of keying in point descriptors. The Descriptor Code Table is provided for this purpose. Basically, the Descriptor Code Table is a text file in SURVEY-PRO's memory that consists of a table of commonly-used point descriptors.

The descriptor table can take two forms. The first, is a list of codes or abbreviations along with a descriptor with which it is associated. These codes may be keyed into the descriptor field in place of the full descriptor. When one of these codes is found in a descriptor field, SURVEY-PRO will replace the code with its associated descriptor. The second form is simply a list of descriptors that you can select from when you are prompted for a descriptor.

Once you have established a Table of commonly-used descriptors, then whenever the descriptor prompt appears in SURVEY-PRO program, a code may be keyed in or a descriptor selected. SURVEY-PRO will insert the complete descriptor from the table in the Coordinate and Raw Data files.

The Descriptor Table is a special text file in SURVEY-PRO. The Descriptor Table itself is composed of a series of lines of text. Each line of text consists of either a code followed by the full descriptor separated by exactly one space or just a full descriptor. A sample of each form of descriptor files appear below:

Form 1

```
1 POB
02 HUB
CB CURB
T4 OAK TREE
POB PT. OF BEGINNING
F FENCE
f FENCE
```
.....(etc.)

Form 2

```
CURB
FENCE
HUB
OAK TREE
POB
PT. OF BEGINNING
ROCK WALL
```
.....(etc.)

FORM 1 Codes and Descriptors

Let us look at each type of code file with their advantages and weaknesses. First Form 1 or the Code and Descriptor pairs. This file is made up of a series of codes that you enter followed by the descriptor that will be exchanged for the code. Codes may be up to seven characters in length and may be numeric, alphabetic or alpha-numeric. Examples of each of these are: 17, ABC, B17. The code is case sensitive, which means that the "F" and "f" codes are not the same and could have different descriptors. If you want an upper or lower case "F" to be interpreted as FENCE you need to enter it twice (as above). The code and the descriptor are separated by one space, and the remainder of the line is the descriptor that is linked to this code. The descriptor may contain alpha-numerics, spaces, punctuation or symbols; basically anything that can be typed into a descriptor manually.

During a survey, when SURVEY-PRO requests a descriptor (typically after the electronic total station has taken a shot), you may key in the full descriptor such as CURB; or, you may key in the corresponding code, such as CB, 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 above, SURVEY-PRO will store the full descriptor from the table into the job file.

There are two advantages to this method of descriptor table: First, it can be used in both the screen and prompted descriptor fields. The second method can only be used when prompted for a descriptor. Second, you can combine text and codes to create the descriptors needed (see below). The disadvantage of this method is the need to memorize the codes or carry a crib sheet.

Using Codes With Keyed In Descriptors And Combining Codes

Often, you want to use a descriptor from the Code Table, but you would like to add additional characters to the descriptor from the keyboard. As an example, suppose you wanted to use the descriptors "NE 1/4 CORNER", "SE 1/4 CORNER", etc. Lets assume that the descriptor "1/4 CORNER" has been keyed into a Code Table under the code "15". To combine text and codes from the Code Table , 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 "NE*15". SURVEY-PRO will combine the keyed-in descriptor "NE" with the descriptor associated with code 15 to create the complete descriptor "NE 1/4 CORNER".

Codes may also be concatenated with 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 with say code 23. Then, in response to the descriptor prompt, key in 23*A1, 23*A2, 23*A3, etc.

Codes may also be concatenated with other codes. Assume you have code-descriptor pairs for: T TREE, T1 PINE, T2 OAK and T3 MAPLE. The result of the following entries: T1*T; T2*T; T3*T; would be: PINE TREE; OAK TREE and MAPLE TREE. This technique may be used to concatenate up to three descriptor codes or text segments.

FORM 2 Descriptor Lookup Table

Form 2 is made up of a list of descriptors, one per line, that you can select from as you are prompted for a Descriptor. The descriptor may contain alpha-numerics, spaces, punctuation or symbols; basically any thing that can be typed into a descriptor manually. This list should be sorted alphabetically.

During a survey, when SURVEY-PRO requests a descriptor (typically after the electronic total station has taken a shot), you may key in the full descriptor such as CURB; or, you may key in the first letter, "C", and select CURB from the table of descriptors that is listed. When you are first prompted for a descriptor, you should see a Desc prompt. A page of descriptors choices will also be displayed if the descriptor you have in the prompt matches a descriptor from the table.

At this point there are two modes for entering a note: First, with the alpha mode **OFF**, (the α enunciator **not** displayed at the top of the HP-48 screen) you can use the **[↑]** or **[↓]** keys to scroll through the table of descriptors. As you scroll up or dawn, beyond a page, the next page will be displayed. The

descriptor that is highlighted will also be copied to the prompt line. When you have highlighted the descriptor that you what press the **|ENTER|** key and the point will be stored.

The second mode is with the alpha mode **ON**, (the α enunciator **is** displayed at the top of the HP-48 screen). Now as you enter character it is placed in the prompt field. As a character is entered the screen will display the descriptors from the table that match the prompt. For example, if you enter a "C" for CURB, the first descriptor that starts with "C" will be displayed followed by the next screen full of descriptors. If you have a large number of "C" descriptors they may not all fit on the screen. Now you enter "U" and the display will start with the first descriptor that starts with "CU". You can enter as many letters of the descriptor as is needed to narrow down the selection, up to eight characters.

These mode can be used in combination with each other. For example, first you may enter a letter or two, to display a page of descriptors that is close to the one you want. Next you turn the alpha mode off and scroll to the desired descriptor. Finally you turn the alpha mode on again and you could add some more text to the end. When you are in the alpha mode you can press the **|DEL|** key to clear the entire descriptor prompt and start again.

The advantage to this method of descriptor table is that you do not need to memorize codes. But you cannot concatenate descriptors and the table will only be displayed when entering the descriptor from a Desc prompt. It is not available from a descriptor field such as in the Traverse / Sideshot Screen.

Setting Up And Deleting A Code Table In SURVEY-PRO

The method for establishing either type of descriptor file in SURVEY-PRO, is the same. You should proceed as follows:

Path:	From the Main Menu, Press **|G|** Job Menu, **|O|** Descriptors File Menu, **|G|** Select descriptor file.

You will see a list of the .TXT files in your SURVEY-PRO. (If you do not have any descriptor files in the data collector you will need to create one as described below.) Use the [↑] [↓] keys to highlight the descriptor file you wish to use as the descriptor look up table. Press **|SELECT|**. You will be prompted to select

the type of table to create. The display will say "Do you intend to use code when entering description?". Press **|YES|** if the file is of form 1 with codes and descriptors. Press **|NO|** if the file is of form 2 with just descriptors. If you find that you have selected the incorrect mode you can either re-select the descriptor file or change the setting in the Operating Modes screen.

Creating and Deleting a Descriptor Code Table

You can create a descriptor file in SURVEY-PRO.

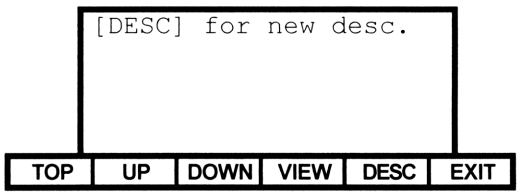
Path:	From the Main Menu, Press **|G|** Job Menu, **|O|** Descriptors File Menu, **|I|** Create descriptors.

This key sequence will prompt you for a filename and create a .TXT file in SURVEY-PRO's memory. If a file by that name already exists, you will get an error message.

Likewise, the keystrokes **|G|** Job Menu, **|O|** Descriptors File Menu, **|J|** 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|**, **|O|**, and then **|H|**. You will see the current Code Descriptor Table, if one exists. If the descriptor file does not exist, then create one as described above.



To add a descriptor to the code table, press **|DESC|**. Then, enter the new descriptor; e.g. MAN HOLE COVER.

NOTE:

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

Building And Editing The Descriptor Code Table In A PC

While it is possible to set up a Code-Table from SURVEY-PRO's keyboard, the difficulty associated with "typing" a long list into SURVEY-PRO 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 SURVEY-PRO. To facilitate this process, you should use your favorite editor software or word processor. 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 or store it to an ASCII file format. The file should be named "<Filename>.TXT" and should consist of the following elements keyed on each line.

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

The completed descriptor file may then be downloaded to your TDS-48 by using your TFR software. In the TFR Main Menu, select the "Send file to data collector" option. Change the file type to "TEXT" and enter the file name as <Filename>.TXT.

NOTE:

If your TFR, is ver 4.3 or older, then use the "Send Text File to TDS-500" option. Even though this option refers to the TDS-500, the routine will also transfer a text file to SURVEY-PRO.

4. ADJUSTMENTS

In this chapter, you will learn several ways you can adjust your coordinates under various constraints. You can scale your job or translate blocks of coordinates in any direction, including elevation. You can rotate blocks of coordinates about any point in the file through any specified angle. You can also adjust a traverse using Angle Adjustment and then the Compass Rule.

This chapter is an introduction to SURVEY-PRO's various adjustment routines. You will be using the coordinates that were computed as a result of the SMITH survey. Be certain that you have the SMITH job as the active job. If you have not done the Field Work from Chapter 3 or no longer have the SMITH job available, you can create a new job file and enter the coordinates from the table below. Your coordinate file should look as follows:

PT NUM	NORTHING	EASTING	ELEV.	NOTE
1	5000.0000	5000.0000	100.00	START
2	5710.2358	5040.8379	103.29	PT2
3	5740.5392	5497.5792	106.37	PT3
4	5654.9688	5679.7808	108.22	PT4
5	5158.3849	5658.6252	117.36	PT5
6	5198.2397	5438.2280	114.79	PT6
7	4970.3105	5385.8397	112.30	PT7
8	5000.0783	4999.9135	100.00	Close to pt1
50	5341.9353	5363.1789	237.88	PT50
51	5116.1320	5095.2835	230.51	PT51
52	5307.3676	5262.7343	236.42	PT52
53	5628.1565	5115.0212	232.23	PT53
54	5573.0213	5418.9250	235.75	PT54
55	5380.9779	5402.4624	236.57	PT55
56	5232.4298	5628.8757	242.76	PT56
57	5251.0577	5402.4228	239.78	PT57
58	5089.0863	5374.0411	239.29	PT58
59	5182.8260	5274.5365	235.98	PT59

This first thing you may wish to do is to compute the precision of the survey. You can determine the precision of a survey from the Compass Rule Screen.

Path:	From the Main Menu, select **[N] Survey adjustment**; then, **[K] Compass Rule** Screen.

Step 1: Enter From point: as "1" and To point: as "8". Then press **[PRECI]**. The precision is displayed as: 23,245, which should be read as 1 in 23,245. The precision may vary slightly if you have typed in your coordinates. Press **[EXIT]** to return to the Survey Adjustment Menu.

TRANSLATION

To acquire some practice with the adjustment features of SURVEY-PRO, let us assume that selecting your beginning elevation as 100 ft was simply for arbitrary convenience. However, In Chapter 3 while doing your Benchmark calculation of point 50, you discovered that, you must add 127.53 to the elevation of each boundary point in the file. You would like to bring all of the boundary points of your survey into line with the elevations of the topo.

Path:	From the survey adjustment Menu, select **[H] Translate job**. The Translate Job Screen is shown below:

From pt: - To pt: or
Using point list =>

Azimuth / Bearing =>

```
     Translate Job
>From point: 1
To point   : 8
>Azimuth   : 0
Horiz dist: 0
Elevation+-: 127.53
```

SOLVE	PTLST	INVRS			EXIT

Step 1: The elevation of only the boundary points, in the SMITH job, should be adjusted; so, enter "1" in the From point and "8" in the To point: field. In this example there is no need to change the position of the survey only its elevation so set the Azimuth: and Horiz dist: to "0". Enter 127.53 in the Elevation+- field. When your screen is filled out with the same values as displayed above, press **[SOLVE]**.

ADJUSTMENTS

After pressing **[SOLVE]**, SURVEY-PRO will adjust the elevations by the amount specified. You may return to the Point Data Screen to confirm this.

NOTE:

Since you were adding an elevation, you simply keyed in the amount to add. To **subtract** an elevation, key in a **negative** value for the amount to subtracted. The translation of the coordinates' positions can be done at the same time as changing its elevation. Simply enter the proper values in the Azimuth and Distance Fields.

The **[INVRS]** key will bring up the Inverse screen from the CO-GO menu allowing you to inverse between two known points. Entering your 2 points, press **[SOLVE]** and **[EXIT]** from the inverse screen. The inverse results will be stored in the bottom three lines of the Translate Job screen.

ROTATE JOB

Let us also assume we learn that our backsight was entered in error and should have been 276.5315. A simple rotation will correct this problem.

Path:	From the survey adjustment Menu, select **[1] Rotate job**. The Rotate Job Screen will be displayed:

From pt: - To pt: or
Using point list =>

```
        Rotate Job
>From point: 1
To point   : 59

Rotation pt: 1
Old bearing: N83.3645W
New bearing: N83.0645W
```

SOLVE	PTLST	DFDIR			EXIT

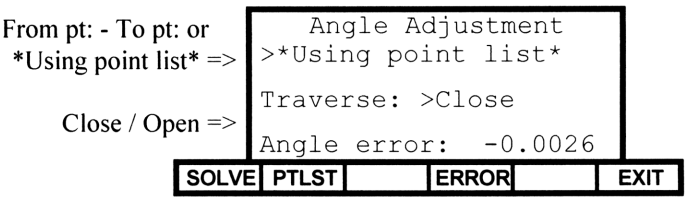
Step 1: The position of all the points in the SMITH job including the topo should be rotated, so enter "59" in the To point: field. Enter "1" as the Rotation pt: and N83.3645W and N83.0645W as the Old and New Bearings. The screen should look like the display above. Press **[SOLVE]**.

After you press **[SOLVE]**, SURVEY-PRO will rotate all of the coordinates around point "1" by the difference between the two bearings.

ANGLE ADJUSTMENT

For practice with traverse adjustments, let us perform an angle adjustment and then the Compass Rule adjustment on the SMITH job.

Path:	Select **[J]** from the Adjustment Menu. The Angle Adjustment Screen appears as:



Step 1: Again you want to adjust all the points in the SMITH job, but simply entering "From pt 1 To point 59" will treat every point as a traversed point. Points 50 to 59 need to be adjusted as sideshots. In order to differentiate between Traverse points and Sideshots, we must use a Point List.

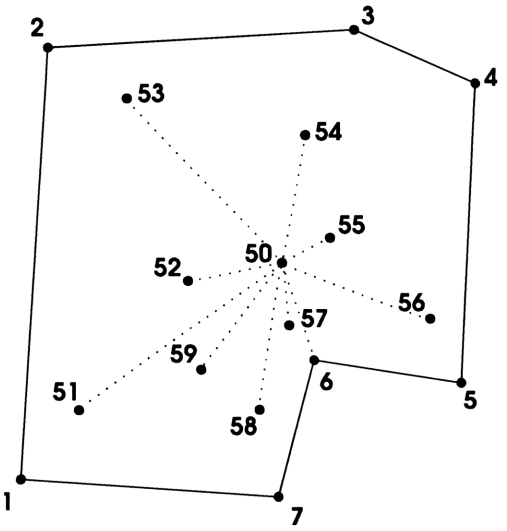
Press **[PTLST]** to bring up the Point List Menu; then **[H]** to clear any current list; then **[G]** to display the Point List Screen.

At the NXT PT prompt, enter:

1-6	**[ENTER]**
SS 50-59	**[ENTER]**
7-8	**[ENTER]**

This has defined a Point List that will treat 1 to 6 as traverse points; 50 to 59 as sideshots of point 6; and, 7 to 8 again as traverse points. Press **[EXIT]** twice to return to the Angle Adjustment screen. Now, change the From pt. prompt to display, *Using point list*.

ADJUSTMENTS



NOTE

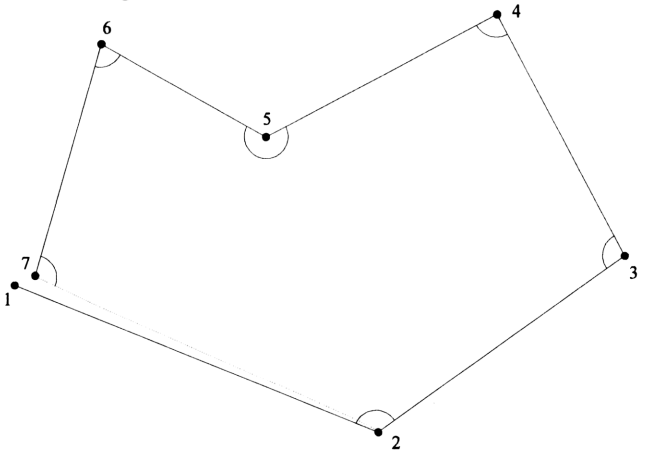
The Point List is used throughout SURVEY-PRO to specify points to be used in a variety of functions. For example, a Screen Plot may use the point list to select those points that you want to display. To get the most out of SURVEY-PRO, be certain that you understand the concept of the Point List. It is described in greater detail in the Reference section.

Step 2: Now you need to determine the angular error of your traverse. Press **[ERROR]** and the following screen is displayed:

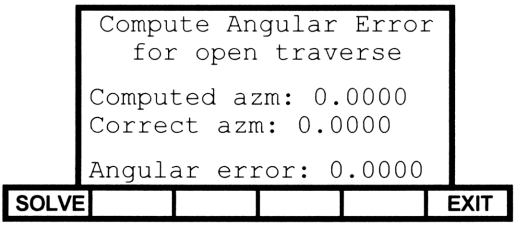
```
Compute Angular Error
 for closed traverse

Closing ang: 91.0645

Angular error: -0.0026

SOLVE                    EXIT
```

When adjusting a closed traverse there are two methods that SURVEY-PRO can use to calculate the angular error. If you have measured the closing angle you can enter that angle in the Closing ang field. The closing angle is the circle angle from a backsight of the next to the last traverse point, while occupying the closing point/starting point and turning to the second point of the traverse.

The second method is to let SURVEY-PRO calculate the closing angle using the next to the last point, the last point and the second point in the point list.(See diagram below) If the closing angle field equals zero then the closing angle will be calculated other wise the value in this field will be used as the closing angle. Both methods calculate the angular error by adding together the internal angles at each traverse point. The sum is then compared to **N-2*180** where **N** equals the number of traverse points. The difference is the angular error.



If you are adjusting an **OPEN** traverse you must enter both the observed or computed closing azimuth and the correct closing azimuth. The Error Routine will calculate the difference between these to azimuths to determine the error. The Compute Angular Error for open traverse screen is displayed below:



We will let the routine calculate the closing angle. Make sure the closing angle is 0 and press the **[SOLVE]** key to compute th angular error.

Step 3: You can now view the angular error as -0.0026 and decide if the closure is acceptable. If so, press **[EXIT]** to return to the Angle Adjust screen and press **[SOLVE]** to adjust the traverse angles. The angular error is divided by one less than the number of traverse points. The internal angle at each traverse point is adjusted by this fraction of the total error, starting from the third point in the traverse.

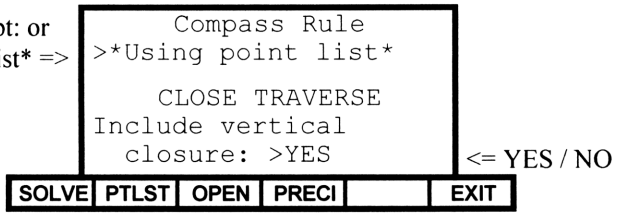
At this point, the traverse has the correct sum of internal angles for a 7 sided polygon. Points 1 and 8 do not yet close, but the internal angles are adjusted.

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 order of the *traverse points*. If sideshots were taken from the occupied points during the traverse, they may be included in an adjustment, as sideshots. In the Point List, following the occupied point from which the sideshot was taken, keying in **[S] [S] [SPACE]** and the point number (SS ##). By including your sideshots in the Point List, your sideshots as well as your traverse point coordinates will be adjusted when you solve for the various adjustments in the Adjustment Menu.

COMPASS RULE

The last exercise is to adjust the closure of the coordinates with the Compass Rule routine.

Path:	From the Adjustment Menu, select **[K] Compass Rule** Screen. This screen is displayed below:



Step 1: The Point List you created for the angular adjustment is correct for this closure also. Be sure the screen says **CLOSE TRAVERSE** on the center line. If not then press **[CLOSE]** or **[C]** to change the display.

NOTE:

If you want to calculate the precision again, do so at this time. The precision, and the angular error as well, are determinations made from the errors in the traverse. Once the adjustments are made, these values cannot be recalculated without returning the coordinated to their original values.

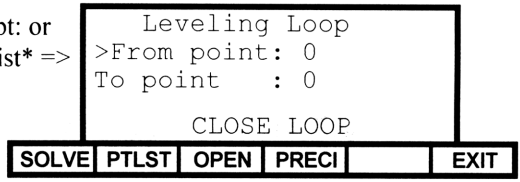
Step 2: Press the **[SOLVE]** or **[A]** key to adjust the traverse.

LEVELING LOOP

This adjustment can be used to close a loop of the coordinates collected with the Diferentual Leveling routine. The Diferentual Leveling routine is described in Chapter #7.

Path:	From the Adjustment Menu, select **[L] Leveling Loop** Screen. This screen is displayed below:

ADJUSTMENTS



This routine also has an **[OPEN]** and **[CLOSE]** version. This adjustment of the leveling circuit changes only the elevations. In adition you must biuld a point list of the loop an any side shots, instructing the routine how each point is to be adjusted. A more powerful Level loop adjustment will be provided in the Easy Survey PC program. The Easy Survey proutine will read through the raw data file, compute the error, and distribute the error among all the traverse legs. The adjusted elevations will be used to replace the elevation in existing points.

After the compass rule adjustment, your coordinates should appear as in this table:

PT NUM	NORTHING	EASTING	ELEV.	NOTE
1	5000.0000	5000.0000	227.53	START
2	5709.8469	5047.0433	230.82	PT2
3	5736.1695	5504.0370	233.90	PT3
4	5649.0185	5685.4911	235.75	PT4
5	5152.6326	5660.0409	244.89	PT5
6	5194.3888	5439.9992	242.32	PT6
7	4966.9177	5385.6510	239.83	PT7
8	5000.0000	5000.0000	227.53	Close to PT1
50	5338.7259	5366.1916	237.88	PT50
51	5115.2403	5096.3597	230.51	PT51
52	5305.0254	5265.4527	236.42	PT52
53	5627.0670	5121.5103	232.23	PT53
54	5569.3228	5423.9275	235.75	PT54
55	5377.4284	5405.8102	236.57	PT55
56	5226.9342	5630.9345	242.76	PT56
57	5247.5134	5404.6506	239.78	PT57
58	5085.7927	5374.8738	239.29	PT58
59	5180.3867	5276.1809	235.98	PT59

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 true northing and easting coordinate values that the last point in the traverse will close to before pressing **[SOLVE]**.

The Compass Rule routine can be set to adjust or not adjust the elevations. Just set the "**Include Vertical Closure:**" field to "Yes" or "No", depending on whether or not you want the elevations included.

CHANGE SCALE

Within the Survey Adjustment selections there is also the ability to change the scale of your job. This routine is useful either to convert a set of coordinates to or from the state plane grid; or, for modifying a job from feet to meters or from meters to feet. This routine functions like the other adjustments; you simply enter the range of point you want scaled; a base point (a point whose coordinates will not be changed); and, a scale factor. You then press solve to adjust the scale.

Path:	From the Adjustment Menu, select **[G] Change scale** Screen. This screen is displayed below:

From pt: - To pt: or
Using point list =>

```
      Change Scale
>From point: 1
To point   : 60

Base point  : 1
Scale factor:1.0000
Scale elevation:> Yes
```

<= Yes / No

SOLVE	PTLST				EXIT

The scale routine can be set to adjust or not adjust the elevations. When converting to state plane coordinates, you would typically not want the elevations changed. However, when changing the distance units, you would. You will not be changing the scale of this job. It is presented here simply for reference.

NOTE:

The Change Scale routine changes the coordinates of your job. It should not be used to adjust the size of your plotted or printed output as it will change calls, inverses and other distance-related calculations.

5. PRACTICE WITH CO-GO and CURVES

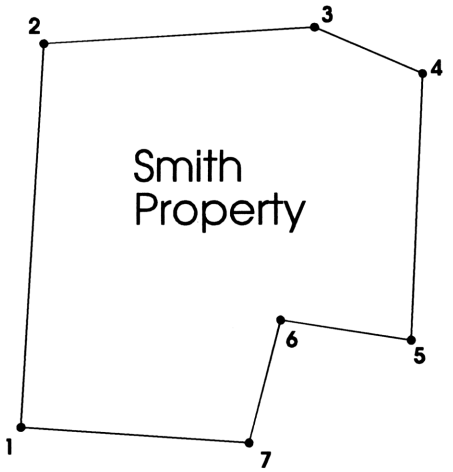
Working with the coordinates of the SMITH job you will:

- **Create new points using various Coordinate Geometry (CO-GO) routines.**
- **Explore various Curve Screens of SURVEY PRO and practice integrating the curve capabilities into the CO-GO routines.**

In this chapter, you will continue to do work on the SMITH job. Make sure that the SMITH file is the currently active job. If you have not done the Field Work from chapter 3 or no longer have the SMITH job available, you can create a new job file and enter the coordinates from the table below. Your coordinate file should look as follows:

PT NUM	NORTHING	EASTING	ELEV.	NOTE
1	5000.0000	5000.0000	227.53	START
2	5709.8469	5047.0433	230.82	PT2
3	5736.1695	5504.0370	233.90	PT3
4	5649.0185	5685.4911	235.75	PT4
5	5152.6326	5660.0409	244.89	PT5
6	5194.3888	5439.9992	242.32	PT6
7	4966.9177	5385.6510	239.83	PT7

If you did not adjust your SMITH survey as described in Chapter 4, the results in this chapter will be different, but you can continue (or else re-enter the coordinates from the table above). Here is a picture of the Smith's property.



Coordinates in SURVEY PRO may have come from several sources:

- collected from field data during a survey.
- computed by the CO-GO functions in the data collector.
- up loaded from a PC.
- keyed into the coordinate editor.

No matter how a point's coordinates get into the TDS-48, they can be used by any of the functions of SURVEY PRO field computer. In addition, you can review them at any time by pressing **|ED CRD|** or **|Z|** (Edit Coordinates) to access the Point Data Screen.

PRACTICE WITH CO-GO

To illustrate this point, take a few minutes now to practice with some of the CO-GO functions on the SMITH job. From the Main Menu, press **|M|.** The CO-GO Menu is displayed. You'll see ten different coordinate geometry functions in the menu: 6 in the first screen and 5 after pressing **|MORE|**. In this chapter, we will cover the following seven functions:

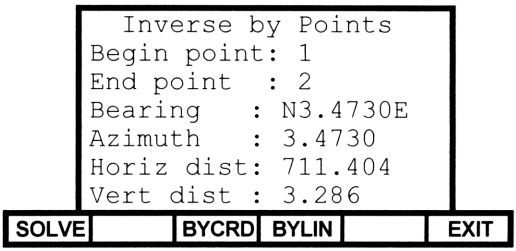
- **Inverse**
- **Intersect**
- **Point in dir.**
- **Area**
- **Predetermined areas:**
  Hinged line method
  Parallel line method
- **Corner angle**

In addition, **Two Point Resection** and **Benchmark** are covered in chapter 3, Field 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.

INVERSE BETWEEN POINTS

Path:	From the CO-GO Menu, press **[J]** to get the **Inverse Screen**. That screen should look like:



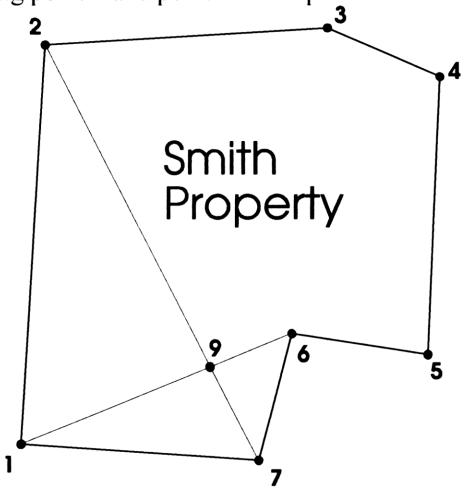
Like all of the screens in the TDS-48, the use of this one is straight-forward. Move the scroll bar to the field in which you want to enter data and key in the data. Then move the scroll bar to another field, key in that data, etc. When you have built the screen to be representative of the problem that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

Step 1: 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 as above:

Notice also that, by pressing **[BYCRD]** or **[C]**, you will see a screen that will let you inverse by coordinates rather than by point number; and, by pressing **[BYLIN]** or **[D]**, you will be able to inverse between a point and a line defined by two other points. These inverse routines simply display the results. The data in your job file is not modified in any way. You may wish to practice with the other inverse screens at this time. **[BYPTS]** key will return you to the inverse between two point numbers.

INTERSECTION

As the next 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:



Path: From the CO-GO Menu, select **[I]** for the **Intersection** Screen.

Azimuth / Bearing / Distance =>

Azimuth / Bearing / Distance =>

```
   Intersection
 Point 1 : 1
>Azimuth : 66.0952
 Point 2 : 2
>Azimuth : 155.2952
 Store pt: 9
```

SOLVE	DFDIR				EXIT

NOTE:

The third and fifth lines of the display have the ">" scrolling prompt character. When you move the prompt to one of these lines and press a horizontal cursor key (**|←|** or **|→|**), both the **value** of the data in that line and the **prompt label** will change. In this case, the Azimuth prompt will change to a Bearing or a Distance. You can use any combination of direction or distance to calculate an intersection.

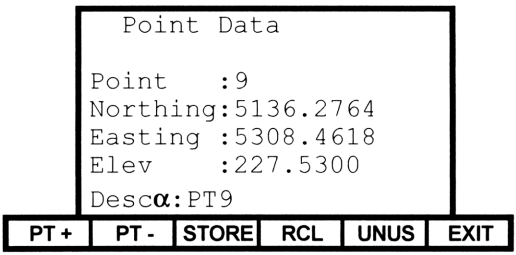
Step 1: Into this screen, you enter the parameters of this problem. The first point is point 1. Next you could use the **|INVERS|** or ⏎ **|J|** key or invoke the command **|DFDIR|** or **|B|, Define Direction**, to specify the azimuth between points 1 and 6, but SURVEY PRO will compute the inverse for you. Simply enter "1-6" and press **|ENTER|** or **|↓|** to move to the next field. The TDS-48 will compute the azimuth of the line and enter it in the Azimuth field. This process may be repeated for the line connecting points 2 and 7. Use point 9 as the stored point. When the screen has been properly filled out, it should appear as displayed above:

NOTE:

If you had set the prompt for bearing, 1-6 would have resulted in a bearing. If a prompt is expecting a distance as its input data, SURVEY PRO will calculate a distance. If the field is expecting an angle, you can enter three point numbers separated by hyphens. SURVEY PRO will calculate the angle starting from the first point number, through the middle point and turning angle right to the last point.

Step 2: Now press **|SOLVE|**. The TDS-48 will give you an opportunity to specify an elevation and a descriptor before adding point 9 to the job file.

You may review the coordinate values of point 9 by pressing **|ED CRD| or** ⏎ **|Z|**. Press **|RCL|** and key in 9 for the point number in response to the prompt. The coordinates are shown as:

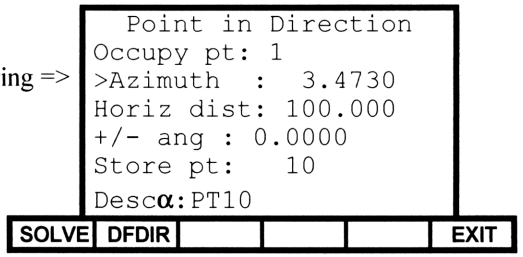


POINT IN DIRECTION

From the previous inverse example, you know that the horizontal distance between points 1 and 2 is 711.404 ft. Assume that you want to create 7 new points at 100 ft intervals along the line between points 1 and 2. You can do this with the Point-In-Direction function.

Path: From the CO-GO Menu, press **|K|** to access the **Pt-in-Dir** screen. You should see:

Azimuth / Bearing =>



As in the Inverse or intersection Screen, the procedure to solve this problem is to build the appropriate screen and then press **|SOLVE|** to calculate new coordinates and store them.

Step 1: You should key in 1 as the occupied point.

Step 2: Enter "1-2" in the Azimuth field and press **|ENTER|** to move to the next field. The TDS-48 will compute the azimuth of the line and enter it in the Azimuth field. Enter "100" as the Horiz dist and 10 for the Store pt. The Point In Dir Screen should be filled out as displayed above.

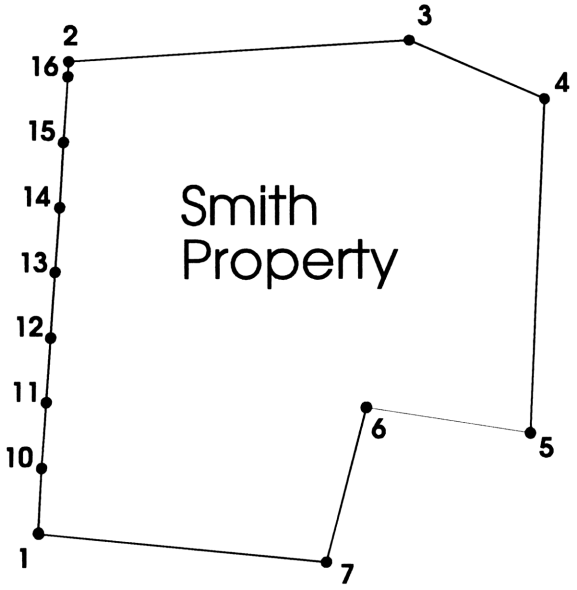
Step 3: Now, press **|SOLVE|** to get the coordinates of your first point that is 100 ft from point 1. This will be stored as point 10. A new screen will prompt you for an elevation. You can enter an elevation here, but, let's use the one displayed for you (227.53 ft in this case) by pressing **|ENTER|**. Next, the TDS-48 will prompt you for a descriptor. Key in a descriptor, such as PT 10, and press **|ENTER|**.

Step 4: The machine will return to the Point in Direction screen set up to solve for the next point, point 11 and can be calculated by simple pressing **[SOLVE].** 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 16.

NOTE:

You do not have to solve for the azimuth each time because it will not change. In fact, there are no changes that need to be made to the screen between each solution. SURVEY PRO automatically increments the occupied point number and store point number for you. All other data remains the same.

After you've created points 10 through 16 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 the plot below:



ACREAGE AND THE POINT LIST

For your next task, you want to find the area of the SMITH property in acres.

Path: From the CO-GO Menu, press **|G|** to select the Area Screen. The Acreage Screen appears as:

From point - To point /Using point list =>

```
   Acreage
>From point: 1
To point   : 7
Acreage :  9.789
Perimeter: 2712.401
Square ft: 426396.03
```

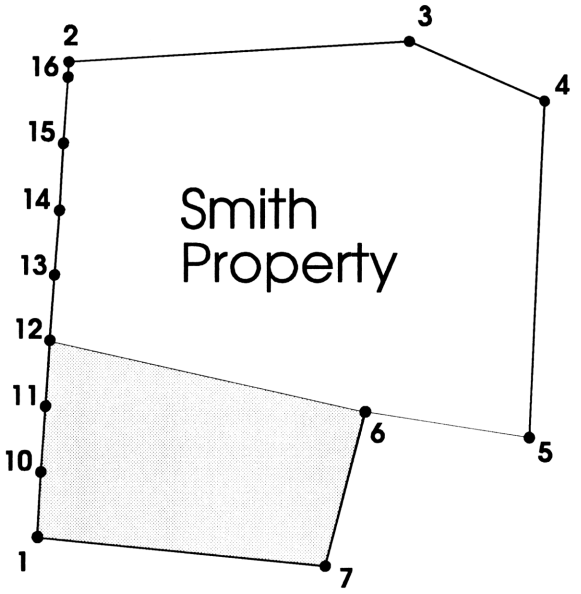
SOLVE	PTLST				EXIT

Step 1: Load the first and last corners of the survey into the "From point" and "To point" fields of the screen: 1 and 7. 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 9.789 acres, 426396.03 sq. ft, and a perimeter of 2712.401 ft.

NOTE: When the distance units of SURVEY PRO 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.

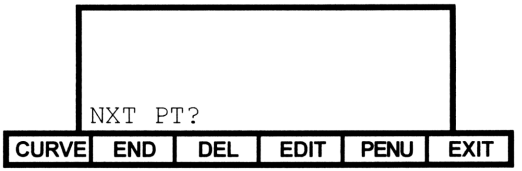
This process works well for those areas that are bounded by lines between points which are numbered *consecutively*. However, suppose you want to compute some other area. Take as an example the area bounded by lines that go from point 1 to 12 to 6 to 7 and back to 1.



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 a list of point numbers. To solve this particular acreage problem, you must do three things. First, you set up the Acreage Screen to compute area using that Point List. Next, you must specify the sequence of point numbers for the TDS-48 to use. Finally, press **[SOLVE]**.

Step 2: 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 switch the expected boundary format from sequential to: * Using Point List *.

Step 3: 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:



NOTE:

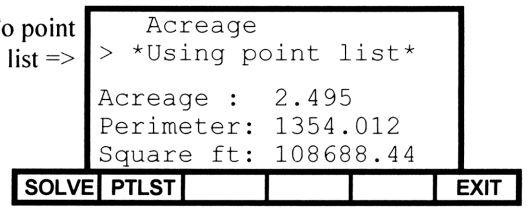
If your Point List is not empty, either press **|DEL|** repeatedly until it is empty; or, return to the Point List menu by pressing **|EXIT|**; press **|H| Clear Point List;** and finally, press **|G|** again to return to the Point List Screen.

The NXT PT? line is where you key in the points that you want; in this case, 1. Key in "1" and press **|ENTER|**; then "12" **|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. The point list should look like:

PT 1
PT 12
PT 6
PT 7
PT 1
NXT PT?

Step 4: 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.

From point - To point /Using point list =>

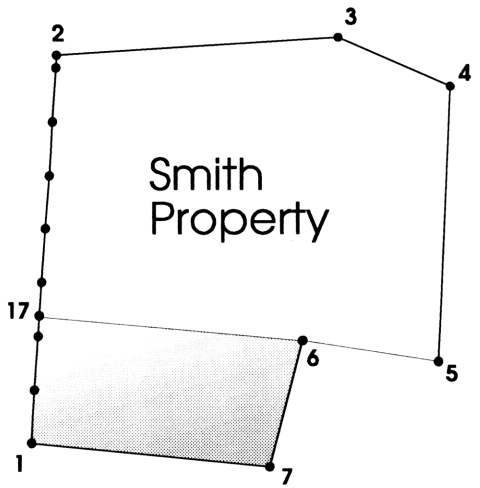


NOTE:

The Point List is used throughout SURVEY PRO to specify points to be used in a variety of functions. For example, the Screen Plot Screen 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 SURVEY PRO, be certain that you thoroughly understand the concept of the Point List. It is described in greater detail in the Reference section. You should practice using the Point List, with several functions.

Calculate Pre-Determined Areas

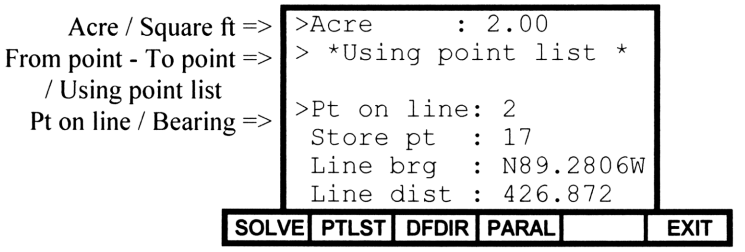
Let's assume Mr. Smith wants to section off a two-acre parcel from the lower notch of his property. To do this, you will need to find the point on line 1-2 that, when connected back to point 6, will section off exactly two acres of land. It is not a trivial task to calculate the boundary point that will provide a two-acre region. But, SURVEY PRO will calculate this for you using the **Swing Hinge Line** Approach. With this method, you can find this boundary point that will provide a pre-determined area; which in this exercise is two acres. This is graphically displayed in the drawing below:



The two-acre parcel will be bounded by the points 1, 7, 6, and a new point along line 1-2. For the new point, use point 17.

To solve this particular problem, you need the Predetermined Area w/ Hinge Line screen to locate the point that will create a 2.0 acre parcel.

Path: From the CO-GO Menu, select **|P|: Pre-Determined Area.**



Using this screen, you can swing the hinge line 6-17 about the hinge point (6) along the known directional line 1-2 until it finds the unknown point 17. All of this information is entered into the Polygon w/ Hinge Line screen as follows:

Step 1: Enter "2" in the Acres field to define the area to be sectioned off. Press **|ENTER|** or **|↓|**.

Step 2: Define the boundary points of the polygon. This requires that you use the Point List screen again. Press **|PTLST|** to display the Point List Menu.

On the Point List Menu, clear the existing point list by selecting **|H| Clear Current List; |Y|** in response to the "Are you sure?" prompt; and then, **|G| Edit Current List**.

Step 3: Enter the points bounding the lower notch of the property, starting with the break point 1 and ending with the hinge point 6. Enter "1, 7, 6" and press **|ENTER|** after each number.

PT 1
PT 7
PT 6
NXT PT?

NOTE:

The boundary for a Polygon with Hinge Line can have as many points as you desire, but the list ***must begin*** with the break point (the starting point of the fixed line that the hinge line intersects with) and ***end*** with the hinge point (the point that the hinge line rotates about).

Press **|EXIT|** twice to leave the Point List screen and return to the Polygon W/Hinge Line screen.

Step 4: To define the fixed intersection line (the line that will be intersected by the swing line at the unknown point), enter "2".

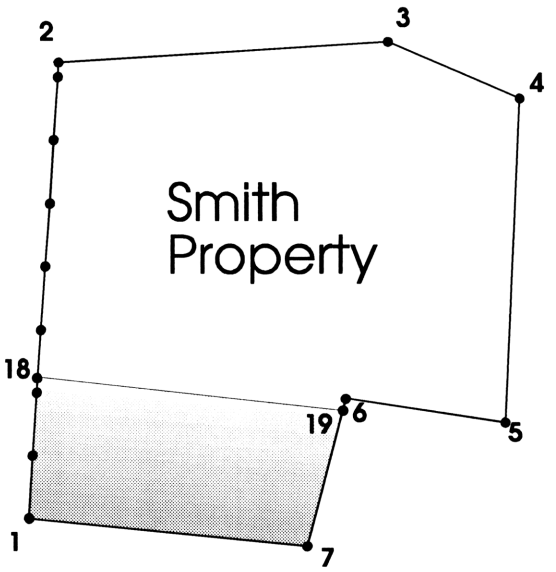
Step 5: Enter "17" as the point number whose coordinates are to be calculated and stored in the SMITH job file.

Step 6: Press **|SOLVE|** or **|G|** to do the actual computation. Again, SURVEY PRO will prompt you for an elevation and descriptor for the point. The coordinates of point 17 will now be added to the SMITH job file.

You can plot point 17 if desired, and you can check that the area is indeed 2.0 acres by returning to the Compute Area screen. Press **|AREA|** or **|G| Compute Area**. Use a new Point List that contains points 1, 7, 6, 17, 1.

The Moving Parallel Line Approach

Another way to calculate the points that bound a pre-determined area is the Moving Parallel Line method. With this method, you section off a pre-determined area by sliding a line (up or down) parallel to a known line of a four sided figure as shown below.



Path:	From the CO-GO Menu, select **[P] Pre-Determined Area** . Then press **[PARAL]** or **[D]** to bring up the Parallel screen

Acre / Square ft =>
pt 2 / Bearing =>
pt 2 / Bearing =>

```
>Acre      : 2.00
Side 1: pt 1:1
>       pt 2:2
Side 2: pt 1:7
>       pt 2:6
Store 1st pt:18
      2nd pt:19
```

SOLVE | | DFDIR | | | EXIT

In order to set up a parallel predetermined area calculation, you must define three lines or sides of the area. SURVEY PRO will determine the fourth side. The middle line is the one that will be parallel to the side that is moved to obtain the predetermined area. The two sides are entered into the screen. The first point (Pt 1:) of these two lines defines the middle or parallel line.

Step 1: In the Parallel Moving Line screen, define the left and right sides of the 2.0 acre parcel by naming two points for each side of the property. The first point of each side must be the point that is in common with the line of the boundary that will be parallel with the moving line; in this case, line 1 to 7. Enter the values as shown in the screen above:

Step 2: Press **|SOLVE|** or **|G|**. You will be prompted for an elevation and descriptor for each new point. Input the data and press **|ENTER|** for each point.

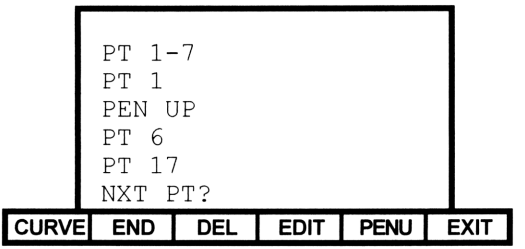
SURVEY PRO will compute the coordinates for new points 18 and 19 and then add them to the SMITH job file. You can check that you have indeed created a 2.0-acre parcel by using the Compute Area screen and the appropriate Point List: 1, 18, 19, 7.

PLOTTING

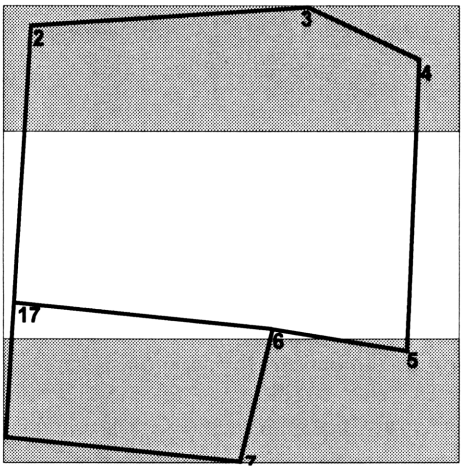
Next let's redo the screen plot of the boundary of the SMITH job and include a line 6 to 17. This will illustrate the feature of inserting a **|PENU|** command in the Point List that controls the screen plot.

Press **|PLOT|** or ↵ **|÷|** and then **|PTLST|**. Press **|H|** to clear the existing list 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. In a Point List, 1-7 means a range of points (from one to seven) and not the azimuth or distance between 1 and 7. Press **|ENTER|** to enter this line. Then key in "1" again. Press **|ENTER|** again. This will design 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 6 to point 17, but you do not want a line between 1 and 6. Press **[PENU]** - pen up key. This command will "lift the pen" before moving to the next point. Now press "6" **[ENTER]** and "17" **[ENTER]**. Properly filled out, your Point List should look like:



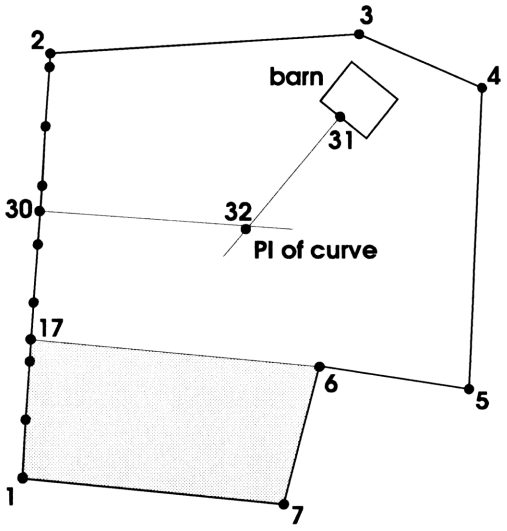
Press **[EXIT]** twice to return to the Screen Plot Screen; set the scrolling prompt to read *Using point list*; and press **[LINES]**.



You should see a portion of the desired plot in the screen. Remember to use the **[↑]** and **[↓]** keys to see the rest of the plot. Don't forget to press the **[ON]** key to return back to the Screen Plot screen.

HORIZONTAL CURVE ROUTINES

Mr. Smith wants to sell the two-acre parcel of land that you previously created with the addition of point 17. Unfortunately, the existing gravel driveway to his barn runs across this parcel. Mr. Smith would like you to design a new 20 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. From a previous survey of this 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 this table. Enter the following coordinates via the Edit Coordinate screen.

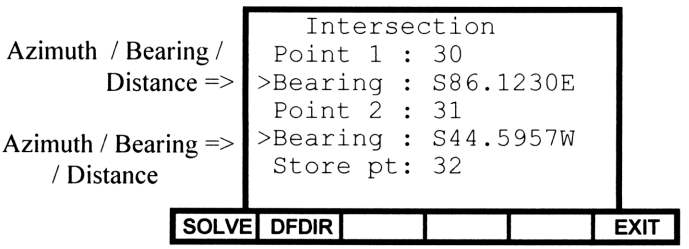
PT NUM	NORTHING	EASTING	ELE.	NOTE
30	5449.0151	5029.7574	229.74	WEST END
31	5553.3876	5488.3254	235.31	FRT. OF BARN

Next, calculate the PI or the intersection of the two sections of driveway.

Path:	Press [INTRSC] or [↵] **[I]** to jump to the Intersection screen.

The bearing of line 30 - 32 is S 86 12' 30" E; the bearing of line 31 - 32 is S 44 59' 57" W

Step 1: 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, fill out the screen as follows:



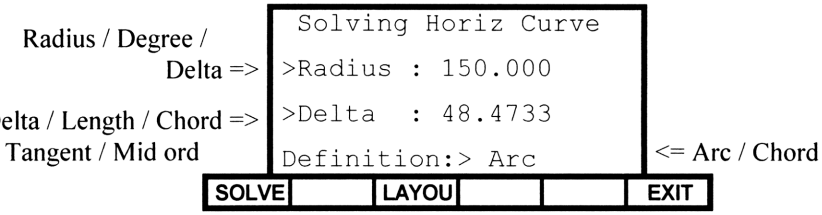
Call this intersection point: point 32. Enter an elevation of 227.53 ft. Its coordinates are:

PT NUM	NORTHING	EASTING	ELE.	NOTE
32	5427.0004	5361.9419	227.53	PI OF CURVE

HORIZONTAL CURVE SOLUTION

Your next task is to put a 150 ft radius curve on this center line.

Path:	Select **[Q]** from the Main Menu. Press **[G]** for the Solving Horizontal Curve Screen.

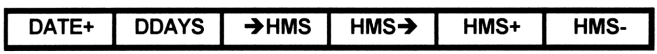


To define a curve, you need at least two of its parameters: one that relates to its curvature and one that relates to its length. The Solving Horizontal Curve Screen has two data input lines that relate to these two properties. You may use the horizontal cursor keys (**[←]** or **[→]**) to set the prompt to the quantities you know.

Step 2: In this case, the **radius** is given as 150 ft.

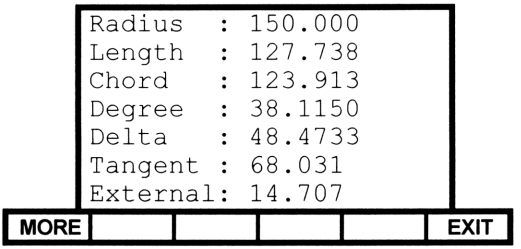
Step 3: The **delta angle** may be computed from the bearings of the center lines of the driveway which are the tangent lines of the curve. However, SURVEY PRO will compute the angle of the PC-PI-PT by entering "30-32-31" and pressing **[ENTER]**.

Next, you need to subtract this result from 180°. Highlight the Delta angle field and press **[ESC]** or ↩ **[A]**. You should now be in the HP-48GX stack with "131.1227" in line 1. Press the **[+/-]** key. Now, enter "180" and press **[ENTER]**. Next you want to add these as Degrees, Minutes, and Seconds. Press ↩ **[4][NXT]** to display up the softkeys:

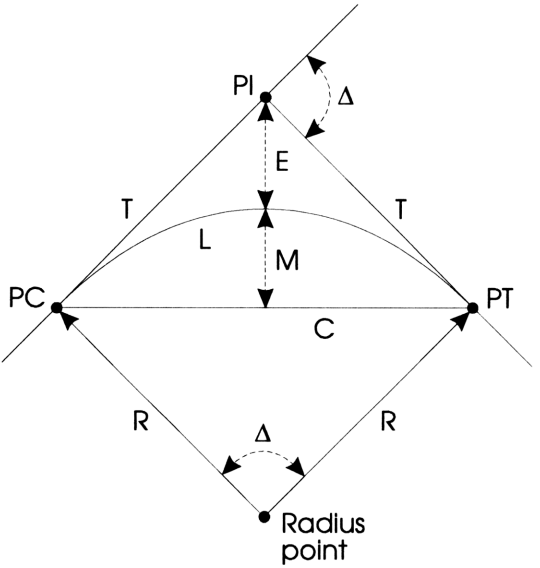


Press **[HMS+]** or **[E]** to add. The delta angle of 48.4733 should now be displayed in the #1 stack position. Press **[CONT]** or ↩ **[ON]** to return to SURVEY PRO program with this result. With the screen filled out as above, press **[SOLVE]**.

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 p) Expressed in degrees, minutes, and seconds.

Step 4: Press **[MORE]** to see the values:

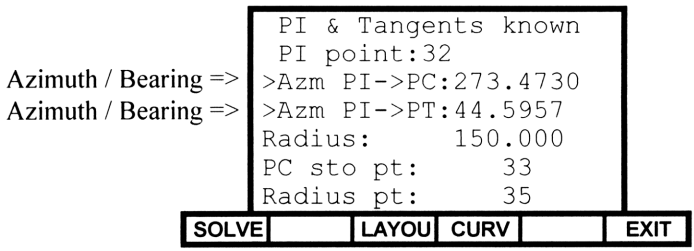
Mid-ordinate: 13.439
Segment : 1122.376
Sector : 9597.030
Fillet : 624.292

NOTE: These values will be automatically placed into any other curve screen where they are needed. For example, if you access the Traverse On A Curve screen now, the radius and length will **already** be entered in the appropriate data fields.

FINDING THE PC AND PT

To complete the curve, you need to compute the coordinates of the Point of Curvature (PC) and Point of Tangency (PT) of the curved portion of the driveway. You could do this from the curve parameters and the CO-GO functions, but SURVEY PRO provides a special PI and Tangents Known screen that makes finding the PC and PT very simple.

Path: From the Curve Menu, select **|H| Known PI and Tangent.**



Step 4: Enter the following:

- "32" as the PI.
- "32-30" in the Azm PI->PC field.
- "32-31" in the Azm PI->PT field.
- the radius as "150."
- the PC Store Pt as "33"

The PT will be stored in the next consecutive number.

- "35" as the radius point.

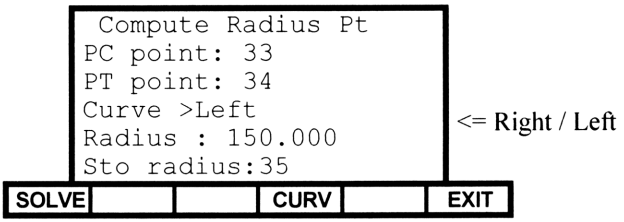
Step 5: Press **|SOLVE|**. The SURVEY PRO will display the results of the radius, PI and tangent. Then, it will prompt you to give an elevation and description for the next three store points. Press enter to accept the default elevations and enter descriptors. The SURVEY PRO will add these points to the job file.

CO-GO & CURVES

COMPUTE RADIUS POINT

You previously generated the radius point (pt 35) in the PI & Tangent routine above. This is presented here, so that you are aware of its availability.

Path: From the Curve Menu, select **[J] Compute radius pt.**

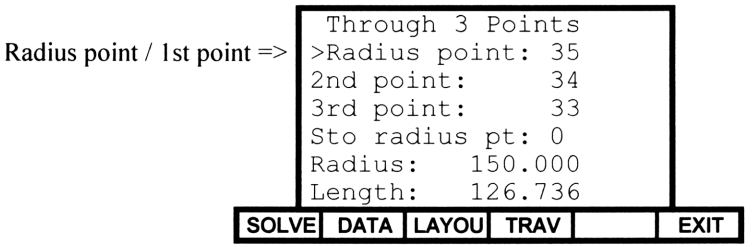


Filled out the screen as desired and press **[SOLVE].** This routine computes and stores the radius point.

CURVE THROUGH THREE POINTS

Just for practice with another curve routine, let's use the Through Three Points function to compute the curve we just created. You will solve for the curve that lies between points 33 and 34, using point 35 as the radius point.

Path: From the Curve Menu, select **[I] Through 3 Points.**



The Curve Through 3 Points screen operates in two modes: one allows you to solve for the curve using three points on the curve itself; beginning point, ending point and one other point on the curve. The other solves for the curve using a known radius point and the begin and end points of the curve.

Step 1: Use the **[←]** or **[→]** on the scrolling prompt of the first line to select the Radius Point option.

Step 2: Enter the Radius Point as "35."
Enter the 2nd Point as "34"
Enter the 3rd Point as "33"

In order to determine the curve you want solved, the points must be entered in clockwise order.

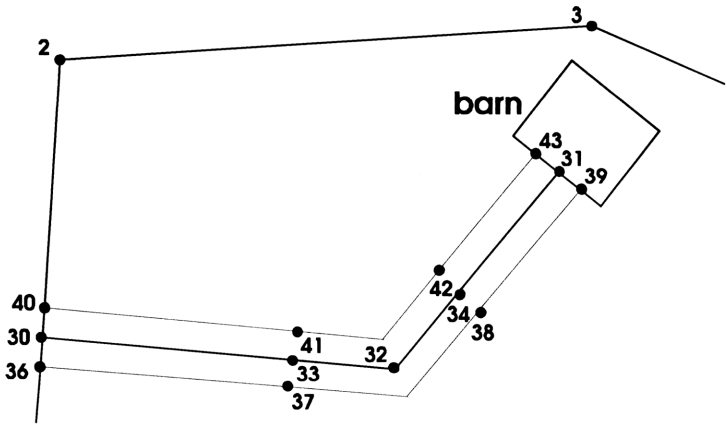
Enter "0" as the Sto radius pt:

With "0" in the Sto radius pt: field, this routine will not store a radius point.

Step 3: Press **[SOLVE]** or **[A]**. SURVEY PRO will solve for the curve and respond by displaying the radius and length. Press **[DATA]** to display the results. You have just verified that you have the correct curve in the driveway.

OFFSETS OF THE DRIVEWAY

Next, let us set offset points at the ends of each segment of the center line so that we can calculate the area of the drive.



The boundary points of the driveway, points 36 through 43 in the figure above, may be located using the Point-in-Direction Screen in the CO-GO Menu. Points 36 and 40 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 Point-In-Direction Screen. We will set point 37 as an example:

Path:	Press **|PT-DIR|** or ↩ **|K|** from wherever you are to bring up the Point-In-Direction Screen. .

Azimuth / Bearing =>

```
  Point in Direction
Occupy pt: 33
>Azimuth   : 93.4730
Horiz dist: 10
+/- ang :   90.0000
Store pt: 37
Descα: PT37
```

SOLVE	DFDIR				EXIT

Step 1: Enter "33" as the Occupy pt:, enter "30-33" to compute the Azimuth; and, enter "10" in the Horiz dist: field.

Step 2: Now, we want point 37 set at a 90° angle to the line 30-33; so, we enter "90.0000" in the +/- ang: field. The store point is "37". With this screen completed as above, press **|SOLVE|**.

Determine the coordinates of the other points along the boundary of the driveway in like manner. When setting a point to the *left* of a line enter "-90.0000" in the +/- ang: field. Also note that when you are using the +/- field, the Azimuth field is modified between each calculations. It will need to be re-entered when you are doing several calculations from the same point.

AREA AND 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 10 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 37 and 38 and another one between points 41 and 42. 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.

Path: Press **|AREA|** or ↩ **|G|** from wherever you are to bring up the Area Screen. Press **|PTLST|** or **|B|** for the Point list menu. Press **|H| Clear Point List** and **|G| Edit point list**.

Step 1: The Point List sequence for this job is:

36 **|ENTER|**
37 **|ENTER|**

Step 2: Press **|CURVE|** and fill out the Horiz/Vert Curve Screen as shown below; then, press **|ENTER|**.

```
   Horiz/Vert Curve
P1: 37     P2: 38
>Radius : 160.0000
Turn: >Left
Arc:  >Small
Beg grade(%):  0.000
End grade(%):  0.000
```

Radius =>

<= Right / Left
<= Small / Large

ENTR					EXIT

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.

Step 3: Enter: 39 **[ENTER]**
43 **[ENTER]**
42 **[ENTER]**

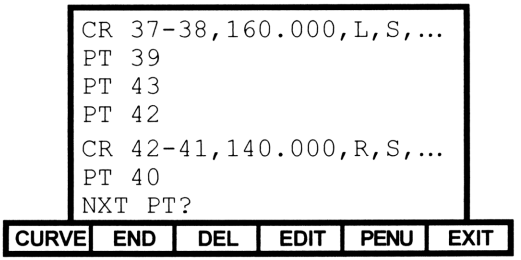
Step 4: Press **[CURVE]** and fill out the Horiz/Vert Curve Screen with:

P1 = 42 P2 = 41
Radius = 140
Turn = Right

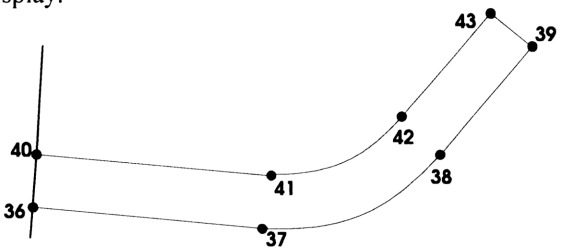
Press **[ENTER]**.

Step 5: Input 40 and press **[ENTER]**.

The Point List Screen will look as follows before you press **[EXIT]**.



The first two points in the point list, PT 36 and PT 37 have scrolled off the top of the display.



Step 6: Press **[EXIT]** twice to return to the area screen and press **[SOLVE]**.

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 0.231 acres or 10066.507 sq. ft. as the area.

That completes the CO-GO and curve section of this tutorial. You should be able to use the various routines to solve your own surveying needs. If there are fields or keys in a screen that you need more information on, please refer to the reference section for a complete description of every routine in the SURVEY PRO.

6: STAKEOUT

This chapter is designed to familiarize you with the TDS-48GX's staking programs. The three stakeout routines are:

- **Point stake (or radial stake).**
- **Offset stake.**
- **Slope stake.**

We will cover each of these and take an in-depth look at using a point list to define a center line.

In this chapter, you will explore the different stakeout routines. 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. And, finally, you will use the Slope Staking routine on this driveway.

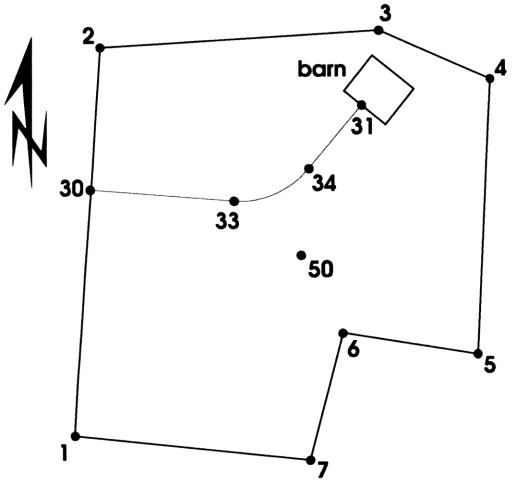
If you have not done the Field Work from chapter 3 or no longer have the SMITH job available, you can create a new job file and enter the coordinates from the table below. Your coordinate file should look as follows:

PT NUM	NORTHING	EASTING	ELE.	NOTE
1	5000.0000	5000.0000	227.53	START
2	5709.8469	5047.0433	230.82	PT 2
3	5736.1695	5504.0370	233.90	PT 3
4	5649.0185	5685.4911	235.75	PT 4
5	5152.6326	5660.0409	244.89	PT 5
6	5194.3888	5439.9992	242.32	PT 6
7	4966.9177	5385.6510	239.83	PT 7
30	5449.0151	5029.7574	229.74	WEST END
31	5553.3876	5488.3254	235.31	FRT. OF BARN
32	5427.0004	5361.9419	227.53	PI OF CURVE
33	5431.4991	5294.0597	227.53	PC OF CURVE
34	5475.1063	5410.0464	227.53	PT OF CURVE
35	5581.1708	5303.9788	227.53	RAD OF CURVE
50	5338.7259	5366.1916	237.88	PT50

If you have done the survey of the SMITH property in chapter 3 but have not set up the driveway from chapter 5, you should only need to enter points 30-35 and 50.

STAKEOUT

The Smith property, with the driveway's center line, is shown below:



POINT or RADIAL STAKEOUT

Before you begin staking, you need to set a couple of parameters. These affect all the stakeout routines.

Path:	From the Main Menu, press **[I] Stakeout Menu**. Then, press **[K]** to select **Set Stakeout Mode**.

```
  Set Stakeout Mode
Store cut sheet: >YES
Horiz R/L tol(ft):0.50
Slope stk tol(ft):0.50
Send stakeout data
  to gun: >No
                    EXIT
```

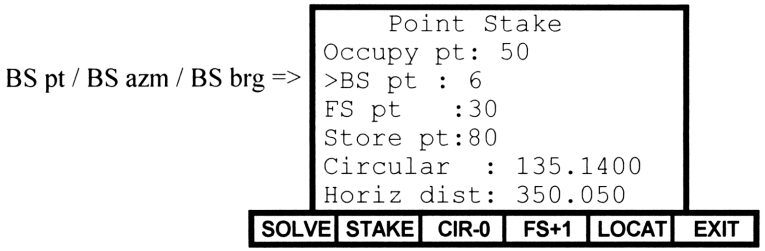
<= YES / NO

When set to YES, the first choice in this screen allows you to store cut/fill data in the raw data file. This information can then be extracted using the TDS TFR program on your PC to print a cut sheet. The other two parameters establish an error tolerance for the horizontal R/L: enter 0.50 sec.; and set a slope stake

tolerance: enter 0.50. If a stakeout computation creates a error greater than the established tolerance, the TDS-48GX will display a warning. Leave the last option as NO and press **|EXIT|** to return to the Stakeout Menu.

The Point stake routine can be told the order and/or range of points to stake using the Point Stake Setup Screen. In the setup screen you can set a range of points in consecutive order or use a point list to describe the point and order that are to be staked. Once the **|INIT|** key has been pressed then from the Point Stake screen you can press the **|FS+1|** key to stake the next point in the defied point list. We will not be using this feature in our example but you may wish to familiarize your self with this feature for future reference. Now, let us start by staking the center line of the SMITH driveway using Point Stake.

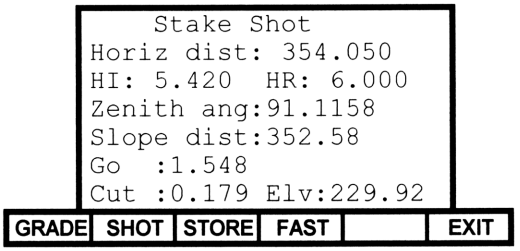
Path: From the Stakeout Menu, press **|H| Points Stake**.



Step 1: Let's assume that you reestablish your gun on point 50 and that you will again use point 6 as your backsight. Remember to scroll the prompt in line 3 of the display to "BS pt" and set it to "6". Specify point 30, the west end of the center line of the driveway, as your foresight.

Step 2: The Store pt is the point number where you can store the actual staked coordinates. In this way, you can have a record of the locations of the stakes to compare with the designed points. The display given above is what your Points Stake Screen should look like.

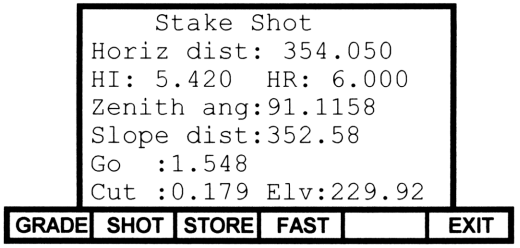
Step 3: Now, press **|SOLVE|**. You will be informed that a new occupied point is being used and asked if you wish to set the backsight and height of instrument. Answer YES or [A] and the following screen will be displayed..



the Backsight point should be 6 from the previous screen but check to see that the BS Circle Reading is 0.000 and set the HI to "5.42". Press **|SOLVE|** and **|EXIT|** this screen.

The TDS-48GX will compute the circle angle and the horizontal distance from point 50 to point 30. The numbers are 135°14'00" for the circle angle and 354.050 for the horizontal distance.

Step 4: You would have your rod man pace off the distance; keep him on line with the gun; and, while he is getting set, press **|STAKE|**. The Stake Shots Screen is displayed. The Stake Shots Screen provides you with an opportunity to change the gun and/or rod height. Set the RH to "6.00".



If you were in the field working manually, you would take a shot and key in the zenith angle and slope distance. Then, press **|SHOT|**. If you were connected to an electronic total station, by pressing **|SHOT|**, the proper data would be gathered and transferred to your TDS-48GX automatically. Either way, the TDS-48GX will display a Come or Go distance for the rod man and a Cut or Fill.

Step 5: Key in the Zenith: 91.1158 and Slope dist: 352.58 and press **|SHOT|**. The TDS-48GX should tell you to Go 1.548 ft. The Stake Shot Screen is shown above, as it should appear after pressing **|SHOT|**.

Step 6: Your rod man would adjust and you shoot again. Enter a Slope dist of 354.16 and press **|SHOT|**. The Come/Go should read Come: 0.032. This process can continue as long as needed to place your rod on the stake point. Let's assume this is good enough.

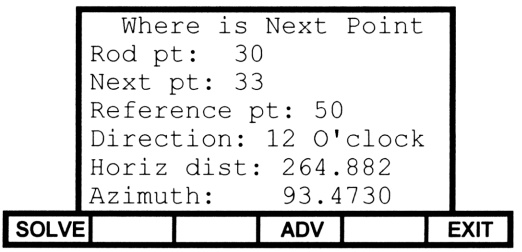
Step 7: At this point, you can press **|STORE|**. The coordinates of the most recent shot will be stored in the file at the point number you set up in the Points Stake Screen, and the point number is incremented. This step is optional; if you don't want to store your as-built coordinates, simply skip the **|STORE|** key.

WHERE TO NEXT?

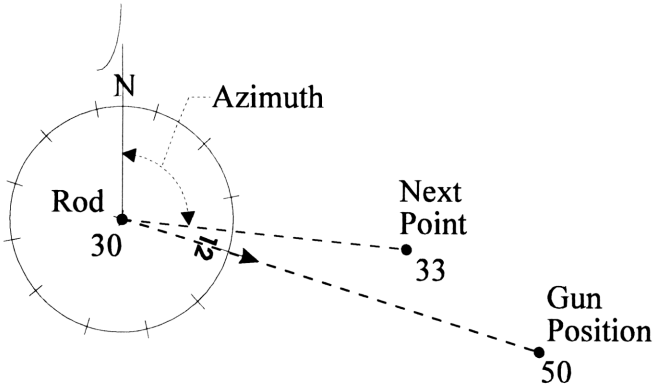
The TDS-48GX has a screen in the Stakeout Menu that may be used by the rod man to locate the next point to be staked. If your rod man has a TDS-48GX, (or the gun man may calculate this for him), he may use it at this time to determine the direction and distance that he should pace to locate the next point to be staked, point 33.

Path:	From wherever you are in the TDS-48GX press **[WHERE]** or [ON] **[2]**

You will see the Where is Next Point Screen which should be filled out as follows; then, press **[SOLVE].** Use the gun location as a reference point. After pressing **[SOLVE],** you will see the following:



By standing at point 30 and facing the gun (point 50) it can be determined that the next point is approximately in the 12 o'clock direction. Imagine a clock at the rod with 12 o'clock facing the gun. In this example the next point happens to be within 15° of the direction of your instrument and therefore results in a 12 o'clock reading. The rod man then turns to the 12 o'clock direction and pace off 261 ft to get close to point 33, the next point to be staked. If he has a compass, he can line up the direction to the next point, at an azimuth of approximately 93 degrees from north. Pressing **[EXIT]** will return you to the Stake Shot screen.



In a similar manner, let's stake point 33.

Step 8: From the Stake Shot Screen, press **[EXIT]** to return to the Point Stake Screen. If our points were in numerical order, or you had setup a point list, you could simply press the **[FS+1]** key to increment the point to be staked and solve it. But, since our old FS pt was 30 and you now want 33, you need to enter "33" into the FS pt field. However, you used the WHERE? function, which set point 33 in the FS pt field, so press **[SOLVE]**.

Step 9: Press **[STAKE]** and enter:
Zenith: 93.4628
Slope dist: 119.82
Then, press **[SHOT]**.

Step 10: You should repeat the **[SHOT]** process until the Come/Go is close enough and press **[STORE]**.

You can stake the last two 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 have just staked 30 and 33, so finish with points 34 and 31.

OFFSET STAKEOUT WITH BOTH HORIZONTAL AND VERTICAL CURVES

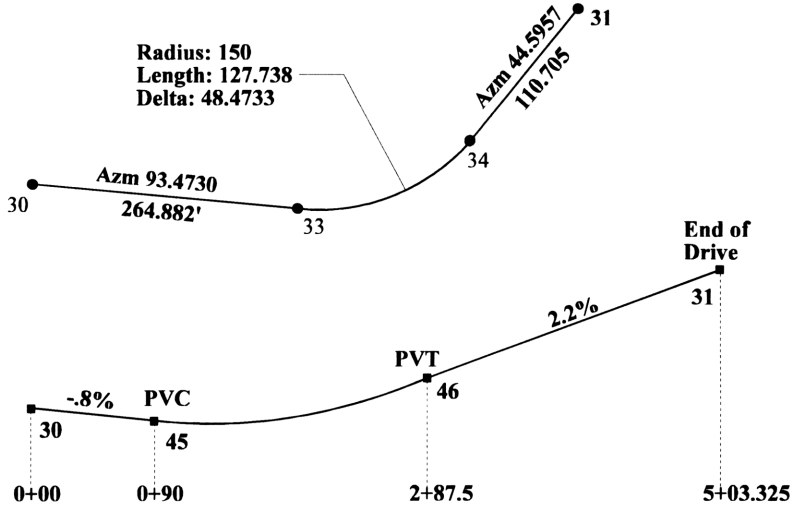
The TDS-48GX Offset Staking is set out along a center line. Therefore the first task in this example is to define a center line. The center line is defined by a series of straight or curved segments. A segment can have both horizontal and vertical components. All changes in curve specification or direction along the center line must occur at a coordinate point. The center line profile definition can't change within a defined segment nor between two adjacent coordinate points in the Point List. This means, when curve features overlap, each point where the horizontal or vertical profile change, must be divided into separate segments. e.g. a vertical curve may overlap horizontal curves or straight sections along the way. The vertical curve must be divided into segments that match the horizontal sections. Of course, a horizontal curve overlapping vertical curves requires similar treatment. Both of these conditions are covered in the example below.

The center line could be defined using TDS-48GX's Co-Go and curve routines to establish each point where there is a change in horizontal or vertical profile. The points and curve information would then need to be manually entered in the Point List screen. This is a tedious and fairly time consuming process with a good chance of error.

The TDS-48GX has automated this process in the Road Layout routine. TDS-48GX's road layout feature allows you to describe a road in terms of horizontal and vertical alignment and then create the points and a point list describing the center line. For the road layout, you simply enter the direction and distance of straight sections and the tangent, length and radius of curved sections. Once this information is entered for both the horizontal and vertical profiles, the TDS-48GX calculates the coordinates for each point and then generates a point list defining the center line.

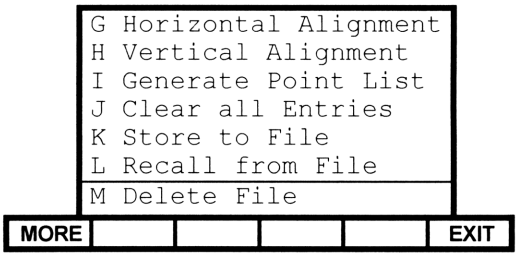
The example given below, is more elaborate than you would normally do in staking a simple driveway. However in order to illustrate overlapping horizontal and vertical curves, we are going to put a vertical curve into the SMITH driveway. To define the center line, you must have coordinate points defined for the beginning and ending of each horizontal or vertical curve and also at the point where a straight section changes direction. In addition, you must calculate the grade at each point along a vertical curve where the horizontal component changes.

The SMITH driveway starts with point 30. We will define this as station 0+00. The PC at point 33 is station 2+64.882; the PT is 3+92.62; and, the ending station at point 31 is 5+03.325. Below is a diagram of the horizontal and vertical profiles we will be using for the driveway.



Road Layout

Path:	From the Main Menu, select **[K] Road Layout Menu.**



STAKEOUT

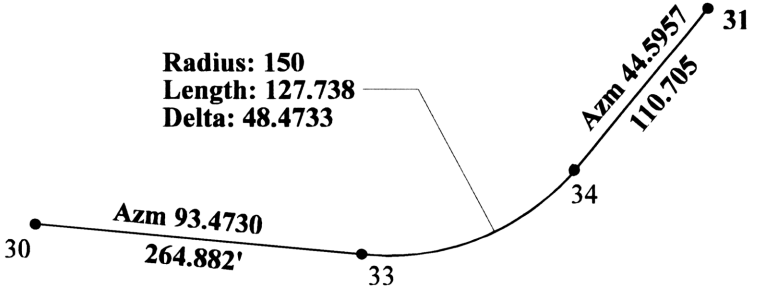
Step 1: From the Road Layout Menu, select **|D| Clear All Entries**. And answer "Y" to the "Verify Clear" prompt.

This deletes the current layout, if one exists, so that you can enter a new one.

Horizontal Alignment

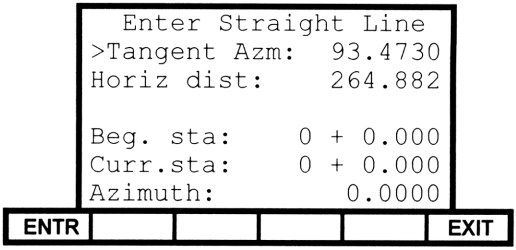
Step 2: From the Road Layout Menu, select **|G| Horizontal Alignment Screen**.

This screen functions somewhat like the Point List screen. In it, you will describe the horizontal alignment of the road in terms of lines and curves by pressing **|LINE|** or **|CURVE|** and thereby entering the parameters of the line or curve.



Our Smith Road starts with a straight section defined by the line 30-33. The center line then curves through points 33-34, and the curve is followed by another straight section from points 34-31.

Step 3: Press **|LINE||F4|**. The Enter Straight Line screen displays as shown below. Here you enter the parameters for the first straight section of the road.



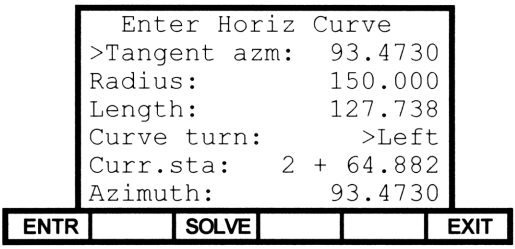
Step 4: use the scrolling prompt to select the Azimuth option. Enter "93.4730" as the Azimuth for the first straight line segment.

Enter "264.882" for the Horiz Dist.

Step 5: Press **[ENTER]**. This enters the values in the Horizontal Alignment screen.

Now we can describe the second region of the road, the curved line 34-35.

Step 6: Press **[CURVE]** to display the Enter Horizontal Curve screen, as shown below.



Step 7: The Azimuth value will already be in place because the azimuth of the line we just defined in Step 4 above is also the forward azimuth of the curve we want to create now.

Enter "150" as the Radius and "127.738" as the Length.

Use the scrolling prompt to select "**Left**" in the Curve Turn field.

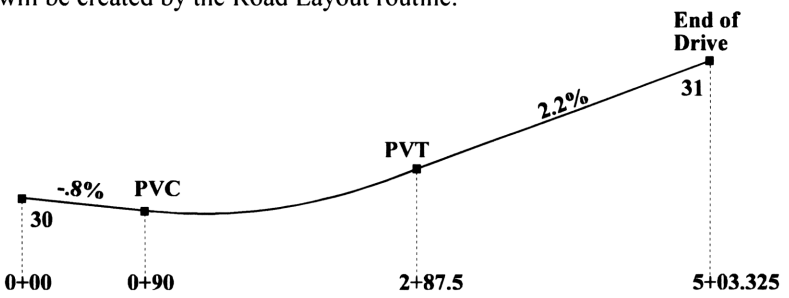
Step 8: Press **[ENTER]** to enter the curve values into the Horizontal Alignment screen.

Step 9: Another straight segment must be added using the **[LINE] [F4]** key and the Enter Straight Line screen. When it appears, leave the Azimuth (44.5958) as it is because the exit tangent of the curve is the azimuth of the line we want to define. Enter the distance of line 34-31 as "110.705" and press **[ENTER]** .

This completes the definition of the horizontal components of the road. Press **[EXIT][F6]** to return to the "Road Layout" Menu.

Vertical Alignment

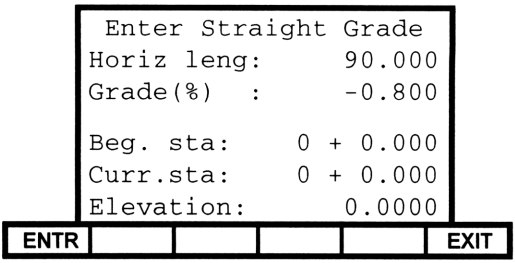
We now must define the vertical components. The same concepts are used, only this time we define the straight grade and vertically curved sections of the road in terms of straight grades **[GRADE] [F4]** and parabolic curves **[PARAB] [F3]**. Note that the PVC and PVT points do not now exist but will be created by the Road Layout routine.



Path:	From the Road Layout Menu, select **[H] Vertical Alignment Screen**.

We begin by defining the grade of the first segment, the first 90 feet of line 30-33.

Step 1: Press **[GRAD]**.
The Enter Straight Grade screen appears as shown below.

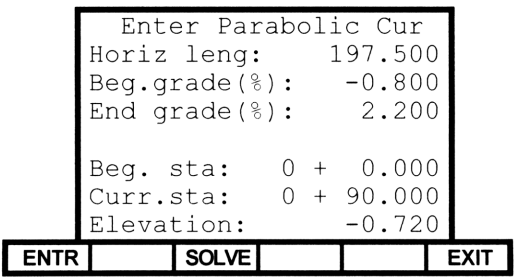


Step 2: Enter "90" as the Horizontal Length.
Enter "-.8" as the Grade %.

Step 3: Press **|ENTER|** will enter the grade line and return to the Vertical Alignment screen.

Step 4: Press **|PARAB| |F3|** to enter the parameters of next section of the road, which is vertically curved. This vertical curve continues through the remainder of the line 30-33 and most of the horizontal curve (33-34).

The Enter Parabolic Curve screen will be displayed as shown below:



Step 5: Enter "197.5" as the Horizontal Length.
Enter "-.8" as the Begin Grade % and "2.2" as the End Grade %. This defines the rise of the curved section.

Step 6: Press **|ENTER|**.

We continue defining straight and curved vertical sections this way using the **|GRADE||F4|** and **|PARAB||F3|** keys.

Step 7: The third section of the road is straight. Press **|GRADE| |F4|**. Enter its length as "215.825" and its grade as 2.2%. press **|ENTER|**

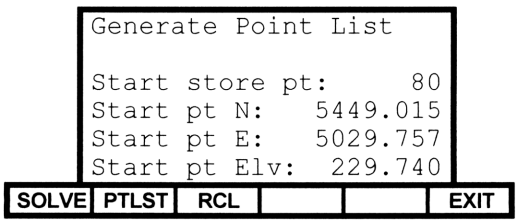
You can now **|EXIT| |F6|** the Vertical Alignment screen, then **|EXIT| |F6|** again to return to the Road Layout Menu.

Generate Points and Point List

The center line is described in a Point List. Straight segments are described by their end points. Curved segments are described by the end points of the segment plus information about the shape of the curve. A horizontal curve is defined by its direction of curvature, its radius and whether it is the larger or smaller arc of the circle. A vertical curve requires the beginning and ending grade % of the curve. Setting the **Radius** line in the curve screen to **Straight vert curve** indicates that the horizontal component of a vertical curve is straight. A beginning and ending grade % of 0 indicates that there is no vertical curvature. Each segment can include data defining both the horizontal and vertical curve specification.

The Road Layout will automatically generate the points and point lists from the data you have define for the horizontal and vertical segments of the Smith road.

Path:	From the Road Layout Menu, select **|I| Generate Point List Screen**.



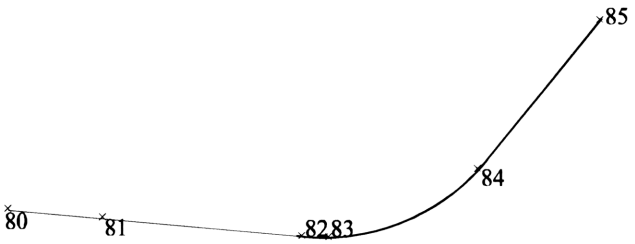
Step 1: Enter "80" as the starting point.

Step 2: To enter the starting coordinates of that point, you could enter the North, East, and Elevation of point #30 from the coordinate file. However, better way is to press **|RCL| |F3|** and enter "30." Pressing **|ENTER|** will recall the starting point's coordinates from the existing point 30.

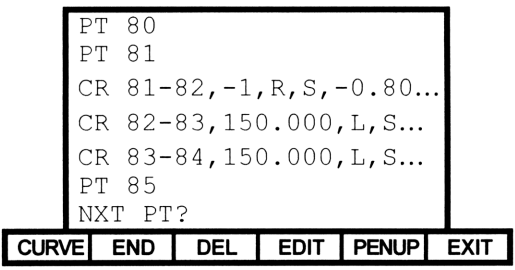
Step 3: Press **|SOLVE|**. The coordinates for each point and point list will be generated from the current road description.

NOTE: Before the TDS-48GX performs the solution routine, it displays a message asking whether to clear the point list that currently exists. Respond "Y".

Let's graph your road layout with its points on the screen. To do this, press **|MENU|** and then **|L| Plot / Print** menu, then **|A| Screen Plot**. Select "Using Point List" option and set Display Pt Numbers: to **ON**. Press **|POINTS|** , hit **|ENTER|** twice and then **|LINES||F3|**.



Hit **|ENTER|** twice again to return to the Screen Plot screen. Now let's look at the Point List that was generated. Press **|PTLST| |F2|** and then **|A| Edit Current List** to view the following Point List:



STAKEOUT

Pt. #80 to #81 define the beginning straight section with an even grade of -0.8% as defined by there elevations. Now use the ← → to place the CURVE 81-82 just above the highlighted POINT? line and press **[EDIT]**.

```
   Horiz/Vert Curve
P1: 81      P2: 82
>Straight vert curve
Turn:         >Right
Arc :         >Small
Beg grade(%): -0.800
End grade(%):  1.856
```

<= Radius / Straight line vert. crv
<= Right / Left
<= Small / Large

This is a straight line vertical curve with a beginning grade of -0.8% and an ending grade 2.2%. Press **[EXIT]** then highlight below curve 82-83 and press **[EDIT]**.

```
   Horiz/Vert Curve
P1: 82      P2: 83
>Radius :      150.0
Turn:         >Left
Arc :         >Small
Beg grade(%):  1.856
End grade(%):  2.200
```

<= Radius / Straight line vert. crv
<= Right / Left
<= Small / Large

This is the beginning of the horizontal curve and the remainder of the vertical curve with a beginning grade of 1.856% and an ending grade 2.2%. Press **[EXIT]** then highlight below curve 83-84 and press **[EDIT]**.

```
Horiz/Vert Curve
P1: 83      P2: 84
>Radius :     150.00
Turn:         >left
Arc :         >Small
Beg grade(%):  0.000
End grade(%):  0.000
```

<= Radius / Straight line vert. crv
<= Right / Left
<= Small / Large

This is the end of the horizontal curve. Its grade is uniform at 2.9%. Press **[EXIT]**. The remainder of the road is straight and of uniform grade defined by points 84 and 85. Press **[EXIT]** four times to return to the stake out menu.

OFFSET STAKEOUT

You are now ready to stake out the *offsets* to the center line. Let's say you have an offset of 10 ft. for the road way, a 4 ft. set back to the stake, and that you want to set a stake every 50 ft. The Offset Stakeout capability of the TDS-48GX makes this task easy and straight forward. Using this feature, you can stake an offset point along a center line by specifying a station and offset distance. The center line is always defined by the current Point List.

Step 1: After exiting from the Point List you should be back in the Offset Stakeout Setup screen. If not, from the Stakeout Menu choose **[H]** for the Offset Stakeout Screen, then press **[SETUP]**. The Setup Screen appears below properly filled out for this job. Mr. Smith's driveway will not have a cross section slope or a curb.

```
Occupy pt: 50
Begin sta:0   +0.000
Sta. intrvl(ft):50.0
Section width  :10.0
Cross slope(%) :0.00
Curb height(in):0.00
Ofst from curb :4.00
```

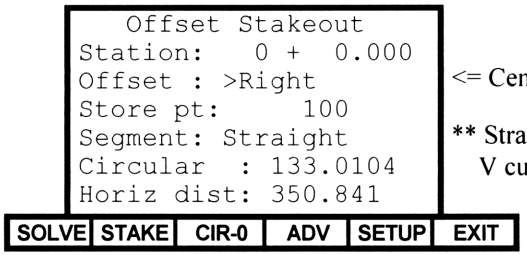
SOLVE	PTLST	BACK			EXIT

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.

Step 2: Use the **[BACK]** key to check to be sure the backsight is still set on point 6. After pressing **[SOLVE]** in the backsight screen, press **[EXIT]** to return to the setup screen. Then, press **[SOLVE]** in the setup screen to compute the setup screen. A result screen will be displayed as shown below:

```
Starting Pt:  30
Backsight Pt: 6
Backsight Az: 152.5501
```

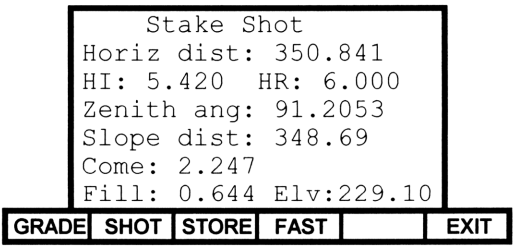
Step 3: Hit any key to exit this screen and return to the setup screen, then press **[EXIT]** to exit from the setup screen, back to the Offset Stakeout Screen. Set the Station to 0+00, the Offset: to read ">Right" and enter "100" for the store point. Press **|SOLVE|**. The TDS-48GX will provide the circle angle and horizontal distance for the first offset point to be staked. The screen should look like:



<= Center / Right / Left

** Straight / H curve / V curve / H+V curv **

Step 4: Have your rod man pace the distance close to the point to be staked. Press **|STAKE|**. You will see the Stake Shot Screen:



Step 5: At this point, if you were connected to an electronic total station, you would press **|SHOT|**. The TDS-48GX would trigger the gun and collect the required data automatically. For this example, you must key in the zenith angle and slope distance to the rod and press **|SHOT|**. Enter:

Zenith: 91.2053
Slope dist: 348.69

Step 6: Move your rod man based on the Come or Go message and take another **|SHOT|**. Enter:

Slope dist: 350.72

Step 7: 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.

Step 8: You have completed staking the first offset point. Press **|EXIT|** to return to the Offset Stakeout Screen. At this time there are several options on how to proceed:

Option 1: You can continue staking the right side of the driveway and return to the beginning to stake the left side when the right is completed. To proceed in this fashion simply 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 offset field.

Option 2: 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 to change it to >Left; then, press **|SOLVE|**. After staking the left side, you can use **|ADV|** as in Option1; then change back to the >Right, etc.

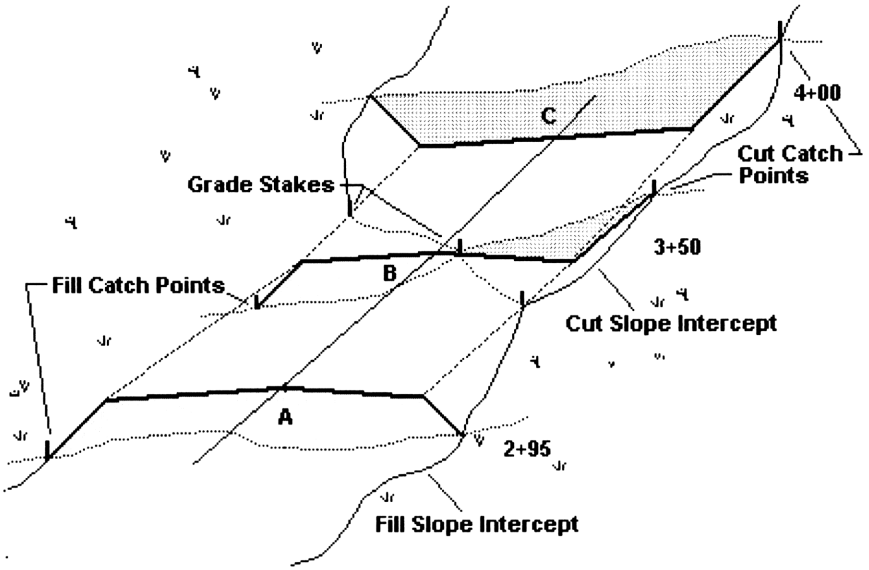
Option 3: At any time, you can stake an offset at a point that does not fall on a station interval by entering a new station on the first line. Then, press **|SOLVE|**. After staking this point, if you want to return to your regular interval stationing, you will need to enter the correct station. Pressing **|ADV|** simply adds the station interval to the last staked station and solves for this new station offset.

Option 4: You can stake the center line itself as you are proceeding down the driveway or by itself. To do this, select ">Center" as the Offset:. Any of the options described above are available while staking the center line.

Using these techniques, the entire driveway may be staked with the same field procedure, regardless of the curves encountered along the way.

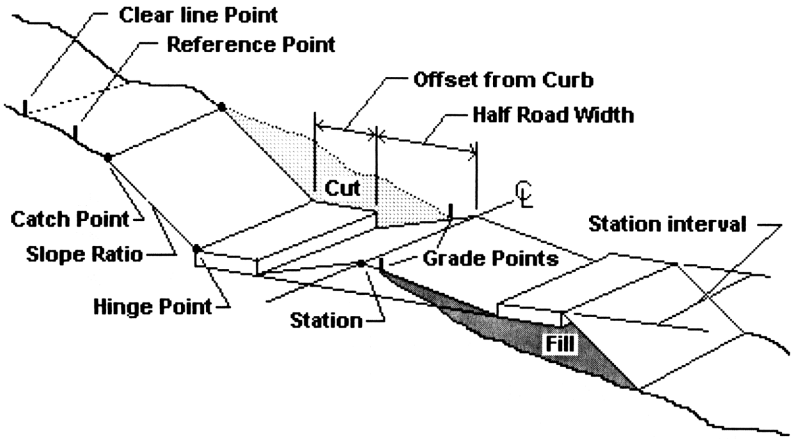
SLOPE STAKE

Slope Staking is a process used to establish the position of a road template on the physical terrain. After defining the width and crown of the road, the height of the curb, offset from curb, and other parameters of the road profile, Slope Staking lets you determine the position where you need to start to cut or the distance that fill must be placed to establish the desired road bed.



As you can see from the diagram above, the road may require fill to both sides (A); one side fill and one cut (B); or, a cut to both sides (C). In addition, the road template may have a slope and width that is symmetrical (B) or each side can be defined independently (A & C).

With the following diagram in mind, let us discuss several terms.



Catch Point: This is the point where the slope of the cut or fill needed to level the road bed meets the surface of the existing terrain.

Clear line point: This is a reference point staked at the line, beyond which construction should not disturb.

Grade Point: Is a point where the road profile and the existing terrain meet. Grade points are points where neither cut nor fill is required.

Half road width: Is the width of the road from the center line to the edge of pavement.

Hinge Point: Is the point where the road template and the cut or fill slope meet.

Reference Stake: Is a stake set some distance and elevational difference from the catch point.

Slope ratio(H / V): The slope of the cut or fill line. This is expressed as the horizontal component of the slope divided by the vertical component of slope.

Station: Is the point along the center line for which a catch point is currently being staked.

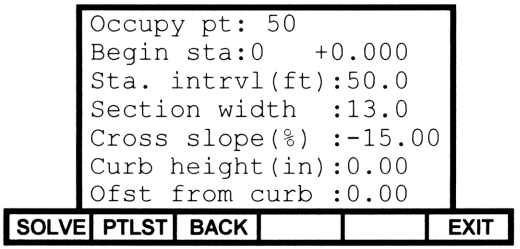
SLOPE STAKE: Setup

This example will use the SMITH driveway to approximate the field steps necessary to establish three catch points along our road way. The lay of the land used in this example is sloping, high from the north down across the driveway to the south and **does not match** the topo you may have done in an earlier chapter. The center line, defined for the Offset stake example, will be used here also. If you have not done the offset stake example, or do not have the Point List available, you will need to go back and generate the Point List.

Our first task is to establish our occupied point, the backsight point and the station information that will be used for staking. We now move to the Slope Stake Screen.

Path:	From the Main Menu, select **[I] Stake Out**, and, from the Stake out Menu, select **[I] Slope Stake**.

The Offset Staking Setup screen is the place this data is entered. Press the **[SETUP]** or **[E]** key to move there. The setup screen is the same here as it was for offset stakeout.



Step 1: Enter "50" as the Occupy Pt:

NOTE:

As with all stakeout routines, the occupied point can be any point in the current job or control files. A point on the center line could have been used just as well.

Step 2: To set the backsight point press **[BACK]** or **[C]**. This will bring up the backsight screen:

BS point /
BS azm / BS brg =>

```
   Backsight
>BS point: 6
 Circle:   0.0000

BS Azm: 152.5501
BS Brg: S27.0459E
```

SOLVE | CHECK | | FAST | CIRCLE | EXIT

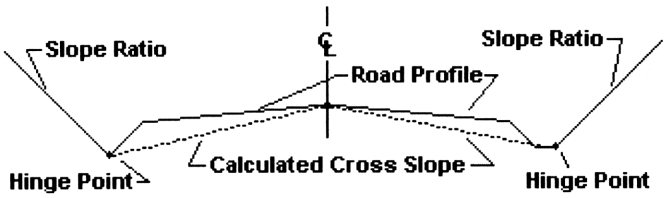
NOTE: If the first data entry prompt does not read **>BS Point:**, use the left or right arrow keys to scroll to the desired prompt.

Enter "6" as the BS Pt:. The Back Circle should be set to "0". Press **|SOLVE|** to calculate the backsight Azimuth (152.5501) and Bearing (S27.0459E). Press **|EXIT|**.

Step 3: Enter the Begin Sta.:(0 + 00) and the Sta. Interval:(50). These entries are the station number where the Point List begins and how much the current station will increment, when you press the **|ADV|** or **|D|** key.

The next task is to define the road template. This involves defining the crown of the road, the height of curb, offset from curb to hinge point, and the slope ratio of the cut or fill line.

The Slope Stake routine will allow you to stake a street with curbs and sidewalks or you can stake a road profile with a ditch to one or both sides. To define a road with a ditch, simply calculate the slope and distance from the center line to the hinge point. Enter this information in the Section width: and Slope ratio: fields. Then, set the height of curb and offset to curb to "0". See the diagram below:



Step 4: Our driveway will have a V ditch on each side as shown on the left side of the above diagram. The cross slope and section width are 13ft. and -15%. Enter them here and finish filling out the screen as shown above.

Step 5: At this point we are finished with the setup screen. Press **[SOLVE]** or **[A]** to enter the values into the system. A result screen will be displayed as shown below:

```
Starting Pt:  30
Backsight Pt: 6
Backsight Az: 152.5501
```

Hit any key to exit this screen and return to the setup screen, then press **[EXIT]** to exit from the setup screen back to the Slope Stake Screen.

```
   Slope Staking
Station:  2 + 50.000
Segment: V curve
Section width  : 13.0
Slope ratio: 2.00
Estimated C/F: 0.50
Store pt: 130
```

** Straight / H curve / V curve / H+V curv **

	STAKE		ADV	SETUP	EXIT

NOTE:

As a typical road progresses, some of these parameters may change. The slope of one or both sides may vary as in a super elevation or for drainage. The slope ratio may also change due to terrain or soil conditions. The road may widen or narrow for a passing lane or a narrow bridge. These changes should be made prior to staking the stations that they effect. In our example, the template is the same throughout the entire driveway.

Step 6: Let's enter "2" as the slope ratio. This is the horizontal distance over the vertical distance of the cut or fill line (2/1).

Step 7: The estimated cut or fill is a guess at the cut or fill needed at the center line. Enter "0.5"

NOTE:

Since the TDS-48GX does not know the actual terrain features during slope staking, the process for locating a catch point is iterative. The estimated cut or fill is an optional entry designed to improve the TDS-48GX's ability to determine the catch point. You will arrive at the same catch point with or without entering the estimated cut or fill. But, the more accurate the estimation you enter for the cut or fill, the fewer iterations the system should take to get there.

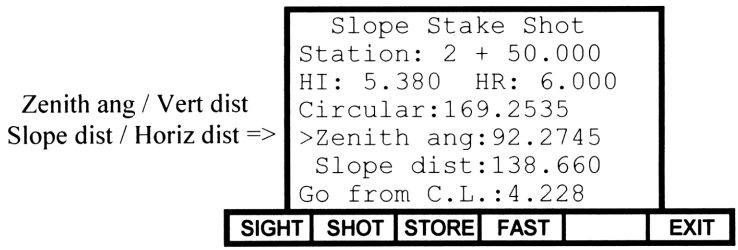
Step 8: Type "130" in the Store Pt field.

The second line of this screen is a display-only line that informs you as to what type of a segment you are currently staking. This display can read: Straight, H-Curve, V-Curve, or H+V-Curve.

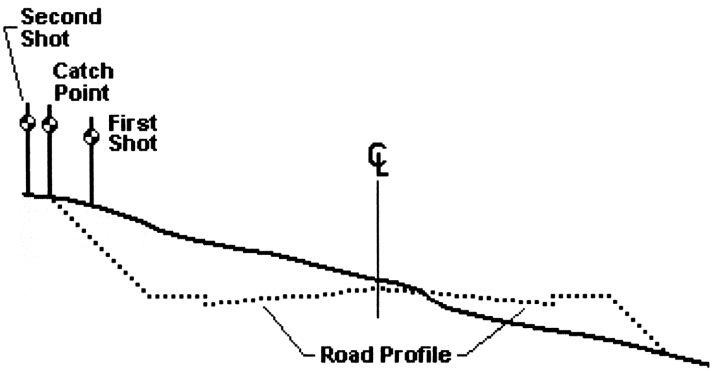
Step 9: Our last step in setting up our slope stake is to tell the system the station you want to stake. For our example, let us assume we have previously staked up to station 2+50. Enter "2" in the first field and "50" in the second.

Start to Stake

Now you are ready to slope stake this example. At this point, press the **[STAKE]** or **[B]** key which brings up the following screen:



STAKEOUT



This is the screen from which slope staking takes place. At this point, if we were working in the field, you would occupy point 50 and zero your instrument on point 6 (the backsight). Your rod man would move to a point perpendicular to the station to be slope staked and where he estimates the catch point to be. The instrument man would then sight the rod and press **[SHOT]** or **[B]**, down loading the angles and distance to the TDS-48GX. Because this is an example, we need to enter this information manually.

Step 1: Enter "5.42" in the HI and "6.00" in the HR.

Step 2: Now, we imitate our first shot by entering:

Circle: 169.2535
Zenith: 92.2745
Slope Dist: 138.66

Press **[SHOT]** to simulate the shot and calculate the results.

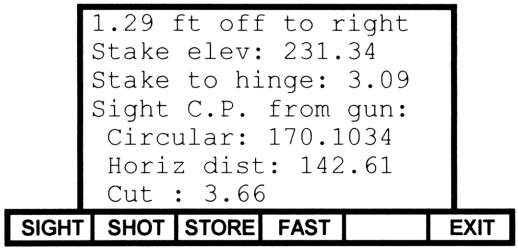
As the results are analyzed, a prompt will inform you that the rod man is 1.29 feet to the right of perpendicular to the center line. When you return to the shot screen, the last line of the screen should display:

Go from C.L.: 4.228

From this display, we see that the rod man needs to go another 4.25 feet away from the center line. As the rod man moves to the new position, he should also move to his right 1.3 feet. Here we take a second shot.

NOTE:

At any time after you have taken the first shot, you can view statistics about your shot by pressing **[SIGHT]**. This brings up the following screen:



Step 3: Now enter:

Circle: 169.5108
Zenith: 92.5734
Slope Dist: 142.09

Press **[SHOT]** or **[B]** to simulate the second shot.

The screen should display the repositioning information as:

Come to C.L.: 1.697

This time the rod man needs to go back about 1.5 foot toward the center line. He is now also closer to the perpendicular.

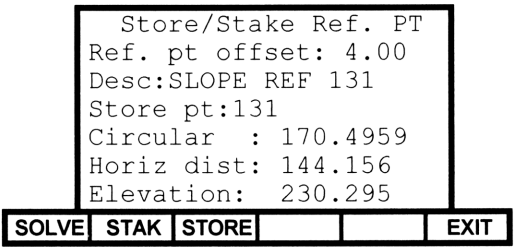
Step 4: Now enter:

Circle: 169.4629
Zenith: 92.5026
Slope Dist: 141.32

Press **[SHOT]** or **[B]** for the third shot.

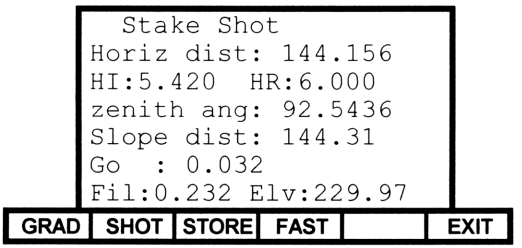
Step 5: For the purpose of this survey, let's say the above shot is close enough. Now, we want to store this catch point. Press **[STORE]** or **[C]** to store this point.

The following screen will be displayed:



Step 6: To store the catch point, enter "0" at the Ref. pt offset field. (If you did not want to store the catch point but only store the reference point, then you would skip to Step 7.) Then press **[STORE]** and the point will be stored.

Step 7: Now, you can set as many reference stakes as you would like. First, enter the offset distance, and then stake the ref. point as you would in the offset stake routine. We will stake one reference point at four feet out from the catch point. Enter "4" as the offset and a descriptor, then press **[SOLVE]**. Now the rod man would place the rod four foot back and you shoot this point. The screen should appear as above. Now press **[STAK]** and the Stake Shot screen will be displayed:



Step 8: Fill out the screen as above and press **[SHOT]**. A come or go will be calculated. Repeat the shot process as many times as necessary. When the come/go is within tolerances press the **[STORE]** key and the reference point will be stored.

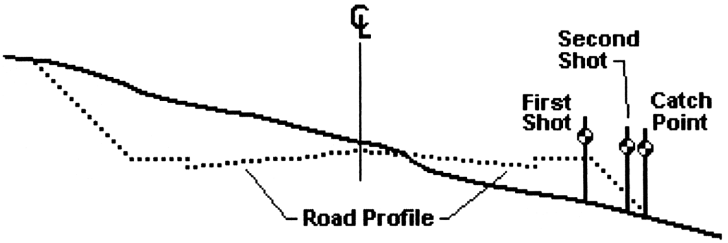
We are now finished slope staking this side of this station. Press [EXIT] until you returned to the slope stake screen. If we were only staking one side of the road, we would press **[ADV]**; but, we will be staking the other side of the road. To stake the other side of the road, simply press **[STAKE]** again.

Stake other Side

Our example is designed such that the slope of the terrain is across the road. As we staked the left side, we were working with cuts, but the right side will be a fill.

NOTE:

You do not need to tell the program which side of the road you will stake nor whether you are staking a cut or fill. If the rod is shot to the left of center, the program calculates the left catch point or vice versa. Also, if the rod elevation is above the road profile, it assumes a cut; if below, it assumes a fill.



For brevity, we will give only the data to be entered and keys to be pressed.

Step 1: Enter:

Circle: 157.5506
Zenith: 96.2947
Slope Dist: 116.76

Press **|SHOT|** or **|B|** to simulate the first shot.

The screen should display the following results:

Go from C.L.: 2.271

The rod man goes out another 2 feet and we take a second shot.

Step 2: Now enter:

Circle: 156.2327
Zenith: 97.0745
Slope Dist: 114.71

Press **|SHOT|** or **|B|**.

The following is displayed:

Go from C.L.: 0.561

The rod man goes another 1/2 foot out, and we take a third shot.

Step 3: Now enter the following and press **|SHOT|** or **|B|**.
Circle: 156.0103
Zenith: 97.1129
Slope Dist: 114.37

Step 4: Again, this last shot is close enough. To store this catch point, press **|STORE| |C|**. Enter "0" as the offset, then a descriptor and press **|STORE|**. Next set the reference stake at a 4 feet offset as you did with the last point.

Advance to next point

You have finished Staking both sides of the road at this station so return to the Slope Stake Screen. We want to stake the next station so press **|ADV|**. This tries to adds 50 feet, the station interval we specified, to the current station which would be 3+00. Instead it has reached point 33, the beginning of the horizontal curve, station 2+64.882. For this example we want to continue staking at 50 foot intervals, so enter 3+00 for the Station. You are ready to press **|STAKE|** again.

Step 1: Enter:
Circle: 187.2644
Zenith: 92.2053
Slope Dist: 121.05

Press **|SHOT|** or **|B|** to simulate a shot.

The screen should display the following results:

Go from C.L.: 1.491

The rod man goes out another 1.5 feet and we take a second shot.

Step 2: Now enter:
Circle: 187.2634
Zenith: 92.4122
Slope Dist: 122.47

Press **|SHOT|** or **|B|**.

Step 3: The above shot is close enough, so again, store this catch point the reference point.

NOTE:

The number of iterations it will take to arrive at the catch point will vary from station to station. It will depend on a number of factors including:

- The estimate of the cut or fill at the center line.
- How the terrain varies.
- The ability of the rod man to estimate the catch point on the first shot.

We have now finished slope staking this side of the road at this station and can return to the slope stake screen.

Summary

This completes our Slope Staking example. If you were actually slope staking you would simply continue to stake catch points as we have done. Let us now go over some points to remember.

- You must define the center line with both horizontal and vertical profile information in order for the TDS-48GX to slope stake correctly.
- Directions for the rod man to Come or Go are perpendicular to the center line.
- Estimate Cut or Fill is optional.
- Don't worry about informing the data collector which side of the road you are working on, or if it is to be a cut or fill. The system can establish this for itself.

7. ADVANCED FIELD WORK

In this chapter, you will learn about certain more specialized field functions of the TDS SURVEY-PRO. You will look at several backsight functions and repetition routines in greater detail. A discussion of Off Center shots is provided as well as a look at Trig, Differential and Stakeout leveling routings. Finally, a look at the Building Pad routines and collimation.

The following routines are fairly specialized. Not every user will have need of all of them. We recommend that you glance through all of them so that you will be aware of their capabilities. Then spend more time with those that you will be using.

BACKSIGHT

The main function of the Backsight Screen is to set a direction of reference for the next series of shots. However, within the backsight screen, there are two softkeys which we have not yet covered: **|CHEC|** and **|CIRCL|**. Each bring up a Menu with two choices. The **|CHEC|** key allows two options. **|G|** will shoot the distance to the backsight point and compare the measured distance with the calculated distance to check for a incorrect backsight point. With selection **|H|** you can, while in the process of collecting sideshots, return to your backsight and check the circle reading.

The **|CIRCL|** key lets you read the circle reading from your gun into the backsight screen, or send the backsight circle value to your gun to calibrate its circle setting. Let's look at each of these options.

Path:	From the Traverse / Sideshot screen, press **|BACK|** to display the Backsight screen pictured below:

BS point / BS azm / BS brg =>

```
   Backsight
>BS azm:  276.2315
 BS Circle reading
  of gun:  0.0000
Occupy pt:  1
HI:  0.000
BS Azm:   276.2315
```

SOLVE | CHECK | | FAST | CIRCLE | EXIT

CONFIRM BACKSIGHT POINT

After you have entered a backsight point and pressed **[SOLVE]** to calculate the BS Azm and BS Brg, you can compare the measured and calculated distances to this backsight point in an effort to confirm that you are sighting the correct point. With your BS point solved press **[CHEC]** to bring up the following menu:

```
   Check Backsight

G Confirm BS point
  by shooting dist.
H Check BS circle
```

Selecting **[G] Confirm BS point** while connected to an electronic total station will prompt you with:

```
Shoot BS point
Hit a key when ready.
```

While sighting a prism on your backsight, pressing any key will fire the instrument and read the distance. The data collector will then compare this distance to the calculated distance between the occupied point and the point number entered in the backsight screen. It will then display the difference. This is not a guarantee that you are sighting the correct point but should detect nearly all miss-sighted backsights.

NOTE:

The confirm BS point routine will only work when electronically connected to a total station. When in the manual mode, selecting **[G] Confirm BS point** will display "**Not applicable**".

This function also requires a backsight point be used. If a **BS azm** or **BS Brg** are solved in the Backsight screen and then **[G] Confirm BS point** is selected, the prompt "**Error: BS point unknown**" will be displayed.

CHECK BS CIRCLE

At any time, as you take sideshots from a point, you can check your backsight circle reading. From the Traverse / Sideshot screen, press **[BACK]** and then **[CHEC]**. Select **[H] Check BS circle**. You will be prompted with:

```
BS circle
Hit a key when ready.
```

Point your scope at your backsight then press a key. The data collector will calculate the difference between the BS circle and the circle reading of your instrument displaying:

```
Angle error=#.####
```

This routine will accommodate any backsight direction entry method. BS point, BS azm and BS brg are all acceptable. It can also be used in the manual mode by keying in the circle reading of the gun. Pressing **[H] Check BS circle** will prompt you with:

```
BS circle
```

Enter the instrument's circle reading and press **[ENTER]**. The data collector will display the angle error.

READ BACKSIGHT CIRCLE FROM INSTRUMENT

The **[CIRCLE]** key allows you to download the instrument's circle reading from your gun or upload the backsight circle value into your gun. Pressing **[CIRCLE]** will display the following menu:

```
   Backsight Circle

G Read BS circle from
  instrument
H Send BS circle to
  instrument
```

Selecting **[G] Read BS circle** will query your instrument for its circle reading and place it in the backsight Circle field. If SURVEY-PRO is in the manual mode, you will be prompted to enter the circle reading. If you are connected to a total station, the display of the 48GX will read:

```
Read BS circle:
Hit a key when ready.
```

While pointing at your backsight, press a key. The instrument's circle reading will be transferred to the backsight circle field.

SEND BACKSIGHT CIRCLE TO INSTRUMENT

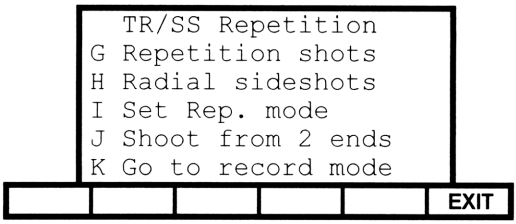
Selecting **[H] Send BS circle** will set your instrument's circle to the backsight circle entry. Enter the value that you would like your total station's circle to be in the backsight circle field. Then press **[CIRCL]** and select **[H] Send BS circle**. The data collector will upload the circle value to the gun and set its circle reading.

This routine cannot be used in the manual mode. If you receive the prompt, "**Can't set HA on gun**", you are either in manual mode or are using an instrument that does not allow the circle to be set using a remote data collector.

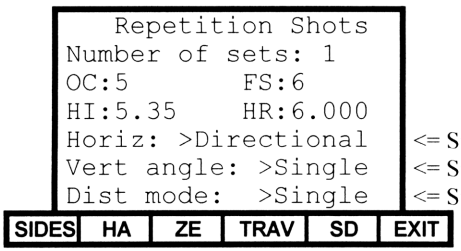
TRAVERSE / SIDESHOT REPETITION MENU

The Repetition Menu allows you to establish a variety of repetition (repeated readings) modes for doing field work.

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



Pressing **[REP]** from the Traverse/Sideshot Screen will display the menu choices shown above. Selecting **[G]** will allow you to take repetitive readings as discussed in Chapter #3. This option functions just like the Traverse /Sideshot routine except it will now take multiple observations, either angles and/or distance, for all points collected using this repetition options. You can customize your repetitive shots so as to collect that data you want repetitively and the remainder singularly. Once the setup is determined, SURVEY-PRO will collect all measurements necessary for the repetitive shots in one set of observations. It will compute the coordinates of the new point from a combination of average data and single readings depending on how it was set. See the example in Chapter 3: Field Work.

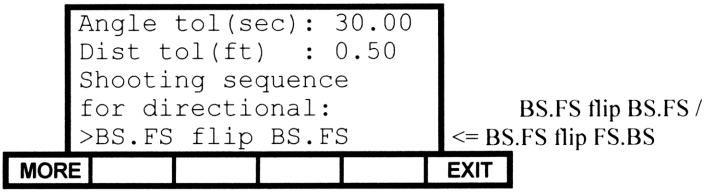


<= Single / Directional / Accumulation
<= Single / Multiple
<= Single / Multiple

The **[HA]**, **[ZE]** and **[SD]** keys will allow you to take the Horizontal angle, Zenith angle or Slope distance individually. One set of Horizontal angles or Zenith angles is a set of direct and reverse. With the slope distance one set is a single reading, therefore 2 or more sets are needed to take a multiple reading ever if the Dist mode is set to Multiple.

ADVANCED FIELDWORK

Selecting **[I]** Set Rep. mode will let you set the remaining Repetition Mode parameters. This screen sets the tolerances at which the data collector will warn you about errors and the order in which the shots are taken.

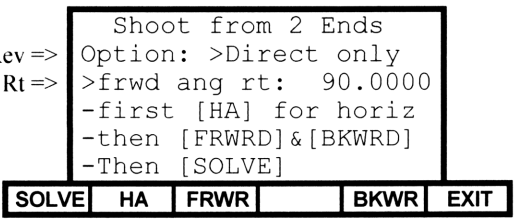


SHOOT FROM TWO ENDS

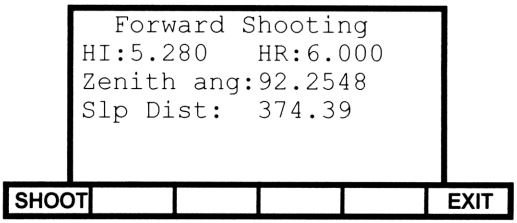
This routine lets you take zenith angle and distance measurements from both ends of a foresight line. The Shoot From Two Ends routine does not care which end you shoot from first. However, the horizontal angle will be computed from the forward occupied point and not the point occupied when shooting the backward observation. Typically, you would gather a horizontal angle first then shoot the forward zenith and slope distance. Then, you would occupy your foresight and shoot the backward zenith and slope distance. For our example, we will follow this pattern. We have gathered our horizontal angle in the above example and will now take the forward shot first. If you have not done the Previous Horiz. dir & rev example, simply enter the resulting angle right of 42.5238 in the Traverse / Sideshot screen .

For our example, let us assume that the Horizontal direct & reverse that we just completed was our horizontal angle for this Shoot From Two Ends.

Path:	From the Traverse/Sideshot Screen, press **[REP]**; then **[J] Shoot from 2 ends** for the following screen:

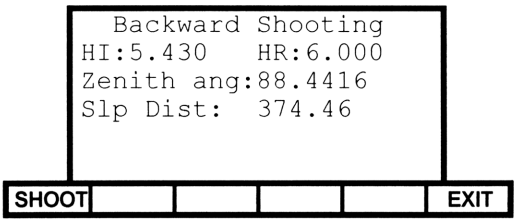


Step 1: Be sure that the Option line reads "Direct only". Press the **|FRWR|** key to bring up the Forward Shooting screen.



Step 2: If you were collecting data electronically you would simply press **|SHOOT|**. For our manual example fill out the screen as above and the press **|SHOOT|**.

Step 3: Now press **|BKWR|** to display the Backward Shooting screen.



Step 4: Again, fill out the screen as it is displayed above and press **|SHOOT|**. Be sure to change the HI.

Step 5: **P**ress **|SOLVE|** to compute the average zenith and slope distance. The screen will prompt you that you must still press **|TRAV|** or **|SIDES|** to store the point.

Step 6: Now press **|EXIT|** twice to return to the Traverse / Sideshot screen. Notice that the Zenith angle is now 92.2543, and the Slope distance is 374.43. These are the correct data for our foresight, and we have collected a horizontal angle using a direct and reverse reading.

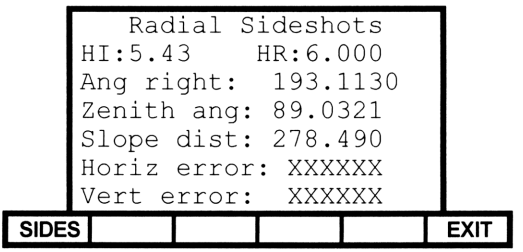
Step 7: At this time, all the data is collected. Pressing **|TRAV|** or **|SIDES|** will calculate the coordinates and store the point.

ADVANCED FIELDWORK

RADIAL SIDESHOTS

The next repetitive reading selection is the Radial Sideshots. It collects all the data it needs in the routine itself. The procedure of the Radial Sideshots routine is to take a series of direct and reverse readings at the backsight. Then, take a series of direct and reverse readings at the first foresight; a series of direct and reverse readings at a second foresight; and so forth, for as many foresights as you want. Let's run through a few Radial Sideshots.

Path:	From the Traverse/Sideshot Screen, press **[REP]**, then **[H]** **Radial Sideshots**.



Step 1: When you press the **[H]** key for Radial Sideshots, you are prompted for the number of sets:

For each foresight,
Number of sets:

Enter "1" which will set the routine to take one set of, a direct and a reverse reading at each observed point, including the backsight.

Step 2: Next a prompt will ask for the backsight shot direct:

BS direct:

Let's assume that you have zeroed your instrument on the backsight; so, enter "0".

Step 3: Now you are prompted for the backsight shot reversed:

BS direct: 0
BS reverse:

You have now flipped your instrument on the backsight; so, enter "180.0009".

Step 4: The next prompt reads:

Ready to shoot FS pts.
1 sets of Dir & Rev
for each point

<Any key to continue>

Press a key. The Radial Sideshots screen will be displayed.

Step 5: The only data that needs to be entered in the screen itself is the HI and HR. The rest of the information will be prompted for. All the observed data would be collected electronically from your total station if you were working in the field. You are now ready to take the first foresight. Press **[SIDES]**.

Step 6: The data collector will prompt:

Set: 1
Shoot FS point
Hit a key when ready.

Hit a key; and, you are prompted for your observations:

Slope dist: 278.47
Horiz ang: 193.1128
Zenith ang: 89.3350

Enter the above data and press **[ENTER]** to bring up the next line.

Step 7: After the zenith angle is entered you are prompted for the reverse observations:

Reverse scope
Hit a key when ready.
Slope dist: 278.51
Horiz ang: 13.1141
Zenith ang: 271.2709

Again, hit a key; then, enter the data and press **[ENTER]**.

Step 8: You are now prompted for a descriptor. Enter "TEST PT" and press **[ENTER]**. The Radial Sideshots screen now displays the results of this sideshot and should match the display shown above.

Step 9: That completes one sideshot. Using the data below, press **[SIDES]** one more time and enter another sideshot.

Set: 1
Shoot FS point
Hit a key when ready.
Slope dist: 159.73
Horiz ang: 71.5133
Zenith ang: 89.2551

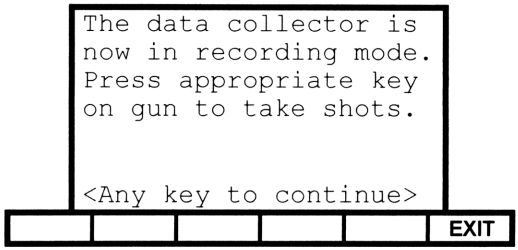
Reverse scope
Hit a key when ready.
Slope dist: 159.81
Horiz ang: 251.5147
Zenith ang: 271.3414

Step 10: You have just shot two sideshots with multiple horizontal angles, zenith angles and slope distances. This process can continue for as many foresights as you might have.

RECORD MODE.

The final option in the TR/SS Repetition menu is the Record Mode. This puts SURVEY-PRO into a mode where you control the total station from its own keypad. The data collector simply logs points as they are received.

Path:	From the Main Menu, press **[J]** Traverse/Sideshot Screen; then **[REP]** then, **[K] Go to record mode** to bring up the following display.



Press a key and the data collector will prompt:

Enter descriptor for
all of the following
shots.
Desc:

Enter a descriptor that will be stored with all shots recorded in this mode. After pressing **[ENTER],** you will see one or two more prompts telling you how to control your particular gun. Follow the prompts, collecting shots until you are finished. Press **[EXIT]** or the **[F]** key to return control to SURVEY-PRO.

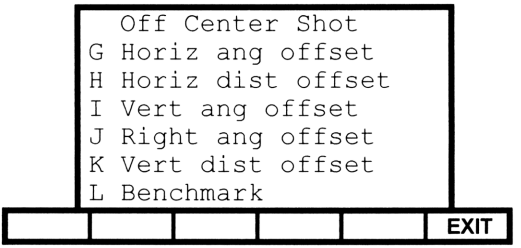
NOTE:

The Record mode routine only supports certain instruments. If you receive the prompt: "**Record mode not supported.**" after pressing the **[K] Go to Record mode** key, you are either in the Manual mode or your instrument is not supported.

OFF CENTER SHOT MENU

The following five screens are used when it is not practical or not possible for the rod to occupy the point to be shot. The Off Center Shot routines allow you to shoot points when you cannot place the rod target exactly on the point.

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



The Off Center Shot Menu covers five common situations that are encountered in the field when it is not convenient or not possible for the rod to occupy the point that needs to be stored. Those five situations are selected from the Off Center Shot menu. They are explained and illustrated in the paragraphs below.

If you were collecting data electronically, you would press the **[OFFCT]** key from the Traverse/Sideshot Screen and select the off-center routine needed. You would then press a softkey to take a shot to the rod. Finally, you would either move the scope and press a second key to read an off-center angle or enter an off-center distance depending on the data required for that situation. Then, you would press **[STORE]** to store the shot. In each of the Off Center screens, there is a **[HELP]** key that will prompt you as to the steps needed for that routine.

As an example, let us step through the Horizontal Angle Offset routine manually.

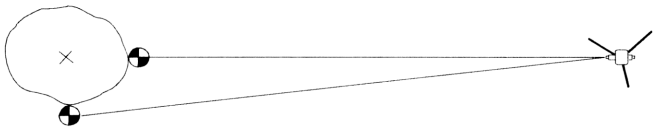
HORIZONTAL ANGLE OFFSET SCREEN

This screen allows you to shoot the center of a large object such as a big tree.

Path:	From the Main Menu, press **[J] Traverse / sideshot**; then press **[OFFCT] Off Center Shot Menu**; Finally, press **[G] Horizontal Angle Offset** to bring up the following screen:

```
  Horiz Ang Offset
FS point: 120
HI:5.260    HR:6.000
Side HA:       0.0000
Zenith:        0.0000
Slp dist:       0.000
Center HA:     0.0000
```

CNTR	SIDE	STORE		HELP	EXIT



Step 1: If you were in the middle of gathering data, the FS point, HI and HR fields in this screen would come from the Traverse / Sideshot screen and would probably be the numbers you would want. For our example, let's use "120" as a FS point. Also enter 5.26 as the HI and 6.00 as the HR.

Step 2: Next, if you were using a total station, you would shoot the rod at the side of the object by pressing the **[SIDE]** key. To manually simulate the data gathered by this shot, enter:

Side HA: 143.5543
Zenith: 89.2419
Slp dist: 257.82

Step 3: Now you want to shoot the rod in front of and at the center of the object. Electronically this would be done with the **[CNTR]** key. To simulate this, enter:

Center HA: 141.0029

Step 4: Press **[STORE]** and you will be prompted for a descriptor. Key in a descriptor, then press **[ENTER]**.

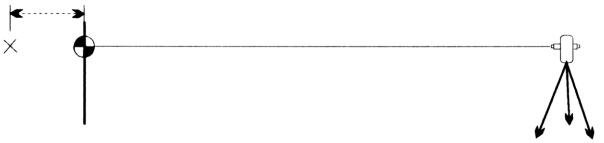
NOTE:

The order in which you take the Off Center shots is up to you. In the example above, the **|CNTR|** shot could have been gathered before the **|SIDE|**. You simply need to have gathered all the data before pressing the **|STORE|** key.

Each of the other Off Center routines are briefly described below. For more details, see the Reference Section of this Manual.

HORIZONTAL DISTANCE OFFSET SCREEN

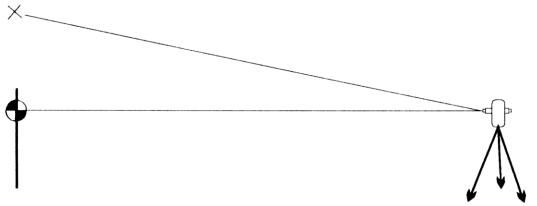
The Horizontal Distance Offset routine allows you to collect a point that is in-line with the rod but on which the rod man cannot occupy; e.g., the middle of a river.



To use this routine, place the rod in line with where the point should be placed. Shoot to the rod and enter the distance to add to the measured slope distance. Enter a negative distance to subtract from the slope distance.

VERTICAL ANGLE OFFSET SCREEN

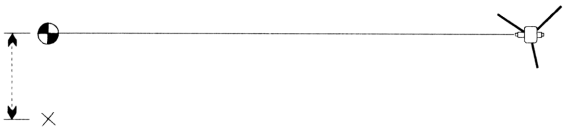
The purpose of the Vertical Angle Offset Screen is to allow you to store a point that is too high for the rod; e.g., the cross-member of a power pole.



This routine is used by placing the rod directly above or below the desired point and shooting the rod. Then, move the scope up or down to sight the true point, and press **|ZEN|** key to read the zenith angle.

RIGHT ANGLE OFFSET SCREEN

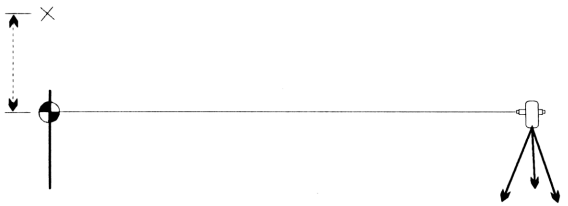
The Right Angle Offset Screen allows you to shoot a point that is at a right angle to your rod position; e.g., around the corner of a building.



Place the rod at a 90° offset to the point you want to store. Shoot the rod and enter the offset distance. From the Instrument man's point of view enter + for offsets to the right of the rod and - for offsets to the left of the rod.

VERTICAL DISTANCE OFFSET SCREEN

The purpose of the Vertical Distance Offset Screen is to allow you to collect a point for which you cannot sight the zenith angle, but to which you can measure the vertical distance; e.g., down a manhole.



Place the rod above or below the desired point and shoot the rod. Then enter the distance to the actual point: + for up and - for down.

TRIGONOMETRIC LEVELING

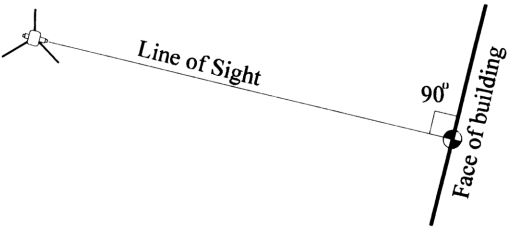
The Trig leveling routine allows you to compute the vertical distance between a point on a vertical plane and the horizontal plane of the instrument.

Path:	From the Main Menu, press **|L| Leveling & X-section Menu**; then **|G| Trig Leveling** to display the following .

```
                Trig. Leveling
Station elv / Station pt => >Station elv:253.91
                            HI: 5.26
                            Horiz dist:   147.620
Zenith / Vert ang =>        >Zenith:      86.5822
                            Target elv:   266.977
                            VD +- hor plan: 7.807
                 SOLVE |    | HD |    |    | EXIT |
```

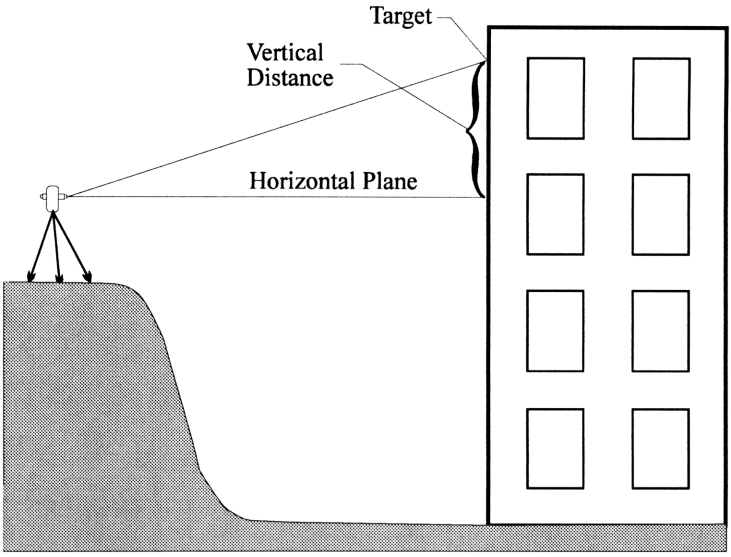
Step 1: Start by entering Station elv as 253.91 and the HI as 5.26.

Step 2: If you were connected to an instrument, you could set a prism against the vertical plane at a point that is perpendicular to the instrument's line of sight and the face of the vertical plane. Then, you could press **|HD|** to fire the gun and read the slope distance. SURVEY-PRO would then calculate the horizontal distance for you.



For our example, enter 147.62 in the Horiz dist field.

Step 3: Now enter "86.5822" in the Zenith field. Press **|SOLVE|** to calculate the Target elevation and the Vertical distance to the horizontal plane. If you were doing this electronically, pressing the **|SOLVE|** key would read the zenith angle from your gun.

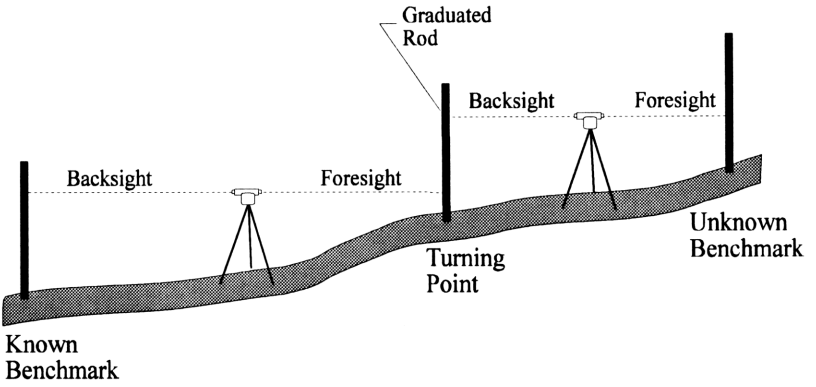


DIFFERENTIAL LEVELING

Differential leveling is a method that uses the known elevation of one point to determine the elevation of another point. The equipment required to do this task is a level and a scaled rod.

The procedure for using this method is simple. First place the rod on a point with a known elevation and read the scale off the rod through the horizontal cross hair of the level. This will determine the elevation of the horizontal plane of the level. Next, move the rod to the point which the elevation is to be determined. Now, read the rod scale and compute the elevation of this point. You can move the rod to various locations, as you would do in side shots, thereby determining the elevation of all nearby points. Then by moving the level ahead and using one of the newly determined elevations as a known point, you can determine the elevation of points farther away, as you would do in a traverse.

ADVANCED FIELDWORK



In practice, distances to the backsight and the foresight should be roughly the same length to eliminate the effect of refraction of the air. For better reading of the rod scale, the distance should not be father than about 250 feet.

In differential leveling, the sight to a known elevation point is the backsight and the sight to a unknown elevation point is the foresight. There are three types of foresights depending on what they are to be used for. If a point's elevation is determined only for the purpose of being read to determine a point farther away, it is called a turning point. The elevation of a turning point is usually not stored. Points who's elevation you set out to find, are called benchmarks, and are stored. When gathering points for a leveling loop, some benchmark's elevations are read to determine further elevations, while others are not. For the purpose of determining the which point are to be used for the closure of the loop, points that are not to be used to determine other elevations are called sideshots.

The function of the differential leveling routine is to gather the data needed for this leveling technique and compute the elevation for either a turning point or a benchmark point. It will also record the raw data of rod readings. These rod readings can be used by TDS's Easy Survey software to adjusting a level loop. The Compass rule adjustment routine in SURVEY-PRO can also be used to adjusted elevation closure from the coordinate data.

For levels with stadia marks above and below the horizontal cross hair, rod readings at these stadia marks can be read and checked to detected misreadings of the scale. This technique is called three wire leveling. Three wire leveling is supported by this routine. In resent years, a new type of electronic level has been introduced to the surveying market. These new levels can read a bar coded scale rod automatically. It not only reads faster than a human can, but it also improves accuracy. This program also supports these electronic levels.

Let us step through a Differential Level shot with three wire sighting.

Path:	From the Main Menu, press **[L] Leveling & X-section Menu**; then **[H] Differential Leveling** to display the following:

BS pt / BS elev =>

```
 Differential Leveling
>BS elv:      132.820
BS rod reading: 24.378
FS rod reading: 3.113
FS pt:  100    :>B Mark
FS elev:      154.0850
B.ds:111.0  F.ds:101.0
```

SOLVE	FS	FS2BS	BS		EXIT

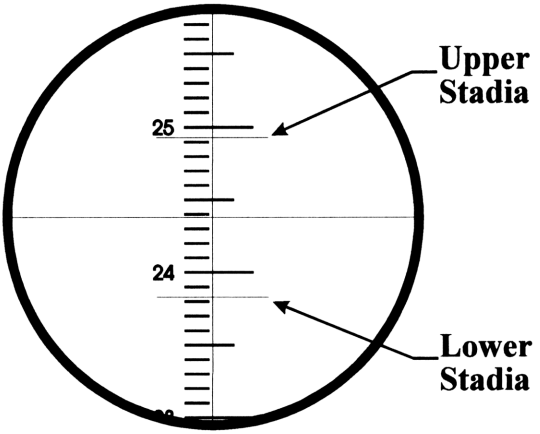
Step 1: Set up your instrument on a point where you can read your graduated rod on both the Backsight and the foresight, approximately equidistant from each. Enter the elevation or point number of the backsight point. In our example, enter an elevation of 132.82.

Step 2: If you were taking a single observation of the rod reading on the backsight you would enter it directly in the BS rod reading. But to do a three wire reading press **[BS]**. The following screen is displayed.

```
 3-Wire Data Input
Upper stadia:    24.930
Middle X-hair:   24.380
Lower stadia:    23.820

Distance:       111.000
Tolerance:        0.050
```

SOLVE					EXIT

Assume that your three readings are as displayed in the screen above. Set the Tolerance to ".05" and press **[SOLVE]**. The routine will check the upper and lower stadia readings to see that they do not differ by more than the tolerance distance.



The upper and lower stadia readings are used to limit errors generated from reading the scaled rod. The distance from upper stadia reading to the middle cross hair and the distance from lower stadia to middle cross hair should be fairly close. The "Tolerance" is used to specify the limit of this error. The error is calculated with the following formula

Error = (upper stadia - middle x-hair) - (middle x-hair - lower stadia)

If the Error is greater than the tolerance, you will be asked to decide if you want to reject the readings. It will also calculate the distance to your backsight. The distance from the level to the rod is computed as:

Distance = (upper stadia - lower stadia) * 100

As you **[EXIT]** the 3-wire Data Input Screen the averaged reading will be placed in the BS rod reading field. The average of scale reading is computed as:

Average={(middle x-hair) + ((upper stadia + lower stadia) / 2)}/ 2

Step 3: To observe the rod reading on the foresight press **[FS]**.
Enter:

Upper stadia:	3.620
Middle X-hair:	3.110
Lower stadia:	2.610

Press **[SOLVE]**. The distance should read 101.

Again **[EXIT]** the 3-wire Data Input Screen, placing the observation in FS rod reading field.

Step 4: Enter "100" as the FS pt and set the scroll to read >B Mark. Now press **|SOLVE|** to calculate the elevation of the foresight and store point 100. If the point where the foresight is to be stored exists, then only the elevation will be changed. Since 100 does not exist, a new point is created with 0.000 in the northing and easting. If the Point Type is Turn Point or Benchmark the SURVEY-PRO will ask you if you want to copy the FS elev. to the BS elev. Answer Yes if you are going to occupy a new point now, and read this point as its backsight. If you are not yet prepared to occupy this point you should answer NO. For our example answer No. The screen should appear as displayed above.

The **|FS2BS|** key will transfer the elevation in the FS elev: field to the BS elev: field, in preparation for your next positioning and observations if you should change your mind.

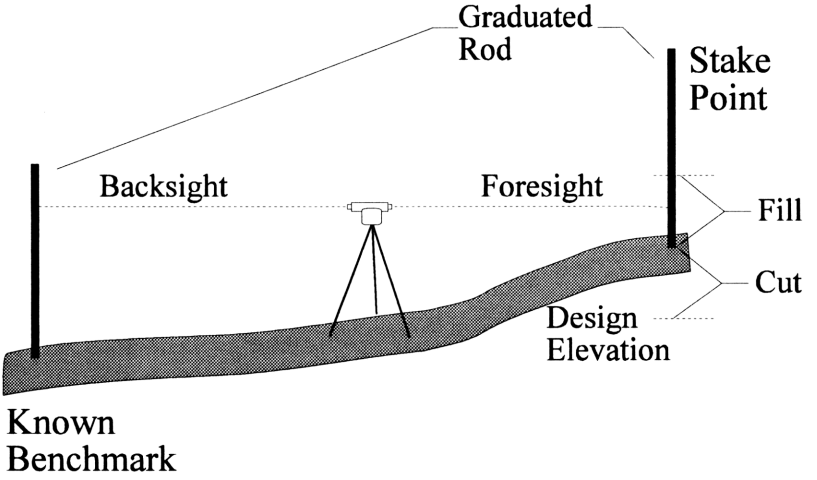
NOTE:

1. Level loop adjustment will be provided in two ways. One is in the Easy Survey. The Easy Survey will read through the raw data file, compute the error, and distribute the error among all the traverse legs. The adjusted elevations will be used to replace the elevation in existing points.

2. A simplified adjustment of the leveling circuit will also be provided in the "Compass Rule" screen. That screen has been changed slightly to provide the option for adjusting only the elevations.

LEVELING STAKEOUT

The Leveling Stakeout routine is very similar to the Differential Leveling. It allows you to use a graduated rod and a level to determine the cut or fill to a design point from the known elevation of another point.



Path: From the Main Menu, press **[L] Leveling & X-section Menu**; then **[I] Leveling Stakeout** to display the following:

BS pt / BS elev =>

```
 Leveling Stakeout
>BS elv:      132.820
BS rod reading: 11.910
>FS elv:      138.260
FS rod reading: 2.060
FS elev:      142.6700
Cut: 4.410
```

SOLVE	FS	STORE	BS	FP+1	EXIT

Step 1: Again set up your instrument on a point where you can read your graduated rod on both the Backsight and the Foresight. Enter the elevation or point number of the backsight point. In our example, enter 132.82.

Step 2: Observe the rod reading on the backsight and enter it in the BS rod reading: 11.91.

Step 3: Enter the elevation or point number of the foresight point. In our example, enter 138.26.

Step 3: Observe the rod reading on the foresight and enter it in the FS rod reading: 2.06

Step 4: Press **[SOLVE]** to calculate the elevation of the foresight and the cut or fill to the design elevation. They will be displayed on the last two lines of the screen, as shown above:

The **[STORE]** key will store the elevation of this point. The point number that will be used is the last point stored + 1. You can set it to a new point number in the X-section Setup Screen, using the Store pt field or any other store point field. If this point exists, only the elevation will be changed. If the point does not exist the northing and easting will be set to 0.000.

You can use the **[BS]** and **[FS]** keys to enter 3-wire observations into the routine as was described in the differential leveling example.

CROSS-SECTION SURVEY

Cross-section survey helps a surveyor to collect terrain profile data at a Cross-section. This Cross-section data is usually used for computing the volume of soil needed to be added or removed to produce a designed profile. The computation is usually based on a series of these cross-section areas of the soil body. This method of computing volume is called "Volume by average end areas".

Conceptually, collecting cross-section data is fairly straight forward. It is largely the same as taking regular side shot points. But in practice, there are two difficulties with cross-section survey:

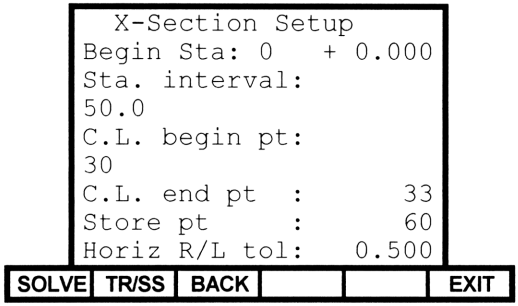
1. When shooting the points, it can be difficult to maintain the rod on the particular cross-section. The field computer should warn the rod-person when he or she is off the cross-section line.

2. Traditional you have to follow a strict shooting sequence in taking the cross-section shots in order for the area computations to be made. The SURVEY-PRO has eliminated this requirement. You can shoot the points of a cross-section in any order. The Cross-Section routine will record the station and offset and EASY SURVEY will compute the area based on this information.

The cross-section survey program is designed to solve the above problems, making cross-section survey a simple task. The procedure of collecting cross-section data is outlined below. As an example let us take a cross-section of the driveway you designed in chapter 4.

CROSS-SECTION SETUP

Path: From the Main Menu, press **|L| Leveling & X-section Menu**; then **|J| X-Section Setup** to bring up the following display:



Step 1: First, you need to set up several parameters. Due to limited screen area, some of these must be set in other screens. As with a regular side shot, you must specify the occupy and backsight points, and backsight circle. These can be set in the Backsight screen. The **|BACK|** key is placed in this screen to take you directly there. Press the **|BACK|** key and enter "6" in the BS point field, "50" in the Occupy pt field, and "5.24" in the HI field. If "BS point" is not displayed use the **|→|** or **|←|** keys to scroll the prompt field. The BS Circle should be set to "0.000" if it is not already there. Press **|SOLVE|** to calculate the back azimuth and then **|EXIT|** to return to the X-Section Setup Screen.

Step 2: Now you need to specify the starting station number (chainage) of the center line. Enter "0 + 0.00" as the beginning station number, "50 as the station interval, "60" as the Store pt and ".5" as the Horiz R/L tol.

Step 3: Next, you need to enter two known points which will define the center line for the cross-sections. Each particular cross-section is assumed to be perpendicular to this line. For our example enter "30" and "33" in the C.L. begin and end pt. With this reference data, the cross-section routine can keep the rod person on line and the shots can be recorded such that they can be group together in their proper order, as cross-sections.

While you can change the azimuth of this by changing the points to fit the terrain of the earth, you should not change this line within a cross-section.

If you do not have the two points on the center line stored in the data collector, you can use the **[TR/SS]** key to bring up the Traverse / Sideshot screen and take two shots that can be used as the end points of this center line.

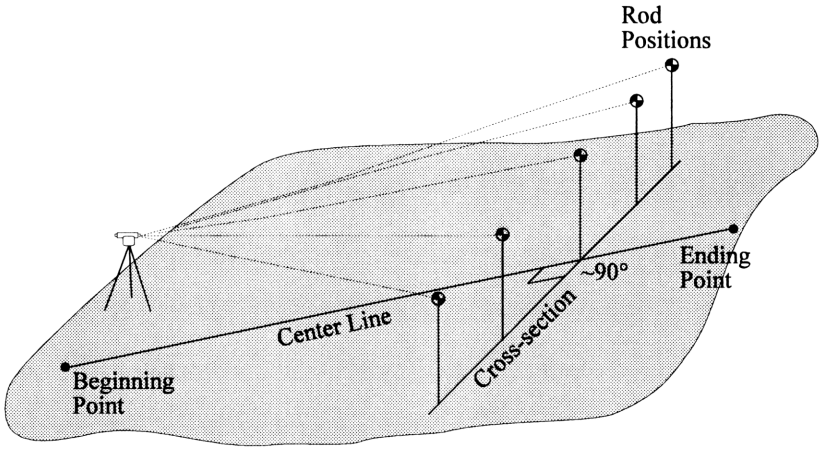
Step 4: With this screen filled out as illustrated as above, press **[SOLVE]**. The prompt:

```
Center Line azimuth:
93.4730
```

will be displayed. This completes the set up for the Cross-Section Survey routine.

THE CROSS-SECTION SURVEY

With everything set up the Survey part of the cross-section is almost like a topo. The only difference is that the points are grouped along a series of lines that are perpendicular to the center line.



Path: From the Main Menu, press **[L] Leveling & X-section Menu**; then **[K] Cross-Section Survey** to display the following:

```
  X-Section Survey
Station: 0    + 25.000
Ang right: 0.0000
>Zenith ang:0.0000
 Slope dist: 0.000
HI:5.260  HR:6.000
Offset:       0.000
```

SIDES		STA	ADV	SETUP	EXIT

Step 1: Now, you need to enter the station number of the particular cross-section you will be shooting. You can place your rod on the center line at the intersection of your next cross-section and take a shot by pressing the **[STA]** key. The computer will calculate the next station number for you. For this example press [ADV] to set a station of "0 + 50.00". Enter "5.24" as the HI and "6.0" as the HR.

Step 2: Now you are ready to take cross-section shots. If you were using an electronic total station you would press **[SIDES]** at this time and the observation data would be downloaded. For this manual example, enter:

Ang right: 135.4837
Zenith ang: 91.2548
Slope dist: 299.41

With the screen filled out as displayed above, press **[SIDES]**. This will store the point as it would when taking a regular sideshot, except that the station and offset information is recorded in the descriptor field. This information can be used to facilitate the automatic computation of the cross-section areas. The descriptor format is as follows:

sss+sss,-fff.fff (station,+/-offset)

e.g. 0+0,25.12 (station 0+0, offset 25.12 ft. to the right)
10+50,-12.25 (station 10+25, offset 12.25 ft. to the left)

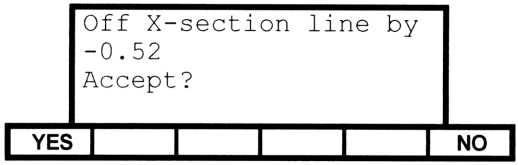
The descriptor for this shot should be: 0+50,10.5 or station 0+50 and offset to the right of 10.5 feet.

Within the same cross-section, you can take the shots in any order you want. The order of the shot sequence is not important because the End Area routine in EASY SURVEY can sort them into order using the offset information stored in the descriptor. Let's take a shot a t the left side of the center line.

Step 3: Enter the following observation:

Ang right: 138.5612
Zenith ang: 91.3518
Slope dist: 304.61

With the above data entered, press **[SIDES]**. This time the rod is off the perpendicular cross-section by more than our tolerance setting. The following prompt is displayed:



If the distance off of the line is too large for your survey press **[NO]** or **[F]** and you can adjust the rod position and retake the shot. For our example this is accurate enough so press **[YES]** or **[A]**. The descriptor for this shot should be: 0+50,-7.11 or station 0+50 and offset to the left of 7.11 feet.

We have only shot two offsets. A typical cross-section would have several more. When you have completed a cross-section, press the **[ADV]** key to add the station interval to current station, or enter a new current station, or enter a new current station, in preparation for your next cross-section observations.

NOTE:

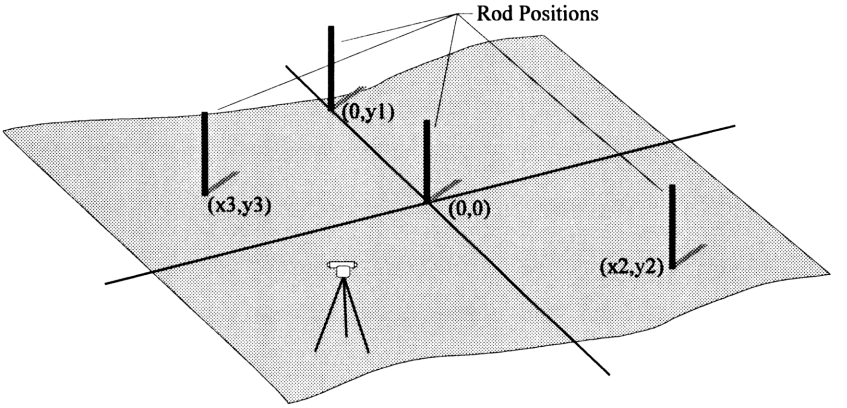
Because of the limited memory and computing power of the data collector, the process of computing cross-section area will not be performed in the data collector. This function is in the Easy Survey Plus software. Easy Survey Plus will not only automatically group and sort the data, it will also graphically display the cross-section as it is computed. It makes the earth work computation very simple and precise.

BUILDING PAD CONSTRUCTION

The Building Pad survey and stakeout routines allow you to establish a local coordinate grid on your construction sight by shooting a point for the origin and a point along the Y-axis. The coordinate system can be aligned to a street, a lot line or any other physical or design feature. The origin and Y axes can be arbitrarily set to fit the construction site. This coordinate system will use an X, Y orientation rather than the Northings and Eastings used in a conventional survey.

Once the grid is established you can then shot any point on the construction site and the Building Pad X, Y, Z routine will calculate the x, y and z coordinates of that point. In addition you can enter any x, y and z coordinates for a point and the Building Pad Stakeout routine will direct you to stake the point on you job site.

These routines allow you to set up and layout a construction site with minimal complication. For this example you will establish a grid, then survey one point and stakeout a second point as illustrated in the diagram below.



BUILDING PAD SETUP

Before any points can be shot, you must first establish the position of the origin and orientation of the local grid. The position of the total station is arbitrary. You would set up your tripod at a point where you have a view of the construction site and are out of the way of machinery and workers. The tripod position can be changed from time to time. As long as the origin and the point on the Y-axis are accurately repeatable the grid will stay constant.

The Building Pad Setup Command is used to establish this orientation.

Path:	From the Main Menu, press **[L]** Leveling & X-section Menu - **[L]**

Step 1: The Building Pad Setup routine will begin by prompting you for the Height of Instrument and Height of Rod. Enter 5.24" and "6.0" respectively. Next you are told to aim at the origin (0,0). The screen will appear as below when completed.

```
Enter height of
instrument:  5.24
Height of rod:6.00

Aim at (0,0) point
of the X-Y axes
Hit a key when ready.
```

Step 2: If you were connected to a total station the data that follows would be downloaded electronically. Since we are entering the data manually, hit a key to display the next screen and enter:

Slope dist: 56.29
Zenith ang: 90.5237

You should also set the Horizontal Circle reading in your instrument to zero while sighted on this point so that all future horizontal angles are referenced from this point. You can think of this point as your backsight.

```
Slope dist: 56.29
Zenith ang:  90.5237

Set HA of gun to zero
Hit a key when ready.
```

Step 3: Next you enter the data for a point that will establish the Y-axis. Hit a key which displays the next screen and enter:

Slope dist: 124.74
Horizontal ang: 348.1631
Zenith ang: 90.3554

The screen will appear as below.

```
Aim at another point
on the Y-axis
Hit a key when ready.
Slope dist: 124.74
Horizontal ang:348.1631
Zenith ang:  90.3554
```

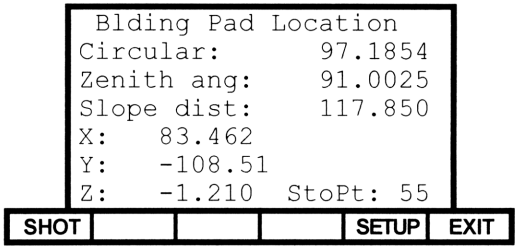
Step 4: This establishes an arbitrary grid from which all other points will be referenced. The setup routine then ask you for the point number where the origin is to be stored and its description. Enter 54 and an appropriate description. This completes the set up and you are ready to survey and/or stake your job sight.

NOTE: Whenever the instrument is moved, you need to return to the setup routine and re-establish the origin and the Y-axis.

BUILDING PAD X, Y, Z

Suppose your rod person is setting on a point located in the lower right hand or (+x,-y) quadrant and you want to know the coordinates of this point. Again, if you are using an electronic total station simply point at the rod and press **[SHOT]**. For our example you must enter the observation manually.

Path:	From the Main Menu, press **[L]** Leveling & X-section Menu - **[M]**



Step 1: Set the StoPt to "55". Now if you where connected to a total station, to determine the coordinates of a point on the job site, simply press **[SIDE]**. For manual mode enter:

Circular:	97.1854
Zenith ang:	91.0025
Slope dist:	117.850

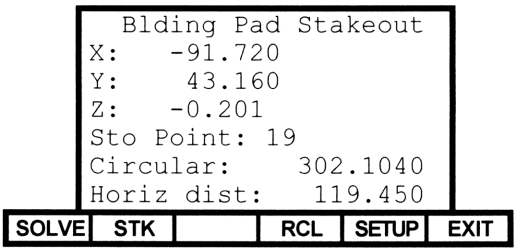
into the Blding Pad Location screen.

Step 2: Now press the **[SHOT]** key to calculate the coordinates. The coordinates for this point will store the in the StoPt number. The coordinates are stored with the Y value in the Nothing the X value in the Easting and the Z value in the Elevation. If you do not want to store coordinates, set the StoPt field to "0". This will turn off the storing feature. The screen should appear as illustrated above.

BUILDING PAD STAKEOUT

Next let's stake a location in the upper left hand or (-x, +y) quadrant. This routine is similar to the Point Stake routine. First, enter an x, y and z coordinate for the point to be staked, after which the routine is the same as with Point Stake.

Path: From the Main Menu, press **[L]** Leveling & X-section Menu - **[N]**



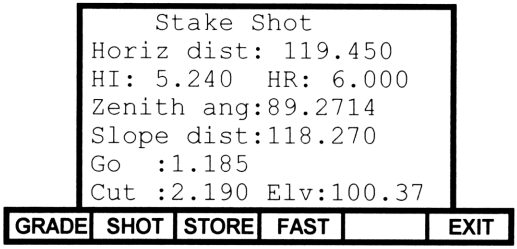
Step 1: To stake a coordinate point on the job site, simply enter:

X: -91.72
Y: 43.16
Z: -0.201

and enter 19 as the Sto point.

Step 2: Press **[SOLVE]** to calculate the circle angle and the HORIZONTAL distance. The screen should appear as illustrated above.

Step 3: Next, turn your instrument to the Circular shown above. Have your rod man pace off the distance; keep him on line with the gun; and, while he is getting set, press **[STK]**. The Stake Shots Screen is displayed.



Step 4: Key in the Zenith: 89.2714 and Slope dist: 118.270 and press **|SHOT|**. The Stake Shot Screen is shown above, as it should appear after pressing **|SHOT|**.

Step 5: Your rod man should move out about a foot and shoot again. Enter a Slope dist of 119.34 and press **|SHOT|**. The Come/Go should read Come: 0.115. This process can continue as long as needed to place your rod on the stake point. Let's assume this is good enough.

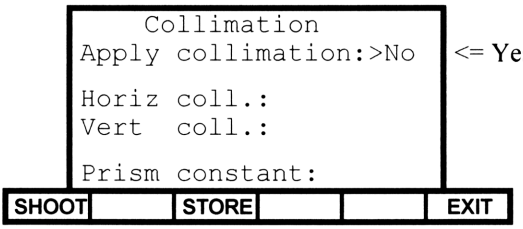
Step 6: At this point, you can press **|STORE|**. The coordinates of the most recent shot will be stored. This step is optional; if you don't want to store your as-built coordinates, simply skip the **|STORE|** key.

ADVANCED FIELDWORK

COLLIMATION

The Collimation screen lets you calculate your instrument's collimation error or simply enter it. This screen is also used to set a prism constant value and choose whether or not you want these corrections applied to your collected data.

Path:	From the Main Menu, press **[H] Setup menu**; then, **[H] Devices**; and finally, **[COLLI]** to display the following screen:



When you first press the **[SHOOT]** key, you will be asked, for the number of sets you wish to take. The **[SHOOT]** key will then read the instruments horizontal and vertical angles both from the direct and reversed scope positions, one set at a time. You can shoot at different points with significant horizontal and vertical separation to improve the collimation. The collimation errors will then be calculated, using the following formulas:

Horiz collimation = Direct HA - MOD 360(reverse HA +180)
Vert collimation = Direct ZE - (360 - reverse ZE)

Finally, the collimation errors are averaged and displayed on the screen.

If the Apply collimation selection is set to Yes, the following corrections will be applied to horizontal and vertical readings.

For direct measurements:
Corrected HA = Measured HA + Horiz collimation
Corrected ZE = Measured ZE + Vert collimation

The slope distance will also be adjusted by the following correction:

Adjusted slope distance = Measured slope distance + prism constant

8. INTEGRATING FIELD WORK WITH AUTO LINEWORK

In this chapter, you will learn how to add field codes to your data collection, thereby enabling EASY SURVEY to generate a map automatically. You will be introduced to Feature codes, which are used to group points, and to command codes, which instruct EASY SURVEY on how to map each group.

OVERVIEW

Auto linework is the ability to gather data in the field and, with limited input from the field crew, then have a PC generate an accurate drawing. Plotting is typically a desk top PC function. With auto linework, however the plotting instructions must be input at the time that the data is collected. The linework is completely a PC function, but the labels that group the points and the instructions on how to connect them, are entered by the field crew.

This Chapter addresses linework with the assumption that you will be using Tripod Data System's EASY SURVEY to generate the plot. You can also use the TDS-48GX as a data collector, then transfer the data to TFR-Link and convert it to a form that a third party software could use to generate linework. The process of gathering data for use by some other software will be similar, but the codes used and the method or order in which the data is gathered may differ. See the TFR-Link Manual for advice on what conversions are available. Look to your third party PC software manual for information on the available codes and the form in which the data is needed.

EASY SURVEY's auto linework uses surveyor-entered "feature codes" to group various shots in a survey. It also uses "command codes" that are entered while collecting data in the field that instruct EASY SURVEY how to treat these groups when it generates the lines or points. A code table is set up in EASY SURVEY to relate the feature codes to the line type, point marker, size, and color that the auto-mapping routine will use to generate the map on the screen.

LINEWORK

Because points and lines are grouped under a feature code, it is usually not necessary to shoot points in a sequential order. EASY SURVEY takes the unordered points and groups them, then it generates points, lines and curves according to the directions of the command codes and the settings in the code table.

Due to the fact that this is a procedure that requires EASY SURVEY to generate the drawing, this chapter will deal mainly with the theory. The data generated in this example is not a complete plot, but only enough to explain the process.

INTEGRATING FIELD DATA WITH AUTO LINEWORK

Before we move on to some specific tasks, it is important to gain an understanding of how field data can be collected with the idea that auto linework will be used to generate a map from that data. The main elements of auto linework are the feature codes, command codes, and the code table.

Feature Codes

Feature codes are user-defined labels, placed in the descriptor field, that identify the kind of point you have shot; e.g. a fence, edge of pavement, etc. Feature codes are used to group similar points into features independent of marker or line types. All points that will be used to define a particular line must have the same feature code. For example you may have codes CENTER, CURB, SIDEWALK and TREE with coordinates that describe the center line , the curb, the edge of the sidewalk and the trees within a subdivision. The first three could then be connected by different line types and the trees might be defined with a distinctive marker. The feature code is used only to group the points and does not have anything to do with how they are connected or displayed.

The feature code can be up to 16 alpha-numeric characters or symbols. EASY SURVEY does not differentiate between case, so you can use either upper or lower case letters. Whether you enter a code as "curb" or "Curb," EASY SURVEY will see it as "CURB".

A feature code **cannot include a space** as part of the code. EASY SURVEY will only recognize the characters up to the first space as the feature code. So, if you want to join two words as a feature code, use the "-" or "_" keys between the words. For example, EASY SURVEY would see FENCE WIRE and FENCE WOOD as the same code : "FENCE". But, FENCE-WIRE or FENCE_WOOD are different, two-word feature codes.

The text after the space can be used as a descriptor. So, you could use TREE OAK, TREE PINE and TREE MAPLE in the descriptor field. They would all be grouped as a "TREE" feature, but you still have a descriptor that distinguishes the type of tree.

Feature codes are not job-specific. Any feature code used for one job can also be used on any other job.

Command Codes

Command codes are system-defined instructions that tell the auto-map routine how to connect points to form the linework. They are entered as Notes in the raw data file just before the data that they act on. Command codes tell EASY SURVEY's auto-mapping routine when to pick up the pen; which points to join and where; where to start and end a line; which points to connect in a curve; and so on.

The command codes are system-defined as described below.

BEG	Starts a line segment. Lifts the pen at the previous point and lowers it at the next observed point.
BC	Begins a Spline curved line. All points with the same feature code, that are shot between the BC and EC command codes, will have a spline curve drawn through them. The slope of the curve at its beginning and end, are defined by the slope of the line leading into and out of the curve
C2 C2###.###	The next two points are the beginning and end points of a curve. When the radius [###.###] is not specified, the two points are assumed to be tangents (PC and PT of the curve). C2 does **not lift or lower** the pen (unless BEG is also specified).

LINEWORK

C3	The next three points are the beginning, middle, and end points of a curve. C3 does **not lift or lower** the pen (unless BEG is also specified).
CP1	The first point of a 3-point curve.
CP2	The second point of a 3-point curve.
CP3	The third point of a 3-point curve. These commands produce the same kind of curve as a C3 command. The difference is that the 3 points do not have to be shot one after another. However the points must have the same feature code and be shot in order.
EC	Ends a Spline curved line. (See BC)
END	Ends the line segment and lifts the pen.
JFS	Joins the current point to the first point in the same feature code. JFS does not lift the pen.
JN	Joins the current point to the next observed point, regardless of the code, without lifting the pen.
JNS	Joins the current point to the nearest point of the same code, without lifting the pen.
JP####	Joins the next observed point to the specified [####] point regardless of the code. It lifts the pen to the specified point and lowers the pen to draw a line to the next observed point.
JPS	Joins the next observed point to the previous point of the same code. It lifts the pen to the previous point and lowers the pen to draw a line to the next observed point.
JT####	Joins the current point to the specified [####] point, regardless of the code, and does not lift the pen.
R3	The next three points are three consecutive points of a rectangle. Auto linework will draw the rectangle defined by these three points. R3 does **not lift or lower** the pen.
SS	Indicates a side shot, taken from the last point, to the point following the SS command. A line will be drawn between these two points and then continue with the linework from the point before the SS command.

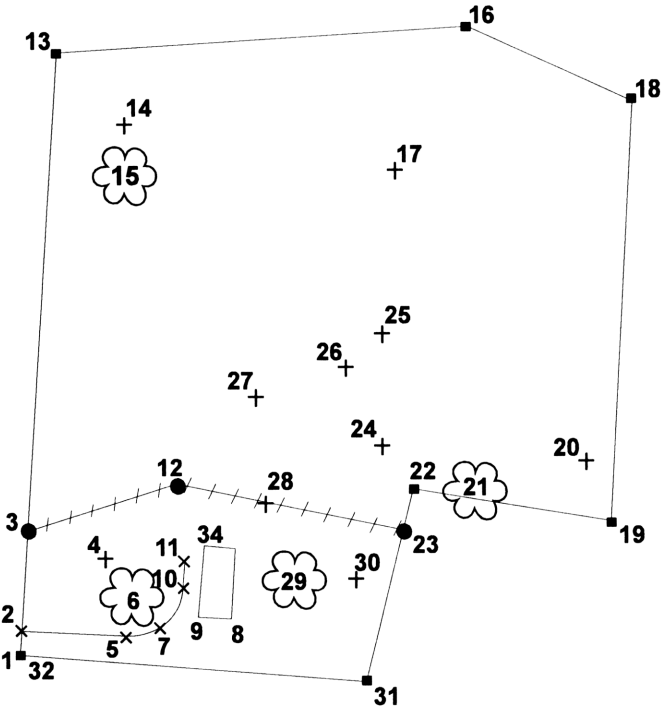
In summary, the feature codes tell how to group the points; the command codes tell how to connect the points; and finally, there is a *code table* in EASY SURVEY that tells whether linework is required for a group of points and how it is to be plotted: e.g. symbol type, color, size, etc. In the code table you assign each feature code or group of points a specific symbol, a line type and several other parameters. The code table is a function of the EASY SURVEY program and is discussed in detail in its Manual.

Auto linework proceeds as follows: You collect data, for the most part, as you would normally; then, add the feature and command codes to the field data. The feature codes classify each point into related groups. With the points linked to a particular group: fence, curb, house, tree, etc.; the command codes tell the auto-mapper how to connect the points to form lines: e.g. begin a fence line at point 3 and end it at point 23; begin a driveway at point 2; curve through points 6, 7, and 8; and end at point 10. The field data is then transferred to EASY SURVEY and, with the aid of the code table, the map is generated.

FIELD SURVEY

We are now ready to walk through the field survey, explaining several survey shots in terms of the raw data that would be created. We pay particular attention to the feature codes and command codes entered in the raw data file. We will use the SMITH property for our example and approach it as if you collected the boundary, traverse, topo and other features in one pass.

LINEWORK



A picture of the plotted SMITH job is shown here for reference. We will refer to parts of it frequently throughout this chapter.

The field survey is performed basically as you would if you were not going to use auto linework except that the Command codes and Feature codes must be inserted in their proper places. As with the other examples, the field data can be collected electronically so that the data would not need to be entered manually. In this example, so that you understand how the feature codes and command codes are entered, we will go through the survey discussing the raw data and how it was generated, line by line.

This example will be a series of grouped sideshots taken from each traversed boundary point. Each shot would be recorded using the traverse / sideshot screen. Sideshots and traverses are taken and recorded in an identical manner. The only difference between the two types of shots is that sideshots are taken to all points that will not be occupied next. Traverses are taken only to those points that will be occupied next. Also, with a Traverse, the TDS-48GX increments the Occupy Point, Foresight Point, and the BS Azimuth fields in the Traverse / Sideshot screen.

Path: From the Main Menu screen, select **[J] Traverse / Side Shot** to display the screen pictured below:

Ang right / Azimuth / Bearing /
Ang left / Def right /Def left =>
Zenith ang / Vert ang / Chng elev =>
Slope dist / Slope dist / Horiz dist

```
OC:        0 FS:        0
BS pt:       0
>Ang right :     0.0000
>Zenith ang:     0.0000
 Slope dist:      0.000
Desc:
HI:   0.000 HR:   0.000
```

SIDES | REP | BACK | TRAV | OFFCT | EXIT

Printed below, we have a raw data file for the SMITH property which shows the shots, the feature codes and command codes for this example. Look over the raw data file now to get familiar with the survey. Then, we will go over it in detail.

```
MO,AD0,UN0,SF1.000000,EC0,EO0.0000
SP,PN1,N 5000.0000,E 5000.0000,EL 100.0000,--BOUNDARY
OC,OP1,N 5000.0000,E 5000.0000,EL100.000,--BOUNDARY
BK,OP1,BP0,BS276.2315,BC0.0000
LS,HI5.32,HR6.00
--BEG
SS,OP1,FP2,AR86.541200,ZE87.285800,SD30.290000,--DRIVE
--BEG
SS,OP1,FP3,AR86.541200,ZE89.301600,SD148.690000,--FENCE
SS,OP1,FP4,AR123.011200,ZE88.363800,SD150.180000,--TOPO
--CP1
SS,OP1,FP5,AR162.152000,ZE87.221200,SD118.630000,--DRIVE
SS,OP1,FP6,AR144.210300,ZE87.563400,SD143.470000,--TREE
--CP2
SS,OP1,FP7,AR161.474200,ZE87.375100,SD154.140000,--DRIVE
--R3
SS,OP1,FP8,AR163.072100,ZE88.143500,SD283.650000,--HOUSE
SS,OP1,FP9,AR160.471800,ZE88.024200,SD204.820000,--HOUSE
SS,OP1,FP34,AR141.062900,ZE88.231300,SD242.560000,--HOUSE
--CP3
SS,OP1,FP10,AR149.245300,ZE88.030000,SD199.260000,--DRIVE
SS,OP1,FP11,AR142.190200,ZE88.081800,SD214.700000,--DRIVE
SS,OP1,FP12,AR124.054900,ZE88.411800,SD268.720000,--FENCE
TR,OP1,FP13,AR86.5412,ZE89.4050,SD711.420,--BOUNDARY
LS,HI5.43,HR6.00
SS,OP13,FP14,AR314.245700,ZE88.585900,SD111.150000,--TOPO
SS,OP13,FP15,AR329.081000,ZE89.174700,SD162.810000,--TREE
TR,OP13,FP16,AR262.544800,ZE89.323600,SD457.760000,--BOUNDARY
LS,HI5.40,HR6.00
SS,OP16,FP17,AR299.032600,ZE89.142300,SD185.140000,--TOPO
TR,OP16,FP18,AR208.571000,ZE89.180300,SD201.310000,--BOUNDARY
```

```
LS,HI5.39,HR6.00
TR,OP18,FP19,AR247.165700,ZE88.523500,SD497.120000,--BOUNDARY
LS,HI5.35,HR6.00
SS,OP19,FP20,AR335.405900,ZE91.041400,SD80.080000,--TOPO
SS,OP19,FP21,AR281.282600,ZE90.312400,SD157.690000,--TREE
TR,OP19,FP22,AR277.483500,ZE90.292600,SD223.980000,--BOUNDARY
--JNS
LS,HI5.40,HR6.00
SS,OP22,FP23,AR92.414300,ZE90.274600,SD50.340000,--FENCE
SS,OP22,FP24,AR225.350800,ZE92.173200,SD63.980000,--TOPO
SS,OP22,FP25,AR248.372000,ZE91.095600,SD187.370000,--TOPO
SS,OP22,FP26,AR232.084400,ZE91.342000,SD162.280000,--TOPO
SS,OP22,FP27,AR201.355300,ZE91.382200,SD206.840000,--TOPO
SS,OP22,FP28,AR164.215700,ZE92.124800,SD164.580000,--TOPO
SS,OP22,FP29,AR130.592600,ZE91.401100,SD171.630000,--TREE
SS,OP22,FP30,AR110.123600,ZE91.222900,SD126.600000,--TOPO
TR,OP22,FP31,AR92.414300,ZE90.274600,SD233.880000,--BOUNDARY
--JFS
LS,HI5.42,HR6.00
TR,OP31,FP32,AR261.275600,ZE91.440500,SD387.250000,--BOUNDARY
```

The first six lines of this file describe how this file was set up. These lines are generated when you create the job file and first set up the traverse/sideshot screen with the OC pt, BS Azm., HI and HR.

```
1 JB,NMSMITH_FW,DT09-14-1992,TM16:30:58
2 MO,AD0,UN0,SF1.000000,EC0,EO0.0000
3 SP,PN1,N 50000.0000,E 5000.0000,EL100.0000,--BOUNDARY
4 OC,OP1,N 5000.0000,E 5000.0000,EL100.000,--BOUNDARY
5 BK,OP1,BP0,BS276.2315,BC0.0000
6 LS,HI5.32,HR6.00
```

Line 1 Gives the job name (JB), date (DT), and time (TM).

Line 2 Gives the different job mode settings (MO).

Line 3 Gives the starting point (SP) as point 1 (PN1), and the north (N), east (E), and elevation (EL) coordinates for point 1. Also, point 1 has been identified as a boundary point by the feature code "BOUNDARY." This is *our first feature code.*

Line 4 States point 1 is the occupied point (OP).

Line 5 States a backsight (BK) was taken from point 1. It gives the back azimuth (BS) as 276.2315. The back circle (BC) is 0.0000.

Line 6 States the original line of sight (LS) taken. The Height of Instrument (HI) is 5.32. Height of Rod (HR) is 6.00.

Let's work through the steps you would complete if you were actually going to gather the data in the field in the manner the SMITH raw data file shows.

Sideshot to FP 2--Start of Driveway

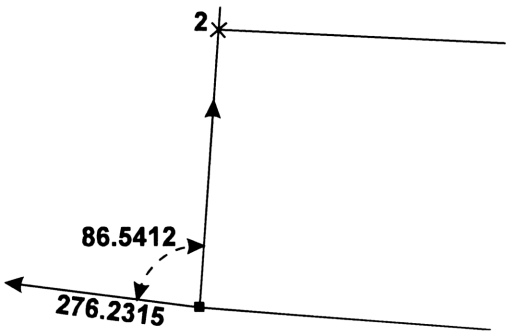
With the raw data file as a reference, let's use the first sideshot to explore how it was taken and how its feature code "DRIVE" and command code "BEG" were entered. This shot is represented by line 8 of the raw data file highlighted below.

```
5  BK,OP1,BP0,BS276.2315,BC0.0000
6  LS,HI5.32,HR6.00
7  --BEG
8  SS,OP1,FP2,AR86.541200,ZE87.285800,SD30.290000,--DRIVE
9  --BEG
10 SS,OP1,FP3,AR86.541200,ZE89.301600,SD148.690000,--FENCE
```

In line 8, foresight point 2 (FP2) marks the beginning of the driveway. The driveway is indicated by the feature code "DRIVE". The "BEG" command code, inserted immediately prior to line 8, signals the map routine to begin a new line at this point.

NOTE:

A command code is **always** inputted immediately prior to the point(s) to which it applies.



If you were to gather the field data as shown in line 8 and enter it into the Traverse/Sideshot screen, you would follow these steps:

Ang right / Azimuth / Bearing /
Ang left / Def right /Def left =>
Zenith ang / Vert ang / Chng elev =>
Slope dist / Slope dist / Horiz dist

```
OC: 1        FS: 2
BS pt: 0
>Ang right :86.5412
>Zenith ang:87.2858
 Slope dist:30.290
Desc:DRIVE
HI: 5.320   HR: 6.000
```

SIDES | REP | BACK | TRAV | OFFCT | EXIT

Step 1: Press **|NOTE|** or ↩ **|B|** to enter "BEG." This identifies the next point you enter as having the command code "BEG" defined for it. **The command code must always be inserted prior to the point it affects.** Command codes are always entered with the **|NOTE|** or ↩ **|B|** softkey; feature codes are always entered in the Description field.

This step can be completed any time prior to pressing **|SIDE| |A|**, but it's a good habit to enter it first.

Step 2: Enter the Occupying Pt as "1."
Enter the Foresight Pt as "2."

Step 3: Press **|BACK| |C|** and use the scrolling prompt to select the BS Azimuth option. This allows you to set the back azimuth for your first shot.

Enter 276.2315.

BS point / BS azm / BS brg =>

```
   Backsight
>BS point:276.2315
Circle:    0.0000

BS Azm:    276.2315
BS Brg:    N83.3645W
```

SOLVE	CHEC		FAST	CIRCL	EXIT

The Circle prompt represents the horizontal circle reading of the gun while sighting on the backsight. This is customarily zero, but may be any value.

Step 4: Enter "DRIVE" in the Descriptor field. This identifies point 2 as having a feature code of "DRIVE."

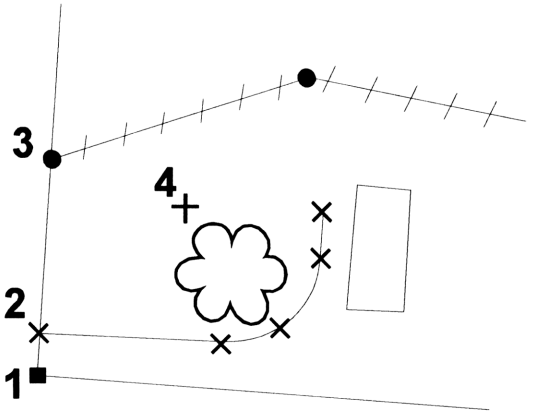
Step 5: Enter "86.5412" as the Angle Right.
Enter "87.2858 as the Zenith.
Enter "30.2900" as the Slope Distance.
(These values are shown in the raw data file.)

Step 6: At this point, you would press **|SIDE| |A|**. The TDS-48GX would compute the coordinates of your foresight point; in this case, point 2. The coordinates of the last stored point would be displayed at the bottom of the screen.

Now let's go through the remainder of the raw data file to discuss how survey data, including feature and command codes, are set up.

COMPLETE THE SURVEY
Sideshot to FP3--Start of Fence

The next shot taken was a sideshot to foresight point 3, as represented by line 10 of the raw data file.




```
6  LS,HI5.32,HR6.00
7  --BEG
8  SS,OP1,FP2,AR86.541200,ZE87.285800,SD30.290000,--DRIVE
9  --BEG
10 SS,OP1,FP3,AR86.541200,ZE89.301600,SD148.690000,--FENCE
11 SS,OP1,FP4,AR123.011200,ZE88.363800,SD150.180000,--TOPO
```

As you can see, another "BEG" command code was required to tell the map routine to begin a line at point 3. The feature code "FENCE" indicates that point 3 is a point on the fence line. See line 10 of the raw data file above.

The first thing you'd do is enter the "BEG" command code using **[NOTE]** or ↵ **[B]**. Again, although the command code can be added any time *prior* to pressing **[SIDES]** or **[A]**, it's a good idea to get used to entering it first.

You would then gather the data for point 3 just as the raw data file shows. To enter the feature code for point 3, you would enter "FENCE" in the Descriptor field.

Sideshot to FP4--Topo

The sideshot to point 4 is a topo pt. as shown in line 11 of the raw data file.

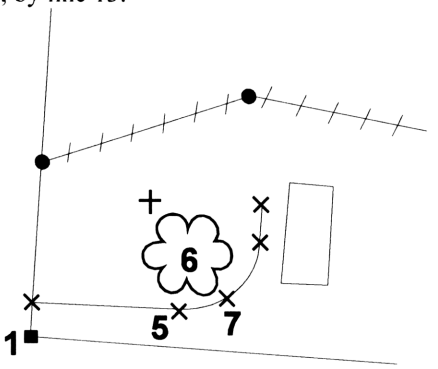
```
8  SS,OP1,FP2,AR86.541200,ZE87.285800,SD30.290000,--DRIVE
9  --BEG
10 SS,OP1,FP3,AR86.541200,ZE89.301600,SD148.690000,--FENCE
11 SS,OP1,FP4,AR123.011200,ZE88.363800,SD150.180000,--TOPO
12 --CP1
13 SS,OP1,FP5,AR162.152000,ZE87.221200,SD118.630000,--DRIVE
```

Notice that there is no "BEG" command in the raw data file prior to foresight point 4. The reason is that point 4 is a topo shot and topo points do not require linework. The linework field in the Code table would be "OFF" because it identifies a group of points that are to be displayed with a marker only. EASY SURVEY will *not* connect point 4 to point 3 because they have different feature codes i.e., the points belong to different groups. Point 4 will not be connected to the next topo point because the linework is off. Therefore, point 4 will be mapped as an individual point.

To enter this information, you would gather the data for point 4 as shown in the raw data file. The feature code "TOPO" would be entered as the point descriptor. You would **not enter a command code**.

Sideshot to FP5--Start of Driveway Curve

Still occupying point 1, the next shot was a sideshot to point 5. From the map, you can see that point 5 is the second point on the driveway and the start of the driveway's curve through points 7 and 10. This is reflected in the raw data file as well, by line 13.



```
11 SS,OP1,FP4,AR123.011200,ZE88.363800,SD150.180000,--TOPO
12 --CP1
13 SS,OP1,FP5,AR162.152000,ZE87.221200,SD118.630000,--DRIVE
14 SS,OP1,FP6,AR144.210300,ZE87.563400,SD143.470000,--TREE
15 --CP2
16 SS,OP1,FP7,AR161.474200,ZE87.375100,SD154.140000,--DRIVE
```

The "CP1" command code instructs EASY SURVEY to start a curved line beginning at the next point. Then through the point following "CP2" and end at the point following "CP3". These three points do not have to be shot together, but they must be recorded in order. You cannot shoot the middle point first or last; it must be in between the two end points. The CP1 command tells the map routine to begin a curve and use the next CP2 and CP3 points that have the same feature code to define it.

For point 5, you would enter the CP1 command by pressing **[NOTE]** or **[B]** and entering "CP1". The feature code "DRIVE" would be entered in the Description field. This defines point 5 as belonging to the same group as point 2 which is also defined by the feature code "DRIVE". Command codes are always entered with the **[NOTE]** or **[B]** softkey; feature codes are always entered in the Description field.

You will gather the data for point 7 and point 10 later. When the map routine generates the map, it will know to map points 2, 5, 7, and 10 with one continuous line of a specific type because: 1) all points have the same feature code; and 2) the command codes "BEG" and "CP*x*" say where to begin the line and draw the curve.

NOTE:

There are three other curve commands that could have been used to define this curve. Each has its advantage, depending on the data you wish to gather to define the curve. **C2** requires the PC and PT and uses the direction coming into the PC as the forward tangent. **C2###.###** requires the PC, PT and the radius of the curve. **C3** requires three points on the curve, as in CP1,CP2 and CP3, but the three points must be shot immediately after the C3 command. Review the curve commands in the command codes toward the front of this Chapter.

Sideshot to FP6--Tree

Here we have another sideshot. This sideshot defines a tree which is identified by the feature code "TREE" in line 14 of the raw data file. Again, we have no command code because no linework is needed for this group.

```
11 SS,OP1,FP4,AR123.011200,ZE88.363800,SD150.180000,--TOPO
12 --CP1
13 SS,OP1,FP5,AR162.152000,ZE87.221200,SD118.630000,--DRIVE
14 SS,OP1,FP6,AR144.210300,ZE87.563400,SD143.470000,--TREE
15 --CP2
16 SS,OP1,FP7,AR161.474200,ZE87.375100,SD154.140000,--DRIVE
```

For this shot, you would gather the data as shown in the raw data file and enter "TREE" as the point descriptor.

Sideshot to FP7--Mid point of Driveway Curve

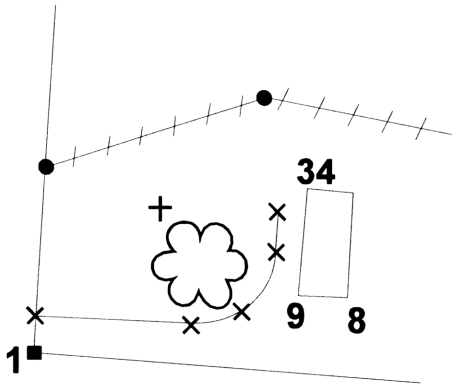
Here we have another sideshot. This sideshot is to the second point in the driveway curve. We enter CP2 as the command code by pressing **[NOTE]** or ↩ **[B]** and entering "CP2". The feature code DRIVE would be entered in the Description field.

```
13 SS,OP1,FP5,AR162.152000,ZE87.221200,SD118.630000,--DRIVE
14 SS,OP1,FP6,AR144.210300,ZE87.563400,SD143.470000,--TREE
15 --CP2
16 SS,OP1,FP7,AR161.474200,ZE87.375100,SD154.140000,--DRIVE
17 --R3
18 SS,OP1,FP8,AR163.072100,ZE88.143500,SD283.650000,--HOUSE
19 SS,OP1,FP9,AR160.471800,ZE88.024200,SD204.820000,--HOUSE
```

For this shot, you would gather the data as shown in line 16 of the raw data file, and enter "DRIVE" as the point descriptor.

Sideshots to FP8, 9 and 34--House

Here, another sideshot was taken, this time to point 8. It is illustrated on the map as a corner of the house. The R3 command was used to start a rectangle defined by the next three points to represent the house. Lines 18-20 of the raw data file shows us that these points are identified by the feature code "HOUSE."




```
16 SS,OP1,FP7,AR161.474200,ZE87.375100,SD154.140000,--DRIVE
17 --R3
18 SS,OP1,FP8,AR163.072100,ZE88.143500,SD283.650000,--HOUSE
19 SS,OP1,FP9,AR160.471800,ZE88.024200,SD204.820000,--HOUSE
20 SS,OP1,FP34,AR141.062900,ZE88.231300,SD242.560000,--HOUSE
21 --CP3
22 SS,OP1,FP10,AR149.245300,ZE88.030000,SD199.260000,--DRIVE
```

You would enter the R3 command code by pressing **[NOTE]** or **[B]**, then enter point 8 as the Foresight point and "HOUSE" as the feature code in the Description field. You would press **[SIDES] [A]** as you would have done for the other sideshots. The map routine will know to begin a rectangle at point 8 and use the next three points in the raw data file as three of the corners. The forth corner is generated by connecting the two ends with a right angle.

Points 9 and 34 were shot next and have no need for command codes because they are a part of the R3 command. Each one of them, however, needs to have the feature code of "HOUSE".

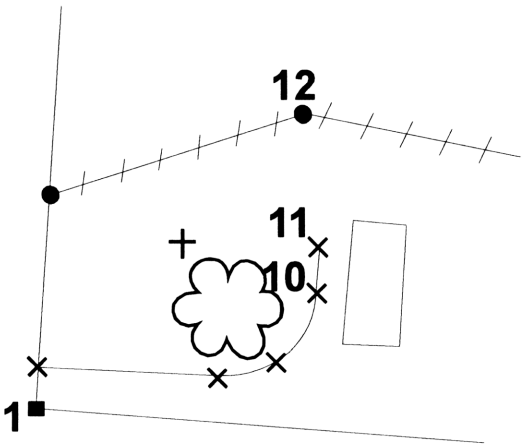
NOTE:

> We used point 34 as the final point in the HOUSE feature to illustrate a point. The ordering of the points is in their sequence in the raw data file and not their point numbers. Point numbers can follow any order you choose.

Now is a good time to point out that, during a field survey, points do not need to be shot in sequential order. After the starting point was established, point 2, the beginning of the driveway, was the next shot taken. Point 5 was not taken until points for the fence and topo had been shot. It is important to understand however, that when the R3, C3 or C2 commands are being used, all the points they will affect *must* be entered immediately following the command and must be entered in order.

Sideshots to FP10, 11, and 12--DRIVE and FENCE

Three more sideshots were taken at this time: the last point on the driveway curve (point 10); the end of the driveway (point 11); and the middle of the fence (point 12). See lines 22-24 below.

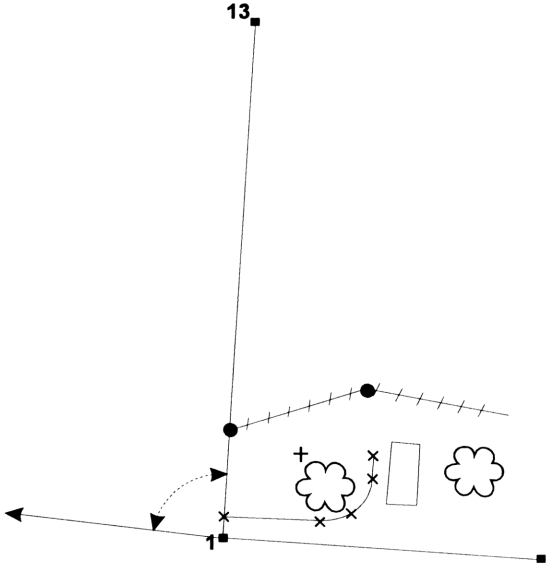


```
20 SS,OP1,FP34,AR141.062900,ZE88.231300,SD242.560000,--HOUSE
21 --CP3
22 SS,OP1,FP10,AR149.245300,ZE88.030000,SD199.260000,--DRIVE
23 SS,OP1,FP11,AR142.190200,ZE88.081800,SD214.700000,--DRIVE
24 SS,OP1,FP12,AR124.054900,ZE88.411800,SD268.720000,--FENCE
25 TR,OP1,FP13,AR86.5412,ZE89.4050,SD711.420,--BOUNDARY
```

To finish the curve the Command code "CP3" is needed before point 10. Commands have already been inserted for previous points identified with DRIVE and FENCE feature codes; therefore, it is not necessary to insert command codes for these last two shots. You would simply collect the data as you have in the previous shots, entering the appropriate feature code in the description field for each point.

Traverse to FP13--BOUNDARY

Line 25 of the raw data file indicates that the next shot was a traverse to point 13; it is shown on the map to be the upper left corner of the boundary. This is the last shot taken from occupied point 1. Point 13 will be the occupied point for the next several shots. See line 25 in the raw data file below.



```
22 SS,OP1,FP10,AR149.245300,ZE88.030000,SD199.260000,--DRIVE
23 SS,OP1,FP11,AR142.190200,ZE88.081800,SD214.700000,--DRIVE
24 SS,OP1,FP12,AR124.054900,ZE88.411800,SD268.720000,--FENCE
25 TR,OP1,FP13,AR86.5412,ZE89.4050,SD711.420,--BOUNDARY
26 LS,HI5.43,HR6.00
27 SS,OP13,FP14,AR314.245700,ZE88.585900,SD111.150000,--TOPO
```

The traverse data is entered exactly like the sideshot data. The feature code for point 13 would be entered as "BOUNDARY." This groups point 13 with point 1, the starting point. The only difference in entering data for a traverse is that you press **[TRAV] [D]** rather than **[SIDE] [A]** when you are ready to shoot.

When **[TRAV] [D]** is pressed, the traverse function operates just like the sideshot function, except that TDS-48GX knows to change the foresight point (Pt 13) to be the occupied point and the old occupied (Pt 1) to be the backsight point automatically. The foresight point is automatically incremented by one (see line 25 of raw data), and the back azimuth is changed to reflect the new backsight point.

Line-of-Sight

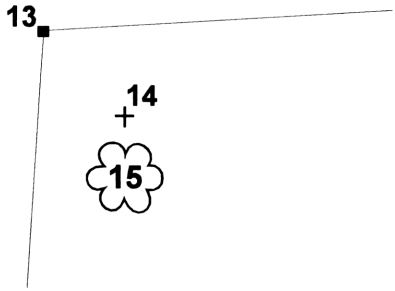
After the traverse was shot, the instrument was moved to occupy point 13. From here, the instrument height was measured and entered as shown in line 23 of the raw data file.

```
22 SS,OP1,FP10,AR149.245300,ZE88.030000,SD199.260000,--DRIVE
23 SS,OP1,FP11,AR142.190200,ZE88.081800,SD214.700000,--DRIVE
24 SS,OP1,FP12,AR124.054900,ZE88.411800,SD268.720000,--FENCE
25 TR,OP1,FP13,AR86.5412,ZE89.4050,SD711.420,--BOUNDARY
26 LS,HI5.43,HR6.00
27 SS,OP13,FP14,AR314.245700,ZE88.585900,SD111.150000,--TOPO
```

All you would need to do for the line-of-sight adjustment is enter the new value in the HI field and press **[ENTER]**. The TDS-48GX automatically makes the instrument adjustments to the screen and displays the new values for Occupy Pt, Foresight Pt, and BS azimuth.

Sideshots to FP14, FP15--TOPO & TREE

The next two shots taken from occupied point 13 were sideshots to FP14 and FP15. Point 14 is a topo feature, and point 15 is a tree. These points are illustrated on the map and are identified by their feature codes in the raw data file in lines 24 and 25.




```
25 TR,OP1,FP13,AR86.5412,ZE89.4050,SD711.420,--BOUNDARY
26 LS,HI5.43,H46.00
27 SS,OP13,FP14,AR314.245700,ZE88.585900,SD111.150000,--TOPO
28 SS,OP13,FP15,AR329.081000,ZE89.174700,SD162.810000,--TREE
29 TR,OP13,FP16,AR262.544800,ZE89.323600,.SD457.760000,--BOUNDARY
```

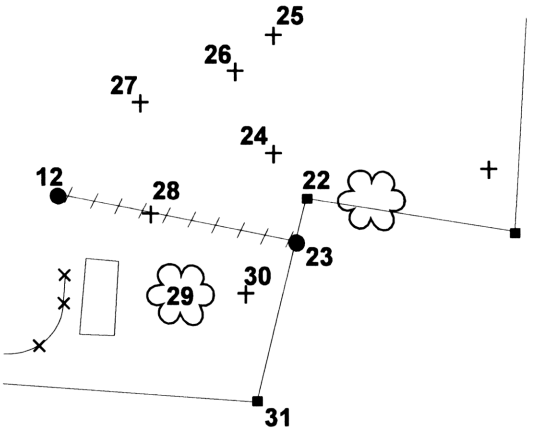
Again, we see the feature codes of "TOPO" and "TREE." These are points that do not require any linework and, thus, no command codes were issued for them. When the Traverse / Sideshot screen is filled in for each point and the feature code entered, you would press **|SIDE| |A|** again rather than **|TRAV| |D|** because the shots were taken as sideshots.

Traverse to FP16--BOUNDARY

From point 13, another traverse is performed to occupy point 16. From point 16, the way is clear to get another topo, point 17, and the other boundary points, 18 and 19, as the map and raw data file show. Another series of sideshots add points 20 and 21. Next is a traverse to point 22. Each time a traverse is made to shoot a boundary point, a new "line-of-sight" is taken to adjust the height of instrument. This is reflected in lines 30, 33, 36 and 40 of the raw data file. The new height is entered in the HI field, just as it was done previously for the traverse taken to point 13. As we begin the sideshots taken from point 22, there is a new code, **JNS**, at line 39.

```
28 SS,OP13,FP15,AR329.081000,ZE89.174700,SD162.810000,--TREE
29 TR,OP13,FP16,AR262.544800,ZE89.323600,.SD457.760000,--BOUNDARY
30 LS,HI5.40,HR6.00
31 SS,OP16,FP17,AR299.032600,ZE89.142300,SD185.140000,--TOPO
32 TR,OP16,FP18,AR208.571000,ZE89.180300,SD201.310000,--BOUNDARY
33 LS,HI5.39,HR6.00
34 TR,OP18,FP19,AR247.165700,ZE88.523500,SD497.120000,--BOUNDARY
35 LS,HI5.35,HR6.00
36 SS,OP19,FP20,AR335.405900,ZE91.041400,SD80.080000,--TOPO
37 SS,OP19,FP21,AR281.282600,ZE90.312400,SD157.690000,--TREE
38 TR,OP19,FP22,AR277.483500,ZE90.292600,SD223.980000,--BOUNDARY
39 --JNS
40 LS,HI5.40,HR6.00
41 SS,OP22,FP23,AR92.414300,ZE90.274600,SD50.340000,--FENCE
42 SS,OP22,FP24,AR225.350800,ZE92.173200,SD63.980000,--TOPO
```

The JNS command tells the map routine to join the next point entered to the nearest point with the same feature code. In other words, point 23 will be joined to point 12, the nearest point with the feature code "FENCE." Points 22 or 30 are the nearest point but neither have a feature code of "FENCE". The "TOPO" point 28 is on the fence line but only by coincidence and is not actually part of the line.



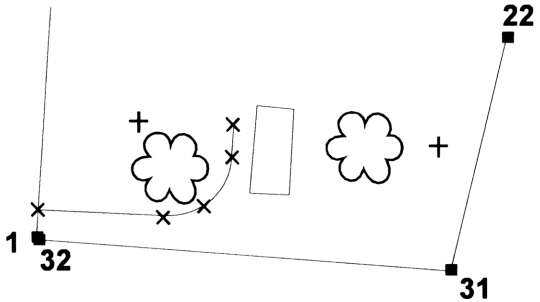
NOTE:

There are a number of **join command codes** that direct the Auto Linework routine to connect the current point with some other point in the survey. See JFS-Join First Point, JN-Join to Next, JP####-Join to Same Code number ####, JPS-Join to Previous and JT####-Join to Point number #### in the command codes toward the front of this Chapter.

The survey continues in the same manner, taking sideshots and traversing to the next occupied point.

Traverse to FP34--Closing Point (BOUNDARY)

When the last (closing) shot was reached, the instrument was occupying point 31 and point 32 was the foresight point. Even though the survey will close back to point 1, the last shot taken was entered as point 32.




```
47 SS,OP22,FP29,AR130.592600,ZE91.401100,SD171.630000,--TREE
48 SS,OP22,FP30,AR110.123600,ZE91.222900,SD126.600000,--TOPO
49 TR,OP22,FP31,AR92.414300,ZE90.274600,SD233.880000,--BOUNDARY
50 --JFS
51 LS,HI5.42,HR6.00
52 TR,OP31,FP32,AR261.275600,ZE91.440500,SD387.250000,--BOUNDARY
```

By storing the closing point as point 32, you will have two sets of coordinates for virtually the same point. This will enable you to compare the ending and beginning coordinates to determine the precision of the survey. If you had reset the foresight point as point 1, the TDS-48GX would have alerted you to the fact that point 1 was already used; that is, it already had coordinates assigned to it. It would ask you if you want to overwrite these coordinates.

SUMMARY

We went through a number of exercises in this chapter to illustrate the idea of integrating your field work with the elements of auto linework. Feature codes are user-defined and group the points you shoot according to type. Command codes are system-defined and tell the map routine how to connect points according to group. Both feature and command codes are entered in the *raw data file* during the actual survey. To demonstrate this, we went through all the lines of the raw data file and explained how each point was shot; how its feature code was entered using the Description field; and, why each command code was entered using the **[NOTE]** or **[B]** softkey.

We have not discussed how feature code attributes can be defined or changed by editing the code table. This is done in EASY SURVEY and is explained in the EASY SURVEY Manual. The EASY SURVEY Manual also discusses how the auto linework is actually performed on your screen.

The use of "**descriptor codes**" can reduce the number of key strokes required to key in the feature codes. You can establish codes for the feature codes to shortcut their repetitive entry. See Chapter 3-Field Work for a complete discussion of descriptor codes.

9. PRINTING AND DATA COMM WITH YOUR TDS-48GX

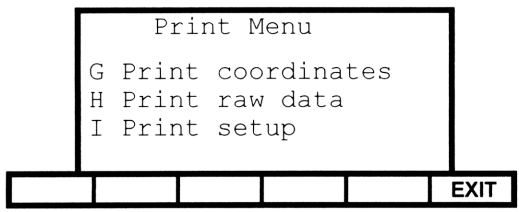
In this chapter, you will learn how to print out your coordinates or raw data directly from your TDS-48GX. You will also learn how to prepare your TDS-48GX to transfer your coordinates and raw data to an office PC. The last several sections explain procedures that support data transfer to other 48-GX programs

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-48GX can use the HP-48GX's built-in infrared wireless data communications capability to print on the HP-82240B Infrared Printer. Or, you can use the serial port (RS232) to print to a printer with a similar serial port. The process for doing this is quite straightforward.

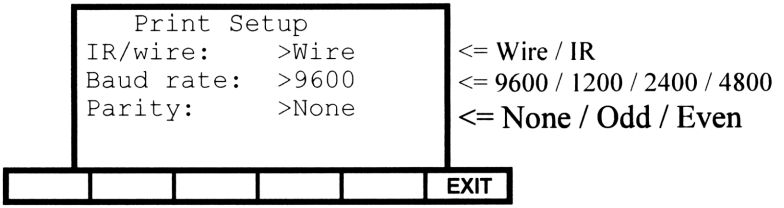
First, you should make sure that the active (open) job is the job whose data you want to print. You may select the job you want to print by using the Open Existing Job option from the Job Menu. Select **|G|** and then **|H|** from the MAIN Menu. Move the cursor to the proper job and press **|ENTER|**.

Next, **|EXIT|** back to the MAIN Menu and select **|R|** for the Print menu. The Print Menu will appear as:



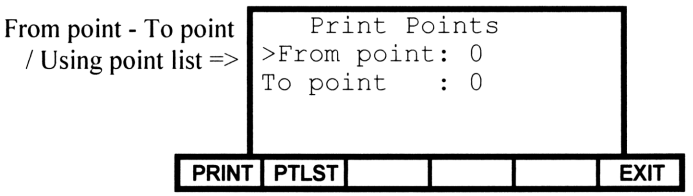
PRINTING & DATA COMM

First let's 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-48GX, you may define a block of points to be printed 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 **|←|** or **|→|** while highlighting the "From point" line in the display and change the prompt to "*Using point list*". 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 your TDS-48GX into your "wire" printer with the appropriate RS232 cable or configure your TDS-48GX 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-48GX 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|**. Below is a sample printout to a serial printer:

```
JOB   : SMITH          TIME:  15:57   DATE: 11-24-1992  Page 1
============================================================
Point      Northing          Easting         Elevation  Note
 ==========================================================
     1     5000.000000     5000.000000       100.000  START
     2     5710.235800     5040.837900       103.286  PT2
     3     5740.539200     5497.579200       106.365  PT3
     4     5654.968900     5679.780800       108.221  PT4
     5     5158.394900     5658.625700       117.360  PT5
     6     5198.246000     5438.227700       114.792  PT6
     7     4970.316800     5385.838900       112.303  PT7
```

NOTE:

The output to the infrared printer is one-way communication only. Thus, there is no way for the TDS-48GX 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 similar. You have no control over the amount of raw data that you can print. The process, therefore, is to select (open) the job you want to print, as in printing coordinates above. Make sure that you have filled out the Print Setup Screen properly (see above) and have your specified printer properly configured . Then, select **[R]** from the MAIN Menu. 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-48GX. See sample below:

```
JOB : SMITH_FW     TIME:  09:56    DATE: 11-25-1992    Page 1
============================================================
JB,NM,SMITH_FW,DT09-14-1992,TM,16:30:58
MO,AD0,UN0,SF1.000000,EC0,EO0.0000
SP,PN1,N 5000.000000,E 5000.000000,EL100.000000,--BOUNDARY
OC,OP1,N 5000.0000,E 5000.0000,EL100.000,--BOUNDARY
BK,OP1,BP0,BS276.2315,BC0.0000
LS,HI5.32,HR6.00
SS,OP1,FP2,AR86.5412,ZE87.2858,SD30.2900,--DRIVE EAST
SS,OP1,FP3,AR86.5412,ZE89.3016,SD148.6900,--FENCE WEST
SS,OP1,FP4,AR123.011200,ZE88.363800,SD150.180000,--TOPO
SS,OP1,FP5,AR144.210300,ZE87.563400,SD143.470000,--TREE
SS,OP1,FP6,AR162.1520,ZE87.2212,SD118.6300,--DRIVE EAST
SS,OP1,FP7,AR161.4742,ZE87.3751,SD154.1400,--DRIVE WEST
SS,OP1,FP8,AR149.2453,ZE88.0300,SD199.2600,--DRIVE WEST
SS,OP1,FP9,AR160.471800,ZE88.024200,SD204.820000,--HOUSE
SS,OP1,FP10,AR142.190200,ZE88.081800,SD214.700000,--DRIVE
SS,OP1,FP11,AR141.062900,ZE88.231300,SD242.560000,--HOUSE
SS,OP1,FP12,AR124.054900,ZE88.411800,SD268.720000,--FENCE
TR,OP1,FP13,AR86.5412,ZE89.4050,SD711.420,--BOUNDARY
```

See Appendix D for a listing of the meanings of the various abbreviations that you will see in the printout. You may obtain a printout of the raw data, with the codes expanded, by transferring the raw data file to your office PC and using the TDS TFR PC software to generate a printout of the raw data on your PC's printer. (Consult the TDS's TFR User's Manual.)

PRINTING SCREENS

At any time, you may print the contents of any screen in your TDS-48GX by using the global key sequence ↩ **|D|**. When you want to make a hard copy of a 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.

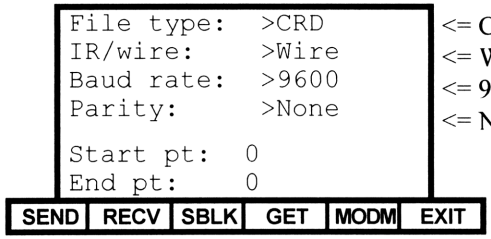
NOTE:

Screen prints may only be sent to the HP-82240B Infrared Printer.

DATA COMMUNICATION TO AN OFFICE PC

One of the most useful features of the TDS-48GX is that you may transfer the 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-48GX for stakeout or other field work. The process for setting up your TDS-48GX to transfer a coordinate file to a PC running TFR, Tripod Data Systems communication and file conversion software, is as follows:

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



<= CRD / RAW / PLST
<= Wire / IR
<= 9600 / 1200 / 2400 / 4800
<= None / Odd /Even

Step 1: Move the cursor to the first line and, using the horizontal cursor keys, select the CRD option for the File type. If you wanted to transfer a raw data file you would select the RAW option. Or, to transfer a point list file select PLST.

Step 2: The next three lines of this screen are all of the scrolling prompt type and have to do with setting the actual data transfer communication parameters. How you set these values will be determined by the particular software that you will be using in your PC to communicate with your TDS-48GX. If you are using the TFR software in your PC to communicate with your TDS-48GX, these parameters should be set to wire interconnection, 9600 baud and no parity, as displayed in the screen above.

Step 3: Set you PC so that it is ready to receive data. Using TFR, you would choose, from its main menu, the receive file option and set what ever parameters are necessary. (For details pertaining to your particular version of TFR and the actual screens used, see your TFR User Manual.)

Step 4: Once your PC software is waiting for data from your data collector, press **|SEND|** on your TDS-48GX. This will bring up a list of your coordinate files. Highlight the file you wish to send and press **|SELCT|**. The transfer should begin. If it does not, check the trouble shooting appendix at the end of this manual.

As with all electronically stored data, your surveying jobs should be backed up frequently; at least once a day if possible. Tripod Data Systems has done all it can to improve the reliability of the TDS-48GX. But with anything stored electronically in RAM, and especially where it is taken into the field, there is a risk of data loss. **Your best protection is to BACKUP often.**

The process of receiving data from your PC to the data collector is virtually the same as to send. In step 3 above, choose the TFR send file screen and select the file you want to send. Again see the TFR Manual for the specific screen and steps necessary to send a file from TFR. Then simply press **|RECV|** on your TDS-48GX. When you are receiving, the File type is determined by the file that is sent from your PC and not by the selection displayed in the top line of your TDS-48GX screen.

If you want to send a part of a coordinate file, in step 4 above, enter the beginning and ending points of the block you want to send in the Start pt and End pt fields. Then press **|SBLK|** instead of **|SEND|**. All other steps are the same. The points between the Start pt and the End pt, including the start and end points, will be transferred. The numbers in the Start pt and the End pt fields are ignored except when the **|SBLK|** key is pressed.

The **|GET|** key is for users who have an RS232 interfaced floppy drive that emulates the kermit server protocol. The **|GET|** key can be used to retrieve a file from this drive. Set the communication parameters to the drives requirements and press **|GET|**. You will be prompted for a file name. Enter the complete file name, then press **|ENTER|** and the file should be loaded into the TDS-48GX. The **|SEND|** key can be used to send files to the drive.

File Transfer Between Two TDS-48GX's

You may use the wireless communication capabilities of the HP-48GX to copy a coordinate or point list file from one TDS-48GX to another or to a TDS system95. 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-48GX just above the Hewlett-Packard logo. Set all of the communication parameters the same on both units. 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.

Transfer Files through MODEM

The TDS-48GX surveying card version 4.2 has added a function for transferring data using a modem. With a modem, you can access your surveying data from a remote job site through the telephone line. You can also send data to the office, without the need to travel in. For sending data through the phone line, you need a modem between your TDS-48GX and the phone line.

In addition you need to setup the computer in your office to have the ability to answer the phone and send and receive data. Version 5.1 of TDS's transfer program - TFR, has added a function for modem communication. The TFR now has a Host mode for answering phone calls. In this mode, it will automatically pick up the phone when it rings and carry out commands from the field computer for sending and receiving data. Once set in the Host mode, you can transfer data to and from the office with out further command on you office PC.

Using the Modem Routine

Sending data over the phone lines is very similar to the transfer routine that is already in the TDS-48GX, but two extra steps are needed. First, you must add an electronic communication device called a MODEM to both the data collector and the office PC. Any Hayes compatible modem should work but some setting of switches or modes and cable wiring maybe needed to configure some models. The modem on your PC must have Auto Answer capability. The dealer who sold you the modem should be able to provide you with the support needed to configure your modems. Once you have a properly configured modem connected to a phone line on your TDS-48GX and PC, you should not need to adjust the modems again.

Second, you need to dial between these two devices and establish a connection. Before communicate over a modem can take place, your PC must be set into a host mode so that it is waiting for your call. This can be done before you leave the office or by someone in the office just before dialing in. To set TFR on the PC to the **|HOST|** mode select **|J|** Transfer through Modem screen.

```
     Transfer through Modem
Phone #:
Phone type:>Tone Dial          => Tone Dial / Pulse Dial

COMM Port  :          >Com1    => COM1 / 2 / 3 / 4
Baud       :          >1200    => 1200 / 2400 / 4800 / etc.
Parity     :          >None    => Even / Odd

File Type      :>Coordinate    => Coordinate/ Raw Data/ etc.
```

F1 SEND	F2 DIAL	F3 HANG↑	F4 GET F	F5 HOST	F6 EXIT

Check to see that the Port, Baud rate and Parity are properly set for your modems communication needs and press **|HOST|**. The screen should display "HOST MODE: (press ENTER to check CARRIER)" and then "OK" when it has checked the modem. The PC is now ready to send or receive data from a remote system and will wait in this mode until you **|EXIT|** from the host mode.

The **|HOST|** function is available only in TDS TFR program. The HOST softkey is NOT available on any TDS Data Collector. When **|HOST|** is hit, the modem will be set to an auto answer mode. This mode sets the PC to listen to the line for a RING. When a ring is detected, it will pick up the line, CONNECT the modems and enter the HOST mode which allows for the remote reading and writing of files. In the HOST mode, the screen will be cleared, and whatever the host is sending or receiving will be echoed to the screen. When the line is terminated, the host computer will automatically detect the loss of the CARRIER, and will re-enter the auto answer mode, ready for the next call. The only active softkey will be **|EXIT|** which allows you to exit the HOST state.

When you are ready to transfer data the TDS-48GX must dial in and establish a connection with your PC. From the TDS-48GX, press **|S|** for the File Transfer Screen and check the IR/Wire, Baud rate and Parity. The parity must be the same as was set in TFR on your office PC. The baud rate must be compatible with your data collectors modem but not higher than the baud rate set on the office PC. Next, to make the phone call, press the **|MODM|** key and enter the Phone number to be dialed. Check that the Phone Type is set properly (normally Tone Dial) and press the **|DIAL|** key. This will instruct the modem to dial the number and establish communication protocols with the office computer on the other end of the line. When the two systems are connected the screen will display "CONNECT". Hit the **|EXIT|** key to return to the File Transfer Screen.

Now, check to see that the File Type is the type you want to transfer and press the **|SEND|** or **|GET F|** key. When communicating over the phone line the **|REC|** key has no real purpose. You either send a file or you get a file. All control is from the data collector end. Now enter or select the file you wish to transfer and press **|ENTER|**. The file will be transferred. Another file can be transferred without re-dialing. Simply press the **|SEND|** or **|GET F|** key and select another file.

When you have completed all the transfers you want at this time press the **|HANG|** key and turn off the modem. The PC will stay in host mode ready to receive an other call at a later time. Simple repeat the calling instructions above when you want to transfer an other file.

ADVANCED TOPICS

The next few sections provide information for those users who wish to write their own programs for the HP-48GX using coordinate data gathered by the TDS-48GX Surveying Card. Effective understanding of this material requires some understanding of the programming language of the HP-48GX.

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

If you plan on writing your own programs to use in conjunction with the TDS-48GX, you will want to set up the HP-48GX to access the TDS-48GX 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 {TDS48} in the command line. To do this you will actually have to press the following keys:  **|{}| |α| |α| |T| |D| |S| |4| |8| |α|**.

2) Press **|ENTER|**.

3) Press  **|MODES|**. Even though the **|MODES|** function is printed on the keyboard in *green*, you should use the *purple* shift key for this command.

4) Press the **|MENU|** softkey which brings up a second group of softkeys. Press the **|MENU|** softkey again (it will **not** be the same key).

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

USING TDS-48GX 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-48GX Surveying Card. However, it is recognized that a user proficient in the programming and use of the HP-48GX itself may choose to develop his or her own routines to solve additional problems. To this end, the TDS-48GX includes two functions which allow you direct access to the coordinate data files from the standard HP-48GX operating system.

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

RETRIEVING 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 -

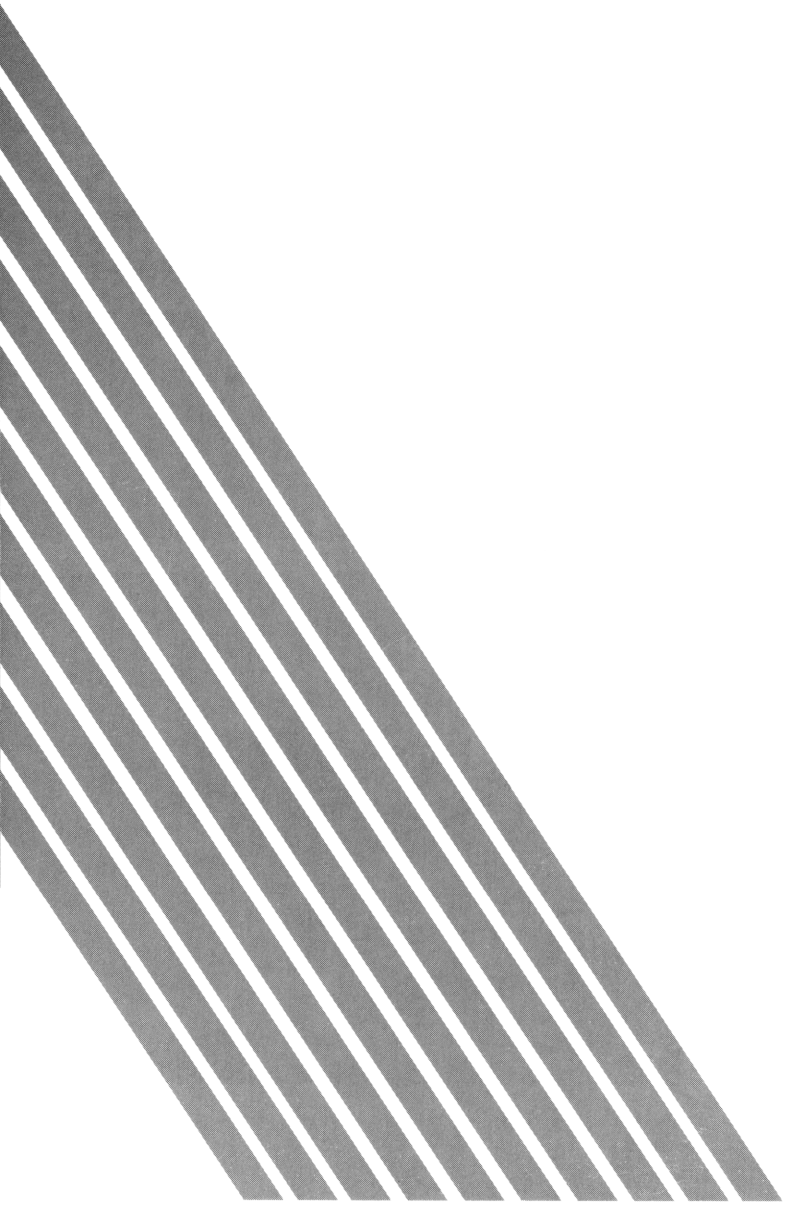
Northing - 2500
Easting - 3000
Elevation - 100
Descriptor - "POINT"

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.

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-48GX.



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