SMI Version 7 User Guide by Eagle Point

SMI Version 7 User Guide

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About SMI's Surveying Cards

Chapter 1

In this chapter:

SMI's Surveying Cards Features

SMI's surveying cards for data collectors represent the most exciting hand-held software available today for land surveyors and construction stakeout surveyors. Here are only a few of the reasons:

- Assembly language programming provides almost instant results.
- The Multi-Point Free-Station Resection feature saves setup time of 10 - 30 minutes each time you set up for staking or collecting.
- This program will automatically find your scale factor when you are working in State Plane Coordinates.
- Multiple sets of angles and distances to multiple points. Allows the user to utilize either of two methods for reading angles.
- Full accuracy of data to 11 places past the decimal. ***SMI*** now works with any size State Plane Coordinates.
- A screen menu system is now available as an option.
- Remote points can now be stored without a prism.
- Remote elevations can be stored on points with known points just by sighting the known point.
- Convert from feet, inches, and fractional inches to decimal feet.
- Store staked points to a cutsheet.
- Storage registers similar to the HP 41.
- Shortcut keystrokes.
- Trig level adjustment.
- Use ***SMI*** to run levels and store level notes.
- Design spirals.
- Template editor.

PREVIOUS USERS OF SMI VERSION 5

CHAPTER

2

In this chapter:

Key Definitions

Key	*Function*
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
Hard Keys	Hard key functions are imprinted on each key itself. The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card. **Hard keys are represented in this manual as black lettering on a gray, rectangular background.**
Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

What's New

This chapter describes product changes subsequent to Version 5.

Angle Point and Intersection Point

- If angle points are stored consecutively and X PT shots are taken in order beginning with the first angle point, the point numbers are automatically stored properly.
- Angle point and X point have been removed from the shift-left side shot position.
- Angle point now stores the coordinates of the point occupied with a note of "ANG PT xxx.xxxxx" where xxx.xxxxx is the angle shot from the first occupied point. When X PT is used, a special record is stored in the raw data file, as well as coordinates in a point number.

Bench

ALTS (Alternate Slope) is used in ***Construction Five***, Version 5. In Version 6, the function name changed from ALTS to BNCH (Bench). BNCH is found at CONST (the S key) NXT NXT and BNCH.

Benchmark Menu

- Pressing B M turns on the Elevation flag (flag 3).

✎ B M *is assigned as a shortcut to the P key.*

- A shortcut: B M can now also be accessed by pressing P.

  If the instrument is turned on, with the prism on the benchmark and the instrument pointed toward the prism, press B M or press P as a shortcut. The screen shows the angle right, the zenith angle, and the slope distance. Taking a reverse reading is optional; however, if you flop the scope and press REV, you will see the reading and the zenith angle error displayed.

Change/Defaults

The soft keys have been divided into submenus for better organization.

- The DCE / DOT key toggles between two overlays. (The DCE key will depend on which card you have installed. For example, if you have ***Construction Five***, it will toggle CVC / DOT]). This is under CHG , NXT , INPUT .
- The FIX4 / FIX4 ■ key toggles whether certain values (like stakeout) will be shown with the same precision as coordinates. This is under CHG , NXT , DSPLY .
- The METR ■ / METR (Convert Meters to Feet) function now only converts distances collected electronically. This is under CHG , NXT , ADJST .
- The FINE / CRS key has been moved to the Instrument menu (SETUP NXT NXT INST). SETS is not needed – use the Shots menu. Top mounted EDM (TOPMT) is no longer supported.

Construction Five

- Ditch bottom width can be entered as part of the template. Version 6 templates that do not use a ditch bottom width can be used in Version 5 cards.
- A spiral entered in HCCL can have points on the tangents instead of the TS and ST. The coordinates of the points entered will be replaced by the coordinates of the calculated TS and ST.
- An arc can now be entered with a negative radius point to indicate a delta angle > 180.
- The entire chain is searched for the station that has the smallest offset to the shot taken. This eliminates the need for Maximum Offset (MXOF). However, we still have MXOF with a different definition. The MXOF default is now set to 0 as a default so that the entire chain will be searched the first time a shot is taken. The next time a shot is taken in the same horizontal control segment, no search is necessary and the data is computed almost instantly. Setting the MXOF to 50 or 100 will increase the speed of the first time search.
- When adjacent segments of the horizontal control are not tangent, such as two lines meeting at a point or a non-tangent arc, there is, as a result, a region we will call a point region. All locations in this point region have the same station. Offsets in a point region are measured from the point of intersection to the location.
- Options that make adjustments to the template have been moved to the Template Adjustments menu (TADJ). Other options have been moved to a CVC Options menu (OPT).

Curve Stakeout

The TDIST key has been renamed to TL .

Curves

- While traversing from PI to PI, you can now insert a curve at each PI.
- Press TRAV and traverse to the PI of a curve (or you can press SETUP and occupy the PI point and backsight a point along the tangent, then press TRAV). Enter the direction to the next PI (angle right, azimuth, bearing, or deflection angle).

This automatically computes the delta for the curve you wish to insert. Press **IC@PI** (Insert Curve at PI). You will see what appears to be the first soft key page of the Curves menu. Use any of these options except delta, since delta is already computed. Key in a value and press the appropriate key. The curve data for the curve you are about to insert will be displayed and you will see the second page of the traverse soft keys displayed. Key in the information to move to the next PI point (like horizontal distance). The PC, RP, and PT points will be stored, as well as the next PI point. You will be occupying the next PI point ready to traverse to another PI, and while doing so, insert another curve at this PI if you wish.

➥ The PI direction keys on the third page of the Curves menu have been removed. The same function can be performed using the **IC@PI** menu in the Traverse menu.

➥ The **STA** button prompts for the station number at the PC and then calls curve stakeout.

Customize

➥ Register Store (**RSTO**), Register Recall (**RRCL**), and Registers Menu (**REGS**).

➥ Clean (**CLEA**) is not needed. Press **ON** and C at the same time to reset the variables.

➥ In Version 6, User mode does not have to be on. User key assignments made in this menu will only work when SMI mode is toggled to User mode.

Free Station (Two-Point Free Station/Resection)

➥ Direct and reverse shots can be made on both points. A different rod height can be saved for each point. The elevation of the occupied point can be based on either or both points. Pressing ↰ **2PFS** will start the Resection menu without clearing the shot information from the last resection done.

➥ The calculated coordinates are occupied as soon as **RSLTS** is pressed, but the point is not stored and the raw data file is not updated until the **STORE** key is pressed. When coordinates have been occupied by **RSLTS** but not stored to a point by **STORE**, the occupied point number will be displayed as “FREE” instead of a point number.

➥ There are two displays: the shot measurement screen and the results screen. The shot measurement screen will show the last shot taken. The results screen shows the coordinates at the instrument based on the shots taken.

➥ SMI’s Free Station (formerly Resection) program offers the same flexibility as before, but it is now more versatile and more accurate. The soft key has changed from **RSCT** to **2PFS**, and it has moved from the **MORE** menu to **SETUP** **NXT**.

Instruments

➥ MAN 2 mode prompts for an angle right when in Angle Right mode, a circle reading when in DTBS mode, and an azimuth when in Azimuth mode. There is a toggle key (**DZH** / **HZD**) in the Change menu that causes MAN2 to prompt for the horizontal angle first.

➥ Raw data no longer flashes on the screen when the data is collected. To view the data that was collected from the instrument, press **SETUP** **NXT** **NXT** and **RAWD**. Or press **VIEW** and **RAW**.

➥ The instrument drivers are now listed by manufacturer and then by model.

- The TOPG (Topgun) driver has been renamed to NIKN (Nikon).
- The FINE / CRS key has been moved from the CHG menu to the INST menu (SETUP NXT NXT INST).
- The manufacturer submenus list the models that the drivers support. Many are supported that are not listed. If you have an instrument not listed, test it by having the instrument set up and pointing to a prism. Choose a driver and press SIDS . If this works, also test it on SDA .

  If your instrument is not listed, press SETUP NXT NXT INST NXT and choose OTHER .

  You will see:

  KERN 3820 LASER CRIT LLQ EXIT

Instrument Menu Soft Keys

Option	Function
KERN	This key works with the Kern E1.
3820	This key works with the HP 3820.
LASER	This key works with the Laser Atlanta Rangefinder that does not require a prism.
CRIT	This key works with the Criterion Rangefinder that does not require a prism.
LLQ	This key works with Allen Osborne Associates, Inc. GPS receivers. Only available on GPS/Robotic cards.

More

Two-wire and three-wire levels, latitude and departure, and vertical curves have all been greatly improved.

Point-to-Point Inverse

- P - P inverses between points and puts the distance and angle on the stack.
- The P - P key now only displays the inverse. Nothing is left on the stack.

Print

- Delay time for infrared printing: (PRINT OPT DELAY).
- There is an ON / OFF toggle to print screens.
- The Degree Symbol option (DEGS) has been moved from the Change menu to the Print Options menu (PRINT OPT NXT DEGS).
- The IR / WIRE toggle has been moved to the PRINT OPT NXT menu.

Introduction to the HP 48

Chapter 3

This chapter will familiarize you with the basic operation of your HP 48 hand-held calculator.

In this chapter:

For a more complete overview of the HP 48, we recommend that you read your HP 48 owner's manual – particularly the first few chapters.

The HP 48 is a powerful tool because it is a calculator and a computer in one. In this chapter, you will be given a brief overview of how the HP 48 works.

If you are already familiar with the HP 48, you may want to skip to *Getting Started*, which begins on page 17, for an introduction to ***SMI's*** powerful surveying software.

The HP 48 Layout

The HP 48 is divided in four sections:

- The status area
- The stack
- The command line
- The keyboard

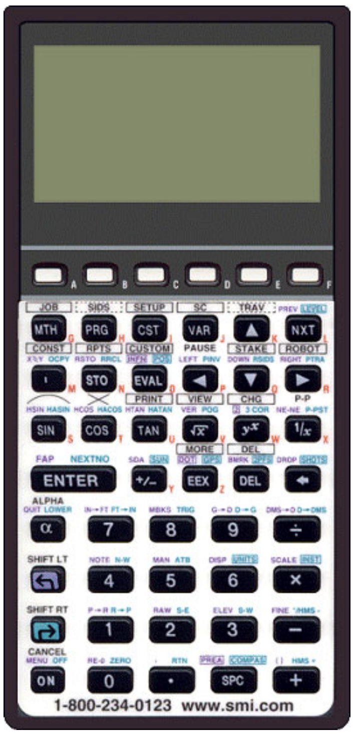

Figure 3-1 HP 48

The Status Area

The status area displays the following:

Annunciators

These show the status of the calculator. Status messages include symbols that indicate:

Annunciator	***Status***
	Right shift (or  left shift) is active.
α	The alpha keyboard is active (you can type letters and other characters).
CVC	The type of ***SMI*** software you are using (varies, depending on which surveying card you are using).

Annunciator	***Status***
((•))	Alert (e.g., low battery); a message in the status area should appear to tell you the cause of the alert.
X	Busy (not ready to process new input, but the HP 48 can remember up to 15 keystrokes and process them when free).
●	Transmitting data to an external device.
SMI	The ***SMI*** default key assignments are active.
USER	The user key assignments are active. See *User Mode* on page 33 for more information.
RZNIM	The indicated user flags are set. See *What You Are Seeing on the Screen* on page 31 for more information.
{HOME} or JOB1:CRD	The current directory path – when you turn on the HP 48 for the first time, the current directory path is {HOME}. When an ***SMI*** program is running in the HP 48, the default directory is JOB1. The CRD indicates that the job is in the RAM card's memory. If JOB1:48 is displayed, the job is in the HP 48's memory. Directories divide memory into segments, just as files divide papers in a file cabinet. See *Working with Jobs* on page 35 for more information.

Chapter 3: Introduction to the HP 48

Other messages inform you when an error has occurred, prompt you to enter data, or provide additional information to help you use the HP 48 more effectively.

The Stack

The HP 48 keeps track of information by "stacking" it in the calculator's internal memory. The stack is actually a series of locations used by the HP 48 for memory storage of numbers and other "objects" (including letters, equations, and even programs). These locations are called "levels," and they are numbered sequentially: 1, 2, 3, and so on.

The number of levels changes according to how many objects are stored in the stack. Put numbers or characters in the stack simply by keying them in and then pressing **ENTER**. As you enter new numbers or other objects in the stack, the stack expands to accommodate them; the new data moves to level 1 and older data is "bumped" to higher levels.

Conversely, as you use data from the stack, the number of levels decreases as the data moves down to lower levels.

The stack is "infinite" in size, meaning the number of objects you can store is limited only by the size of your HP 48's memory. However, the display is only able to show a total of four levels. Any additional levels are maintained in memory, but not displayed.

The Command Line

The command line appears whenever you start keying in or editing characters (letters or numbers). The stack lines move up one row to make room for the command line.

If you type more than 21 characters on the command line, information scrolls off the left side of the display, and an ellipsis (...) displays to indicate that data flows in that direction.

The command line is closely associated with the stack. Use the command line to key in or edit characters (text, values, or other alpha numerics) and then to process it; the results are transferred to the stack.

After you finish using the command line, the stack display moves back down so that the first four levels are displayed.

✎ *One way to know that the command line is active is that you will see a blinking cursor.*

Soft Key Menu Labels

Menu labels across the bottom of the display show the operations associated with the six white menu keys (or soft keys) across the top of the keyboard (see *Soft Keys* below).

The HP 48 Keyboard

This section describes keypad functions.

On/Off

The ON key is located at the bottom left corner of the keypad. Press it once to turn on the calculator.

To turn off the HP 48, press ↱ and ON. If the HP 48 is left on, it will automatically turn off if you have not used it for 10 minutes.

You can turn off your calculator at any time. When you turn it on again, it will be ready to continue where you left off – any information you had on the display will still be there.

Soft Keys

There are six keys just beneath the display, labeled A through F. Although these keys are part of the keyboard, we refer to them as "soft" because their functions (and labels) change, depending on the ***SMI*** or HP 48 menu you select; thus, they represent different operations or choices you can make when you are running various programs.

Generally, you use the soft keys to enter values, such as bearing and distance. Key in the value, then press the appropriate soft key. Or press the soft key and the display will ask you to enter a value.

The current function of each soft key is identified along the bottom line of the display (menu labels). Soft keys are represented in this manual as white lettering on a black, rectangular background. For example: 2PFS.

If the soft key has a tab in the upper left-hand side, this indicates that there are more options to choose from after you press the key, or there is a subdirectory. For example, in the Job menu, when you press the OLD soft key, more options present themselves.

Toggles

A toggle is a key whose function changes each time you press it. Any soft key in the display that has a square after it is a toggle.

For example: Press CHG, then NXT, then DSPLY. This brings you to the Display menu (this menu will be explained in a different section and is only referenced here as part of the toggle example). Press the BRG soft key.

Notice that the key changes to **A Z**; press it again and it changes to **∡RT**; press it again and it changes to **COOR**. Press the key once more and it returns to the **BRG** soft key.

Here is another example that is not a soft key: If you press ↰ then the number 3, it turns off Elevations. Keying in ↰, then the number 3 will turn on Elevations again.

Hard Keys

Hard key functions are imprinted on each key itself (such as the Enter key). When you load and set up your ***SMI*** software, many of these keys are assigned to perform functions that you will be using with your software. The assigned keys are then called primary keys (see *Primary Keys* below).

The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card (see *Normal SMI Overlay Mode* on page 27). Hard keys are represented in this manual as black lettering on a gray, rectangular background. For example: **ENTER**.

Primary Keys

Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. When your ***SMI*** software is loaded, simply press the key that corresponds to the operation (or primary function) you want to use. Some of these functions must be accessed by first pressing a shift key (see*The Shift Keys* below). The keys that can be accessed without pressing a shift key are in black.

As you will see in *Getting Started*, which begins on page 17, ***SMI*** uses a setup program to assign many surveying functions to the keyboard. When ***SMI*** is on (as indicated by the name of the card appearing in the status line at the top of your HP 48 display), the overlay functions and programs are active. When the name of the card is not shown, the normal HP 48 keyboard and math/science functions are active.

If you see "USER" in the status line, it indicates that some customized user keys have been specifically defined by the user. See *User Mode* on page 33 for information on specifying user keys.

Primary keys are represented in this manual as black lettering on a white, rectangular background. For example: **JOB** .

The Shift Keys

Although there are only 49 keys on the keypad, they are able to perform multiple functions, thanks to the shift keys. These functions are imprinted on the ***SMI*** surveying overlay above each corresponding hard key. They are also color coded to correspond with either the left or right shift key. Shift functions are noted in purple (shift left) or teal (shift right) on the ***SMI*** surveying overlay for the HP 48. The Titan shift keys are colored red (shift left) and brown (shift right).

The **ON**/**OFF** key is just one example of how to use the shift keys to select a different function from the same key.

Press a shift key before pressing the desired key on the keypad. (Notice that when you press a shift key, its symbol, or "annunciator," will appear at the top of the display.)

The ↰ (shift left) key changes the primary key to match the function labeled over the key in purple.

The ↱ (shift right) key changes the primary key to match the function labeled over the key in teal.

✎ *If you press a shift key in error, press it again to turn it off. If you press the wrong shift key, simply press the correct one to continue.*

Alpha Keys

You have seen how your ***SMI*** software allows the calculator keys to serve multiple purposes. In addition to functions, certain keys also represent letters of the alphabet.

To do this, you must first turn the alpha keys on by pressing [α]. If ***SMI*** is not initialized, [α] must be pressed twice to key in more than one alpha character. However, you will see in *Getting Started*, which begins on page 17, how your ***SMI*** program sets a flag so that this function key needs to be pressed only once to remain on.

The characters you will type are represented in red on the ***SMI*** overlay (or white on the calculator itself) and are to the right side of each hard key. As you press the keys that correspond to the letters you want, those letters will appear on the screen.

With alpha "on," key in the letters ABC. You should see ABC displayed on the command line, just above the soft key menu. In the ***SMI*** program, pressing [↱] then [α] while the Alpha mode is already on will make the letters lowercase.

HP 48 Basics

As you read at the beginning of this chapter, the HP 48 stacks information to add, subtract, multiply, or divide. Initially, the way you perform calculations may seem a bit "backwards" if you are used to a standard calculator or adding machine. But it is actually quite simple.

Here is how it works:

1. **Key in any number.**

   Notice that the numbers appear at the bottom left of the display, above the soft keys. This is the "command line."

2. **Press [ENTER].**

   The numbers now appear at the bottom right, across from number 1. This means the number is now stored in the computer's "level 1 stack."

3. **Key in another number. (You do not need to press [ENTER] again.)**

4. **Press any of the four function keys: [+], [−], [×], or [÷].**

   Once you have performed the function, the result appears on level 1 of the stack display. You may then key in another number and perform another operation.

The number of items that can be stacked is limited only by the size of your HP 48's memory.

An operation that takes only one argument, such as SIN, COS, TAN, or (square root), uses the value on level 1 of the stack.

For example, to find the square root of 16, you would key in 16 and then press [×]. The result appearing on the command line of the display is 4.

Using Two Entries to Perform an Operation

For example, to multiply 5 by 6: Key in 5 and press [ENTER] to put the number 5 into level 1 of the stack. Now key in 6 and press [×].

The display will show 30 as the result.

You could also key in 5, press the [SPC] key, key in 6, and press [×] with the same result.

Adjusting the Contrast of Your Display

The HP 48 has a built-in contrast control that lets you adjust the display to suit your preference or work requirements.

1. **With the HP 48 on, hold down the ON key. Continue holding down the key while you adjust the contrast.**
2. **To darken the display, press +. To lighten the display, press −.**
3. **Continue pressing + or − until your display has the desired contrast.**

Batteries

Your HP 48 requires three AAA batteries. We strongly recommend using only alkaline batteries.

Under normal conditions, these batteries should last several months. Using RAM cards and transferring data using infrared and serial communications places a heavier drain on batteries and will reduce battery life. With heavy usage, a fresh set of batteries should last about two months.

When your batteries need to be replaced, a low battery symbol, or "annunciator," will normally show at the top of the display, just to the right of center. This display will remain even when your HP 48 is off.

If you are working with an electronic total station, the battery drainage is heavier than normal. You may see "`Low Battery`" or other messages before you see the normal low battery annunciator. Your HP 48 will continue to remind you if the batteries are weak.

Each time the HP 48 is turned on, it will beep and display: `Warning: LowBat(s)`. The warning message will then disappear, but the ((•)) symbol (low battery annunciator) will remain at the top of the display.

✔ ***You should replace the batteries as soon as possible after your HP 48 gives you the low battery warning. Failure to do so may result in loss of job data.***

To replace batteries:

1. **Turn off the HP 48 by pressing ➦ ON.**
2. **Remove the battery cover (on the calculator back, under the serial number).**

✔ ***Be careful not to press the ON key while you are installing new batteries. This will erase any data you may have stored in your HP 48.***

3. **Replace your weakened batteries with fresh AAA alkaline batteries, making sure that each faces in the direction indicated in the battery compartment. This is important, since reversing the batteries may cause you to lose any job data you have stored in your HP 48.**
4. **Replace the battery cover by sliding it closed until it clicks into place.**
5. **If you see the message** `Warning LowBat(P2)`**, see *Changing RAM Card Batteries* on page 16.**

Internal Memory of the HP 48

The HP 48 has a built-in memory capacity of 128K RAM (random-access memory).

A plug-in RAM card may be added to your HP 48 to increase its memory. RAM cards are used only in port 2. (The ***SMI*** program card is always used in port 1).

Both the HP 48/SX and GX accept memory cards in 32K and 128K sizes. The HP 48 also accepts memory cards in 256K, 512K, and 1MB sizes.

About Memory Cards

HP calculators are very reliable; however, in the unlikely event that damage occurs, a memory card can save hours of work recapturing lost data. A memory card with battery backup provides additional security for data – especially when you are working in the field. If your HP calculator's batteries go dead, files on your RAM card stay intact.

Some RAM cards use a battery (photocell, style #CR2016) to preserve stored data. This battery has an effective life of six to twelve months, so should be replaced regularly. These RAM cards have a switch at the top of the card; others recharge themselves from the HP 48's AAA batteries and have no switch.

✔ ***If the HP 48's AAA batteries are not changed often, the RAM card's rechargeable battery may lose its charge and result in loss of memory.***

Changing RAM Card Batteries

Some RAM cards also have batteries. When a RAM card has a low battery, you will see the message `Warning LowBat(P2)` and the low battery annunciator will be displayed at the top of the screen.

✔ ***Do not take the RAM card out of the HP 48 until you have saved all the jobs that are on the RAM card.***

✎ *Remember: RAM cards are used only in port 2. (The* ***SMI*** *program card is always used in port 1).*

1. **Leave the RAM card in port 2.**
2. **Turn on your HP 48 (this will keep power to the card).**
3. **Change the battery.**

If you plan to remove the RAM card from the HP 48 to change the battery, first download job data from the card to your HP 48 or a PC, since all data on the RAM card will be erased.

More information about the calculator itself can be found in your HP calculator owner's manual. *Getting Started*, which begins on page 17, covers installation of the ***SMI*** program card and introduces you to the HP 48's surveying software.

GETTING STARTED

CHAPTER

4

This chapter will help you install and set up your ***SMI*** surveying card and become familiar with the more common keys, commands, and functions you will be using.

In this chapter:

Key Definitions

Key	Function
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
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Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

Overlay or Command Keys

This section will familiarize you with the command keys that drive the ***SMI*** program.

✎ *If you have a PDA, the overlay is part of the program's screen.*

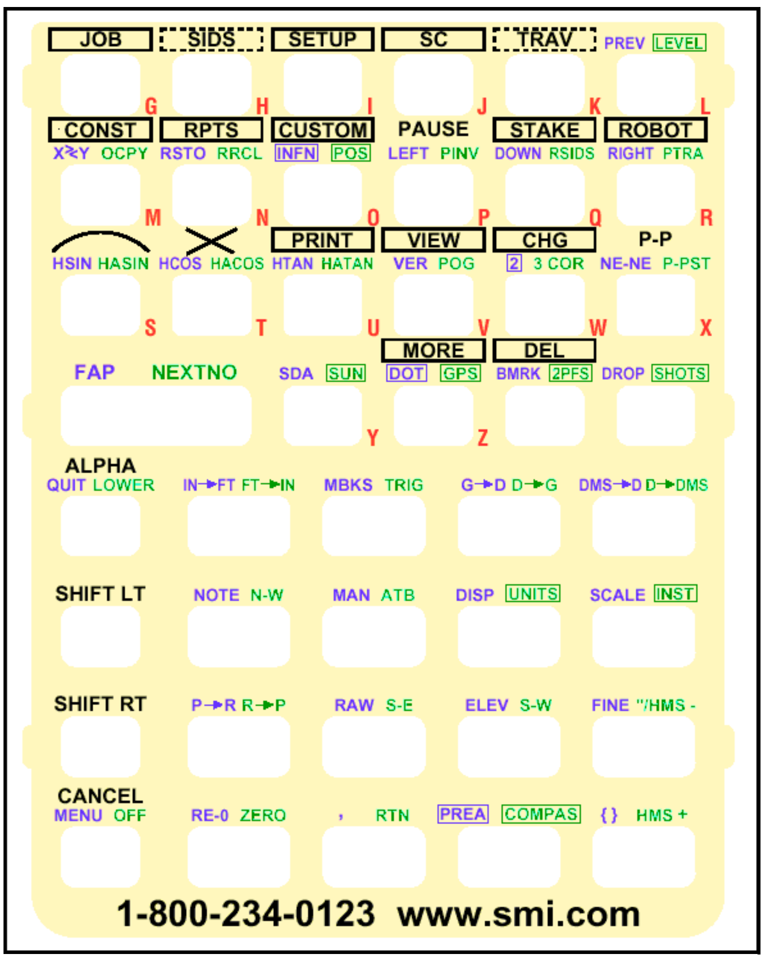


Figure 4-1 Overlay

Overlay Shortcuts

Overlay Shortcuts Sorted by Key Location

Shortcut	Function
JOB	Job menu
↱ JOB	Command menu (toggle)
↰ JOB	Registers Menu
↱ SIDS	Side Shot command: If the Instrument flag is set to On, record a side shot from an instrument; if the flag is set to Off, you may enter a side shot using the Side Shot menu
SIDS	Side Shot (manual)
SETUP	Setup menu
↱ SETUP	Positioning menu
↰ SETUP	Instrument menu (custom)
S C	Store Coordinate
↱ S C	Traverse - Repeat
↰ S C	Side Shot - Repeat
TRAV	Traverse command: If the Instrument flag is set to On, record a side shot from an instrument; if the flag is set to Off, you may enter a side shot using the Side Shot menu
↱ TRAV	Traverse (manual)
↰ TRAV	Turn instrument up (Robotic) or MAN2 Traverse.
NXT	Next menu page
↱ NXT	Levels
↰ NXT	Previous menu page
CONST	***Construction Five*** menu (CVC+)
↱ OCPY	Occupy Point
↰ X><Y	Swap: Swaps the contents of stack one and stack two
↱ RRCL	Register Recall function
↰ RSTO	Register Store function
CUSTOM	Custom menu
↱ POS	Instrument Positioning menu
↰ INFN	Instrument Functions menu

Overlay Shortcuts Sorted by Key Location

Shortcut	***Function***
Pause	Interrupt: Stops current robotic function (Search, turn, etc.) (DCER+)
PINV	Inverse to point
LEFT	Turn instrument left (DCER+)
STAKE	Stake menu
RSIDS	Side Shot (real-time) (DCER+)
DOWN	Turn instrument down (Robotic) (DCER+)
ROBOT	Servo menu (servo-enabled instruments) (DCER+)
PTRA	Point Traverse
RIGHT	Turn instrument right (DCER+)
	Horizontal Curves menu
HASIN	HMS ASIN
HSIN	HMS SIN
	Intersections menu
HACOS	HMS ACOS
HCOS	HMS COS
PRINT	Print menu
HATAN	HMS ATAN
HTAN	HMS TAN
VIEW	View menu
POG	Point on Grade (DOT)
VER	Version of ***SMI*** software
CHG	Change Settings menu
3 COR	Three-corner shot (DOT)
2	Two-corner shot (DOT)
P - P	Inverse from point
P-PST	Copy point-to-point results on the stack instead of reporting them
NE-NE	Inverse between Northing and Easting values on the stack

Overlay Shortcuts Sorted by Key Location

Shortcut	***Function***
ENTER	Enter button
↱ NEXTNO	Set the next number
↰ FAP	First available point
+/−	Currently not assigned
↱ SUN	Sunshot menu
↰ SDA	Separate Distance and Angle (DCE+)
MORE	More menu
↱ GPS	GPS menu (DCER+)
↰ DOT	DOT-enabled commands (Toggle) (DOT)
DEL	Delete menu
↱ 2PFS	Free Station - Two Point (ACE+)
↰ BMRK	Benchmark: Brings observed elevation to the occupied point (ACE+)
←	Delete: Deletes some or all contents of current line in stack
↱ SHOTS	Shots menu (ACE+)
↰ DROP	Drops off the first value from the stack
α	Alpha key to set Alpha mode
↱ LOWER	Lower case when in Alpha mode
↰ QUIT	Exit the ***SMI*** program
↱ FT → IN	Convert from feet to feet and inches
↰ IN → FT	Convert from feet and inches to feet
↱ TRIG	Trig leveling
↰ MBKS	Mean Backsight (DCE+)
↱ D → G	Convert from degrees to gradians
↰ G → D	Convert from gradians to degrees
↱ D → DMS	Convert from decimal degrees to degrees-minutes-seconds (DD.DDDD to DD.MMSS)
↰ DMS → D	Convert from degrees-minutes-seconds to decimal degrees (DD.MMSS to DD.DDDD)

Overlay Shortcuts Sorted by Key Location

Shortcut	***Function***
↱ N-W	North-West bearing
↰ NOTE	Toggle the notes flag (N)
↱ ATB	Azimuth to Bearing conversion
↰ MAN	Toggle to set the flag for Instrument mode or Manual mode (I)
↱ UNITS	Units: Provides access to the HP application and menu (DOT)
↰ DISP	Toggle between angle display modes (DOT)
↱ INST	Instrument menu
↰ SCALE	Scale factor for the job
↱ R → P	Convert from Rectangular to Polar
↰ P → R	Convert from Polar to Rectangular
↱ S-E	South-East bearing
↰ RAW	Toggle the record raw observations flag (R)
↱ S-W	South-West bearing
↰ ELEV	Toggle the record elevations flag
↱ "/HMS-	Subtract two numbers on the stack using the degrees-minutes-seconds format
↰ FINE	Instrument Fine and Coarse modes (toggle)
CANCEL	On and Cancels current command
↱ OFF	Off
↰ MENU	Toggles screen displayed command menu
↱ ZERO	Zeros the instrument from the data collector
↰ RE-0	Backsight and set zero again (robotic) (DCER+)
↱ RTN	Return button: Allows entered text to continue on the next line
↰ ,	Code with a note
↱ COMPAS	Compass Rule menu
↰ PREA	Predetermined area
↱ HMS+	Adds two numbers in the stack using the degrees-minutes-seconds format

Overlay Shortcuts Sorted by Key Location

Shortcut	*Function*
↰ { }	Places function or operand within braces on the stack

Overlay Shortcuts Sorted Alphabetically

Function	*Shortcut*
Currently not assigned	+/−
Two-Corner shot (DOT)	↰ 2
Three-Corner shot (DOT)	↱ 3 COR
Adds two numbers in the stack using the degrees-minutes-seconds format	↱ HMS+
Alpha key to set Alpha mode	α
Registers Menu	↰ JOB
Azimuth to Bearing conversion	↱ ATB
Backsight and set zero again (robotic) (DCER+)	↰ RE-0
Benchmark: Brings observed elevation to the occupied point (ACE+)	↰ BMRK
Change Settings menu	CHG
Code with a note	↰ ,
Command menu (toggle)	↱ JOB
Compass Rule menu	↱ COMPAS
Construction Five menu (CVC+)	CONST
Convert from decimal degrees to degrees-minutes-seconds (DD.DDDD to DD.MMSS)	↱ D → DMS
Convert from degrees to gradians	↱ D → G
Convert from degrees-minutes-seconds to decimal degrees (DD.MMSS to DD.DDDD)	↰ DMS → D
Convert from feet and inches to feet	↰ IN → FT
Convert from feet to feet and inches	↱ FT → IN
Convert from gradians to degrees	↰ G → D
Convert from polar to rectangular	↰ P → R
Convert from rectangular to polar	↱ R → P
Copy point-to-point results on the stack instead of reporting them	↱ P-PST

Overlay Shortcuts Sorted Alphabetically

Function	***Shortcut***
Custom menu	CUSTOM
Delete menu	DEL
Delete: Deletes some or all contents of current line in stack	◀
DOT enabled commands (toggle) (DOT)	↰ DOT
Drops off the first value from the stack	↰ DROP
Enter button	ENTER
Exit the ***SMI*** program	↰ QUIT
First available point	↰ FAP
Free Station - Two Point (ACE+)	↱ 2PFS
GPS menu (DCER+)	GPS
HMS ACOS	↱ HACOS
HMS ASIN	↱ HASIN
HMS ATAN	↱ HATAN
HMS COS	↰ HCOS
HMS SIN	↰ HSIN
HMS TAN	↰ HTAN
Horizontal Curves menu	⌒
Instrument Fine and Coarse modes (toggle)	↰ FINE
Instrument Functions menu	↰ INFN
Instrument menu	↱ INST
Instrument menu (custom)	↰ SETUP
Instrument Positioning menu	↱ POS
Interrupt: Stops current robotic function (search, turn, etc.) (DCER+)	Pause
Intersections menu	×
Inverse between Northing and Easting values on the stack	↰ NE-NE
Inverse from point	P - P
Inverse to point	↱ PINV

Overlay Shortcuts Sorted Alphabetically

Function	*Shortcut*
Jobs menu	JOB
Levels	↱ NXT
Lower case when in ALPHA mode	↱ LOWER
Mean Backsight (DCE+)	↰ MBKS
More menu	MORE
Next menu page	NXT
North-West Bearing	↱ N-W
Occupy Point	↱ OCPY
Off	↱ OFF
On and Cancels current command	CANCEL
Places function or operand within braces on the stack	↰ { }
Point on Grade (DOT)	↱ POG
Point Traverse	↱ PTRA
Positioning menu	↱ SETUP
Predetermined area	↰ PREA
Previous menu page	↰ NXT
Print menu	PRINT
Random Points menu	RPTS
Register Recall function	↱ RRCL
Register Store function	↰ RSTO
Return button: Allows entered text to continue on the next line	↱ RTN
Scale factor for the job	↰ SCALE
Separate Distance and Angle (DCE+)	↰ SDA
Servo menu (servo-enabled instruments) (DCER+)	ROBOT
Set the next number	↱ NEXTNO
Setup Menu	SETUP
Shots menu (ACE+)	↱ SHOTS

Overlay Shortcuts Sorted Alphabetically

Function	*Shortcut*
Side Shot - Repeat	↰ S C
Side Shot (manual)	↱ SIDS
Side Shot (real-time) (DCER+)	↱ RSIDS
Side Shot (real-time) or MAN2 Side Shot	↰ SIDS
Side Shot command: If the Instrument flag is set On, record a side shot from an instrument; if the flag is set Off, you may enter a side shot using the Side Shot menu	SIDS
South-East Bearing	↱ S-E
South-West Bearing	↱ S-W
Stake menu	STAKE
Store Coordinate	S C
Subtract two numbers on the stack using the degrees-minutes-seconds format	↱ "/HMS-
Sunshot menu	↱ SUN
Swap: Swaps the contents of stack one and stack two	↰ X><Y
Toggle between angle display modes (DOT)	↰ DISP
Toggle the notes flag (N)	↰ NOTE
Toggle the record elevations flag (Z)	↰ ELEV
Toggle the record raw observations flag (R)	↰ RAW
Toggle to set the flag for Instrument mode or Manual mode (I)	↰ MAN
Toggles screen displayed command menu	↰ MENU
Traverse (manual)	↱ TRAV
Traverse - Repeat	↱ S C
Traverse command: If the instrument flag is set On, record a side shot from an instrument; if the flag is set Off, you may enter a side shot using the Side Shot menu	TRAV
Trig Leveling	↱ TRIG
Turn instrument down (robotic) (DCER+)	↰ DOWN
Turn instrument left (DCER+)	↰ LEFT
Turn instrument right (DCER+)	↰ RIGHT

Overlay Shortcuts Sorted Alphabetically

Function	*Shortcut*
Turn instrument up (robotic) or MAN2 Traverse	↰ TRAV
Units: Provides access to the HP application and menu (DOT)	↱ UNITS
Version of ***SMI*** software	↰ VER
View menu	VIEW
Zeros the instrument from the data collector	↱ ZERO

To Get Started

✔ ***Read this before you begin.***

Please take a few minutes to read this chapter before you begin experimenting with your data collector and ***SMI*** surveying card. Like the data collector, your ***SMI*** software module is a powerful tool. By becoming familiar with the basics of this tool, you will quickly be on your way to faster, more efficient surveying. A few minutes of preparation now can prevent many questions later.

Install SMI in Your HP 48

Turn off the HP 48 and open the back cover. Plug the program card into port 1.

✔ ***Be careful when plugging any cards into the HP 48. There is only one way to install the card.***

With the card plugged in, you should be able to see the name of the card through the tab on the card when you open the back cover. If you purchased a RAM card, plug it into port 2. Turn on the HP 48. The ***SMI*** program will automatically initialize or load.

What Happened When the SMI Program Was Initialized?

You will be brought to the setup screen. A job called JOB1 was created. Point 1 was created with default coordinates of 5,000 North and 5,000 East. Point 1 was occupied and the back azimuth was set to zero.

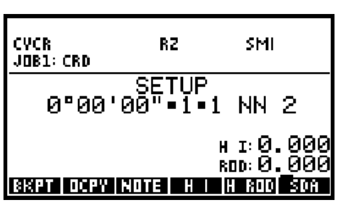


Figure 4-2 SMI Program Initialized

Normal SMI Overlay Mode

Your ***SMI*** surveying module comes with a keyboard overlay for your data collector. If you have not yet done so, install the overlay now. The overlay snaps into place over the data collector's keys and shows the various surveying functions you will be using with your ***SMI*** program card. After everything has been installed, practice a few keystrokes.

When you call for technical support, the technician will need to know the version number of your program.

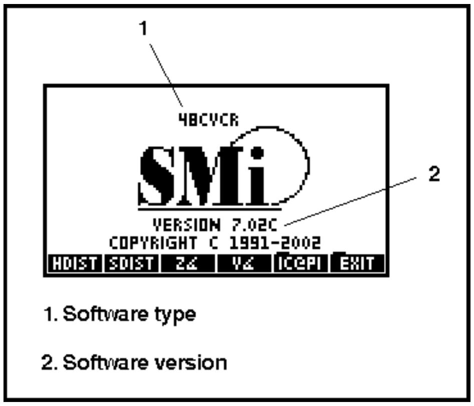


Figure 4-3 SMI Software Screen

1. Check your program version by pressing ↰ V.

2. Now press the ON key.

You will be returned to the setup screen.

The On Key

You will find the ON key to be very useful; it does more than just turn the calculator on and off, it also carries out other functions assigned to it by ***SMI*** and HP. For example:

- **CLEAR**: If you have data on the stack or command line and want to get rid of it, press ON.
- **ERASE**: If you are keying in data as part of an ***SMI*** routine and want to clear the command line, press ON. The command line will be cleared.
- **CANCEL**: If you are in the middle of entering data into a program and you want to cancel the program, press ON.

In other words, press ON to clear, cancel, quit, exit, prepare to reenter data, or get ready to go to some other function or program. Normally, when you end one program and are ready to go to another, you will not need to press ON unless the command line is active. Just press the key for the function you want to use.

If you discover that you have made a mistake or you are unsure how to get out of a problem, press ON once or twice to “back out” and start over. If you were typing data on the command line, ON will let you erase the data you entered. Press ON a second time to cancel entering data entirely. This will not cancel the function you are running.

If you are using the Menu option (see *Menu Option* on page 29), ON will bring you back to the menu screen when you are finished using a function and wish to look at the menu again.

Menu Option

To use the ***SMI*** screen menu option, press [↰] **MENU** or the **ON** key. Now press [α] M (menu) **ENTER**. The ***SMI*** screen menu will be displayed and active. The screens below may differ from the ***SMI*** program you are using.

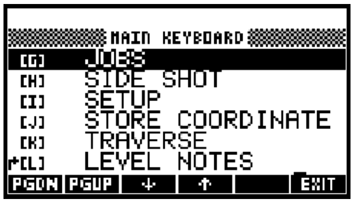


Figure 4-4 SMI Screen Menu Page 1

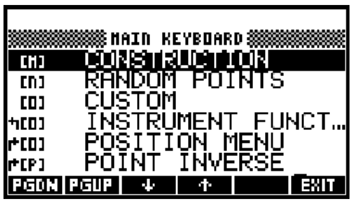


Figure 4-5 SMI Screen Menu Page 2

Figure 4-6 SMI Screen Menu Page 3

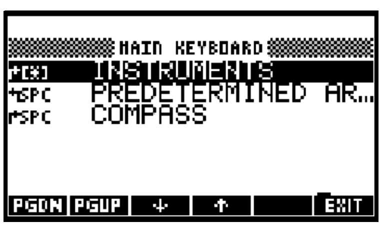


Figure 4-7 SMI Screen Menu Page 4

Pressing the up or down arrows on the **soft keys** scrolls up or down the functions on the current screen.

Menu Option Soft Keys

Option	*Function*
PGDN	This key shows the next screen view down.
PGUP	This key moves a page up. The down and up arrow keys move one function at a time. Press these to select the function you want, and press **ENTER** to execute the function.
EXIT	This key exits the menu option and takes you to the Setup menu.

This menu system is a teacher to help the user find a function and to see how a function works. To run one of the functions, either press ENTER while the function is highlighted, or press the shortcut keys shown on the left. To go back to the menu, press ON.

To return to using the overlay without the screen menu option, press EXIT. This will exit the ***SMI*** screen menu. You will now be using the normal overlay option.

Your SMI Screen

If you have just installed ***SMI***, the software will bring you to the setup screen with a job called JOB1 already started.

See the figure below to view an example of the screen that you will see.

✎ *The screen below may differ slightly from the **SMI** program you are using.*

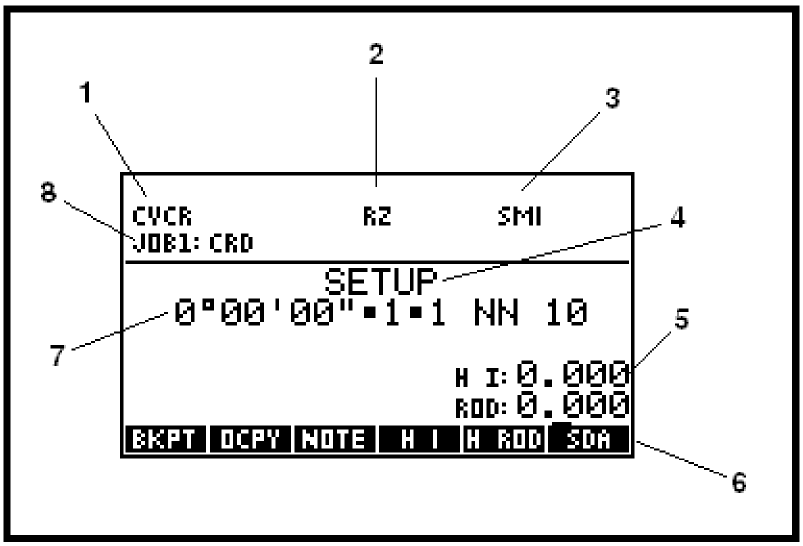


Figure 4-8 The SMI Screen

1. **Software type (see *Software Type* on page 31).**
2. **User flags active (see *User Flags* on page 31).**
3. ***SMI* mode (see *SMI Mode* on page 32).**
4. **Function currently active (see *Function Currently Active* on page 32).**
5. **Function-specific data (see *Function-Specific Data* on page 32); in this case, the Height of Instrument/Height of Rod is shown.**
6. **Soft key menu (see *Soft Key Menu* on page 32).**
7. **More function-specific data (see *More Function-Specific Data* on page 32); in this case, the backsight angle, occupied point, last point stored; next point number to be stored.**
8. **Directory where job files are to be stored/retrieved (see *Directory/Path* on page 33).**

Elevations Off

With Elevations off, flag Z is off and elevation-related keys such as height of instrument and height of rod are inactive and do not appear on the soft key menus or display.

Figure 4-9 Elevations Off

What You Are Seeing on the Screen

Software Type

Displayed Abbreviation	*Product Name/Meaning*
SCE	***Standard COGO***
ACE	***Advanced COGO***
DCE	***Data Collection***
CVC	***Construction Five***
DOT	Department of Transportation
DCER	GPS/Robotic with ***Data Collection***
CVCR	GPS/Robotic with ***Construction Five***
GPS	A GPS driver is in use
DTBS	Directional Theodolite Backsight mode is active
AZIM	Azimuth mode is active

User Flags

To change the status of Point Override, Raw Data, Elevations, and Note Prompting options, go to the CHG (Change) menu. These options turn on or off flags 0 (will check or will not check before overwriting points) through I (Instrument).

If a flag is turned on, you will see the letter of the flag displayed in the status area to the left of SMI. For example, if Elevations are on, you will see a Z displayed to the left of SMI.

There are shortcuts for turning on or off the user options shown in the display.

1. **To automatically overwrite points, press CHG OVRW (no shortcut).**

   The o flag is normally off. The CHG menu is explained further in *Change/Defaults* on page 255.

2. **Press** 2 **to toggle Raw Data on or off (the R flag).**

3. **Press** 3 **to toggle Elevations on or off (the Z flag).**

4. **Press [←] 4 to toggle Notes with a four-way toggle (the N flag).**
   A. **Prompting off, will store last note (AUTO in the Change menu).**
   B. **Prompting, with last note (LNTE).**
   C. **Prompting, with note table (NTBL).**
   D. **Prompting off, will not store last note (NOTE).**
5. **Press [←] 5 to toggle Instrument on or off (the I flag). This assumes the instrument has already been chosen (SETUP NXT NXT INST , find the manufacturer name, then choose the type of instrument. See *Instrument Configuration*, which begins on page 383).**

Once you get the flags and options for a job the way you like, press JOB NXT and SFLG (Set Flags). To get back your flag settings after clearing the memory or reinitializing the ***SMI***, press JOB NXT and RFLG (Recall Flags).

SMI Mode

SMI is displayed when the ***SMI*** program is active and the ***SMI*** overlay is active. If you wish to leave the ***SMI*** program to access the data collector's functions, press [←] [α]. To return to ***SMI***, you have two choices:

1. **To go to the normal *SMI* overlay, press [α] K ENTER.**
2. **To use *SMI's* new menu system, press [α] M ENTER.**

Function Currently Active

This identifies the menu or main function you are currently using.

Function-Specific Data

This section of the screen contains calculations, results, or other information relating to the function you are using. In the example of Figure 4-8 on page 30, Height of Instrument/Height of Rod. This appears only when Elevations are on.

Soft Key Menu

This presents additional actions or menu options and varies, depending on the function selected. Some functions have multiple pages of soft key menus. Press NXT to scroll to the next page of soft key menus. Press [←] NXT to scroll to the previous screen.

Some menus have an EXIT soft key on the first page of the menu. If the EXIT soft key has three periods after it, then there are more keys on the next page of the menu. Press NXT to see them.

Some soft keys have folder tabs on the left side. This indicates that pressing this key will take you to a new menu.

More Function-Specific Data

In Figure 4-8 on page 30, you are being given the backsight angle, the occupied point, the last point stored, and the next point number (default) to be stored.

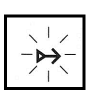
Directory/Path

This tells where your files are being stored and gives the name of the current job. There are two different places where jobs can be stored. The job location is indicated by the last three characters of the job name:

- 48M – files are stored in the memory of the 48.
- CRD – files are stored in the RAM card, if installed.

Screen Symbols

“Annunciators” on the data collector’s screen show the status of the calculator. Status messages include symbols:

Annunciator	***Status***
	Right shift is active.
	Left shift is active.
a	The alpha keyboard is active (you can type letters and characters).
CVC	The ***SMI*** default key assignments are active and show the type of ***SMI*** software you are using.
User	User key assignments are active. See *To Get Started* on page 27 and *User Mode* below.
SMI	The ***SMI*** keyboard is active.
ORZNIM	The indicated user flags (data options) are set. See *To Get Started* on page 27, *Your SMI Screen* on page 30, and *What You Are Seeing on the Screen* on page 31.
((•))	Alert (e.g., low battery); a message in the status area should appear to indicate the cause of the alert.
X	Busy (not ready to process new input; but the data collector can remember up to 15 keystrokes and process them when free).
	Transmitting data to or from an external device.

User Mode

SMI and your data collector give you three modes in which to operate.

The card name showing indicates that ***SMI*** is running. If USER is showing, it indicates that the user key assignments are active, in addition to either the ***SMI*** keys or standard data collector keys, depending on whether ***SMI*** is running.

SMI **with software name showing**:.

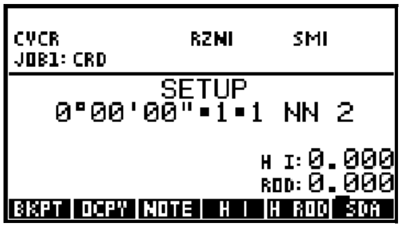


Figure 4-10 SMI with Software Name Displayed

SMI key assignments are active. Some HP 48 calculator keys are also active.

✎ *This is the mode you should normally use.*

User mode with software name showing:

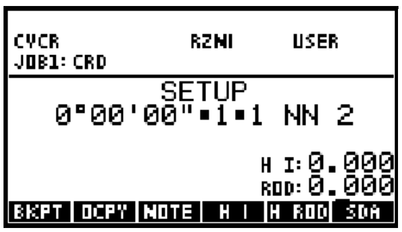


Figure 4-11 User with Software Name Displayed

SMI key assignments and user-defined keys are active. The HP 48 calculator keys are also active.

✎ *This is the mode you should use if you use your own key assignments with the **SMI** overlay.*

When User mode is active, your user-defined keys will replace the ***SMI*** functions assigned to those keys.

Press CUSTOM and USER to access this mode. See *Assigning Custom Keys* on page 35.

User showing, no software name is displayed in the upper left of the screen:

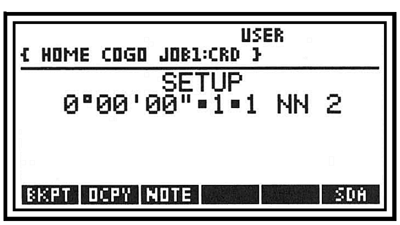


Figure 4-12 User with No Software Name Displayed

The HP 48 key assignments with user-defined keys are active. The HP 48 calculator keys are also active.

✎ *In this mode, the **SMI** key assignments are not active; instead, you may use your own key assignments.*

No User or *SMI* showing, no software name:

Figure 4-13 No Software Name Displayed

The HP 48 calculator keys only are active; no user or ***SMI*** key assignments are active.

This is full calculator mode.

✎ *In each mode, you still have access to many of the calculator functions of the HP 48.*

Assigning Custom Keys

You may choose to assign functions to keys of your own choice. To do this, press CUSTOM then the KASN soft key; type the name of the function or functions that you want to run when your assigned key is pressed. After pressing ENTER, you will be asked to press the key to be assigned. You can also press a shift key before pressing the key to be assigned to indicate a shifted key assignment. After the key has been assigned, USER will replace SMI in the status area to indicate that user key assignments are active in addition to ***SMI*** key assignments.

Note that whenever USER is displayed, your user key assignments are active. When both the software type and USER are displayed (Figure 4-11 on page 34), the user-assigned keys and ***SMI***-assigned keys are active, but your user-assigned keys will take the place of any preassigned keys of the ***SMI*** software.

If you assigned a function or program in place of an ***SMI*** function, you can make the ***SMI*** function active again by pressing CUSTOM and the USER soft key. The USER at the top of the display will be replaced by ***SMI***. Now all ***SMI*** overlay keys are active and none of the user-assigned keys are active. This can be toggled back to your user keys with the rest of the ***SMI*** overlay being active by pressing CUSTOM and USER■. Note that in previous examples, the name of the ***SMI*** surveying card continues to be displayed in the upper left portion of the screen.

You may want to review the figures on the previous pages for clarification.

Working with Jobs

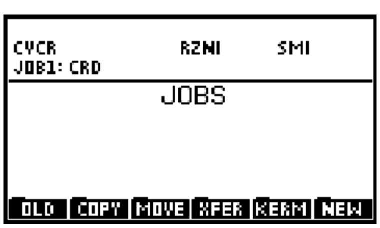


Figure 4-14 Jobs Screen

The Jobs screen shows the version of the ***SMI*** program being used (in the example above, CVCR), and JOB1:CRD at the top of the display. This indicates where the program is storing the data.

An extension is automatically added to your job name to indicate whether your job is stored in the internal memory of the data collector or in the RAM card. In Figure 4-14 on page 35, the job is named JOB1. The CRD extension indicates the job is being stored on a RAM card; a 48M extension would indicate that the job is being stored in the internal memory of the data collector you are using.

✎ *The colon (:) only serves to separate the job name from the extension.*

JOB1:CRD is the name assigned to the current job. This means that if you were to enter points right now, they would be stored in JOB1 and each point would go to the RAM card memory.

When moving or copying jobs, you have the option of saving your job to the RAM card or to the internal memory of the data collector. This is done using the **MOVE** soft key of the Job menu (see *Copying Jobs* on page 37).

✎ *Storing all your jobs on the RAM card is always the safer choice.*

SMI stores coordinates by point number in a job. Using point numbers (that have coordinates attached) to perform operations is much easier and faster than keying in coordinates.

You can copy any set of points from the current job to any place in the current job or to another job by using **RPTS**, (select the random points you want, then press **ENTER**), **NXT** and **COPYP**. In **RPTS**, you define the points you want to copy.

Creating Jobs

SMI allows you to give each job its own name. To create a new job:

1. **Press JOB (the G key), then NEW.**

   At this point, you will see the Create New Job screen. Here you see the default coordinates for the job you will create. Note that Elevations are off in the example below. If you see 100 next to Elev:, skip to step 3.

2. **Pressing EL will automatically turn Elevations on (you will later see flag "Z" in the status area indicating this).**

   The display will show ELEVATION? and prompt you to enter the elevation, after which you will be returned to this screen.

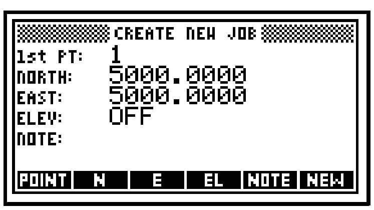


Figure 4-15 Create New Job Screen

3. **Press the NEW soft key again.**

   You are prompted to enter the name of the job you wish to create. Any combination of numbers and letters can be used to name your job(s). (If you wish to transfer jobs via infrared, do not start your jobs with a number. See *Transferring a Job* on page 38 for infrared transferring.)

✎ *You do not need to press the alpha key (α) before typing letters of the alphabet at this point.*

Alpha is turned on automatically when you press the **NEW** *key to create a new job.*

4. **Press ENTER to create the job or ON to cancel. (Remember that pressing ON can be used to cancel out of most operations in *SMI*.)**

   You will see the name of your job in the status area in place of JOB1.

✎ *With a RAM card installed, creating a new job automatically saves it to the RAM card and not to the internal memory of the data collector.*

Old Jobs

You may select jobs from a menu, rather than from the soft keys to speed up job selection.

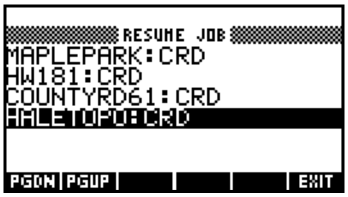


Figure 4-16 Select an Old Job

1. **Press JOB, then OLD.**
2. **Using the Up and Down arrow keys, highlight the job you want to open and press ENTER.**

Copying Jobs

You can have several jobs stored in your data collector and/or the RAM card at the same time by either creating new ones or copying jobs. This section explains how to copy jobs.

1. **Press JOB, then COPY.**
2. **Using the up and down arrow keys, highlight the job name you wish to copy and press ENTER.**

   At this point, you may only have JOB1: listed. The screen can only show 22 characters of the job name.

   You will then be prompted: DESTINATION or NAME?

✎ *You cannot name the job the same thing.*

3. **Name it anything you wish and then press ENTER.**

   If you do not have a RAM card installed, your job will automatically be copied to the internal memory of the HP. If you have a RAM card installed, you are prompted:

   Job Destination? and given two choices:

   A. **Press :48M to copy your job into the HP's internal memory.**

   B. **Press :CRD to copy your job to the RAM card.**

   You now have two of the same job with two different names.

Moving and Renaming Jobs

You can move a job using JOB and MOVE. You would use the Move option if you just recently bought a RAM card, for example, and have jobs you would like to move to it for safekeeping. This works exactly like copying a job; however, the name you enter for the destination replaces your job instead of duplicating it. You now have only one of your job. The same job is there – just as a different name.

Deleting Jobs

Deleting jobs is simple in ***SMI***.

1. **Press JOB NXT and DEL.**

   You are prompted for the job name.

2. **Using the up "K" and down "Q" keys, choose or highlight the job listed on the screen. If you do not see the job name, you may need to press the down arrow or PGDN (for page down) one or more times to scroll through the jobs stored in the calculator.**

3. **Press ENTER after highlighting the job to delete.**

   You will then see on the screen "Proceed With Deletion" and YES and NO soft keys.

4. **Simply press the key corresponding to your choice.**

✔ ***Note that there is no way to get a job back after deleting it, so be careful when deleting jobs.***

Transferring a Job

To transfer a job to the PC or another data collector using the infrared port of your data collector or a wire:

1. **Press JOB then XFER.**

   There will now be an option that can be toggled back and forth to choose which way your job needs to be sent. If you see "Wire," the job will transfer through the wire or cable connection to the data collector. If you see "IR," the job will go through the infrared port of the data collector to another one. Make sure the two data collectors are head-to-head so the infrared windows are facing one another. If both are in hard cases, you can use the same cable you use to send a job to the PC and keep the option on "Wire."

2. **To send or receive the job (or jobs if using *SMI Transfer*), press one of the following options:**

Send/Receive Job Options

Option	Function
PC	Press this key when using the ***SMI Version 7 Transfer*** software. This will open the transfer window on the PC where you can send or receive jobs to and from the PC. (Please see the ***Version 7*** manual for a more detailed explanation.)
SEND	Press this key when sending a job to the PC using ***SMI Transfer 98*** or to another data collector, using the "IR" or "Wire" option discussed previously. Note that you must be working in the job you want to send to send it. The job name will be on the display in the upper right corner.
RECV	Press this key to receive a job.

To send a range of points to the PC, see the ***SMI Transfer 7*** manual.

Once you get the flags and options for a job the way you like, press JOB NXT and SFLG (Set Flags). To get back your flag settings after clearing the memory or reinitializing ***SMI***, press JOB NXT and RFLG (Recall Flags).

More information on the JOB menu can be found in *Job* on page 302.

As you can see, a little practice is all it takes to get you going in ***SMI***. If you have more questions about a particular function, check the *Quick Reference of Menus and Functions*, which begins on page 241. If you still cannot find the answer to a question, call ***SMI*** toll-free for free technical support.

Standard COGO, which begins on page 41, provides you with some practice surveying with ***SMI***.

STANDARD COGO

CHAPTER 5

This chapter is for users of all the ***SMI*** programs. Even if you have a more advanced card, this section will help you build your knowledge of how to use this program.

In this chapter:

Key Definitions

Key	Function
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
Hard Keys	Hard key functions are imprinted on each key itself. The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card. **Hard keys are represented in this manual as black lettering on a gray, rectangular background.**
Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

Standard COGO

Standard COGO gives you the power to enter deeds, field note data, or coordinates. You can even key in the data manually from the instrument and instantly have the coordinates stored by point number to use in ***SMI's*** Standard Coordinate Geometry functions. The card is capable of side shots, traversing, staking, and computing curves, intersections, areas, perimeters, and closures. Work in feet or meters and north or south azimuth. Input can be in bearings, angles right, azimuths, or deflection angles. You can convert feet, inches, and fractions of an inch into decimal feet or convert grads to degrees, minutes, and seconds, and vice versa.

Rotate, translate, and scale any set of points on a job. While in the program, you can add, subtract, multiply, or divide numbers. Add or subtract angles in DMS format using [↰] [+] or [−]. Convert degrees, minutes, and seconds to decimal degrees, and vice versa. Use two points to determine direction while traversing, taking side shots, or computing intersections. Stake a curve from a PC and increment the stations along the centerline or along a specified offset from the centerline.

Standard COGO also includes 3-D surveying (elevations), Earth curvature and refraction, elevations, and an industrial strength Sunshot program with its own ephemeris and ability to compute astronomic or grid north.

Trig-leveling functions let you pull in an elevation from a benchmark and use it to stake and get cuts and fills or use side shot to collect north, east, and elevation points.

Predetermined areas can be computed either by the hinge method or by the slide method. The SCE also offers staking, which gives angles to turn and distance to go, as well as go or come and right or left values.

Basic Surveying

Now that you know a little about what you can do with the ***SMI*** program, work through an example using some of these basic surveying functions.

This chapter assumes you have already installed your ***SMI*** software and overlay. (If not, refer to *Getting Started*, which begins on page 17.) You can use the job that was automatically created when you installed the software, or create your own following the instructions in *Working with Jobs* on page 35 and *Creating Jobs* on page 36. The following examples will show JOB1 as the job name.

Inputting Points Manually

There are three ways to input points or store coordinates in the ***SMI*** program: [SIDS] for side shot, [TRAV] for traverse, and [S C] for Store Coordinate.

The [SIDS], or side shot key, is a function and a menu key. It allows you to electronically (if you have the ***DCE*** or above program) or manually take a single horizontal angle, zenith angle, and slope distance to a point, convert to coordinates, and store by point number without changing the occupied point and backsight point.

The [TRAV], or traverse key, is a function and menu key as well. It works exactly as the side shot function, with one exception: after the point has been stored, the new point is occupied and the backsight point becomes the point that was previously occupied. Think of it as the instrument following the rod around your job with every new point that is stored, whereas in side shot, the rod is the only thing moving around and the instrument is staying put.

The [S C], or Store Coordinate function, lets you enter points using coordinates and data for existing point coordinates.

Examples using these methods will follow.

Inputting Points Manually Using the Side Shot Key

First you will be shown how to input points manually into the ***SMI*** program.

The word SETUP should be on the screen; if it is not, press [SETUP] on the keyboard. You should see these numbers 0°00'00"-1-1 NN 2 below the word SETUP.

SMI Program Setup Screen Definitions

Value	Definition
0°00'00"	This value is your backsight (there is not a point as a backsight, so the backsight angle is shown).
The middle 1	This value is the occupied point, or where the instrument is set up.
The next 1	This value is the last number that was stored in the program. (In this case, the only number in the program is the default point 5000 Northing 5000 Easting, so point number 1 is shown in both locations.)
NN2	These letters stand for Next Number. As you can see, the next number to be stored is 2.
H I	This value represents the height of the instrument used for elevations.
ROD	This value represents the height of the rod used for elevations.

Start a new job (see *Creating Jobs* on page 36), then complete the following steps.

Example 1 – Inputting Points Using Side Shot

Press [SIDS].

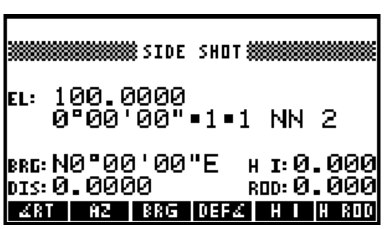


Figure 5-1 Side Shot Screen – Page 1

The side shot screen displays.

This is the first side shot soft key menu for a manual entry.

Side Shot Screen – Page 1 Soft Keys

Option	Function
⊿ RT	This key is used to enter an angle right. For angle left, key in the angle, press **+/−**, and press **⊿ RT**.
A Z	This key is used to enter an azimuth. Enter two point numbers if you want to use the inverse between those points as the azimuth to the next point. Press **A Z** to see the last azimuth. Press **ENTER** to use this value as the new azimuth. Press **↱** **A Z** to put the last azimuth on the stack; then you can add or subtract to the azimuth using **↱** **HMS+** or **↱** **"/HMS-**.
BRG	This key is used to enter a bearing. After entering the bearing, you will be prompted for the appropriate quadrant (NE=1, SE=2, SW=3, NW=4). An optional way to enter bearing and quadrant values is to enter the quadrant as the first digit of the bearing, (e.g., a bearing of S 23° 11' 12" W would be keyed in as `323.1112`), and press **BRG**.
DEF⊿	This key is used to enter a deflection angle to the right, or key in a negative number to enter a deflection angle to the left. Key in the number first, then use the **+/−** key, rather than the minus key, to change to a negative number. After a direction has been entered, the angle is presented at the top of the display. Also shown is the distance submenu that lets you enter a distance.
H I	This key is used to enter the height of the instrument. HI is defined as the vertical distance from the point under the instrument to the axis of the scope on the instrument. To change the last height of the instrument, key in the new HI and press **H I**. When Elevations are on, the current height of the instrument is displayed.
HROD	This key is used to enter the height of the rod. Key in the new height of the rod and press **HROD**.You may choose to have the HROD prompt each time you take a shot. This allows you to take a reading before you enter the HROD. To use this option, press **CHG** **NXT** **INPUT** **HROD**. In this menu, **HROD** is a toggle key.

When you press **NXT** again, the second side shot menu will display.

You can key in the angle right, distance, or horizontal angle in any order, but for this example, the angle right will be entered first.

1. **Key in the number `0` and press the ⊿ RT soft key.**

   This will be the backsight for this example.

Figure 5-2 Side Shot Screen – Page 2

   Notice the **⊿ RT** soft key is no longer visible and 0 is given for the angle right, azimuth, and bearing. The DF angle is the deflection angle.

2. **Key in `96.22` and press SDIST for slope distance.**

   Because slope distance is being used, you will now be prompted for the zenith angle, or vertical angle.

3. **Key in `93.2535` and press Z⊿.**

You will hear a beep, which means that the point has been stored.

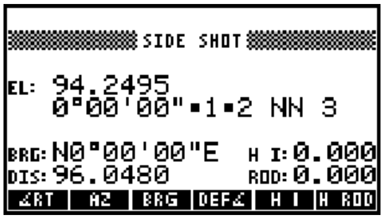


Figure 5-3 Point 2 Stored

This screen shows that 94.2495 is the elevation for the last point stored, and angle 0°.00'00" is the backsight. (This could be a point number, but for this example, an angle is being shown.)

Point 1 is being occupied, 2 is the last number stored, NN 3 is the next number to be used, BRG: is the last bearing stored, and DIS: is the last distance stored.

Notice that all of the soft keys are back. For the next point, perform the following steps.

4. **Key in** `110.4355` **and press** **∡ RT**.
5. **Key in** `38.82` **and press** **SDIST**.
6. **Key in** `86.0755` **and press** **Z∡**.

   Point number 3 has been stored.

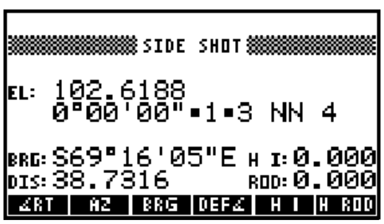


Figure 5-4 Point 3 Stored

One more point will be entered for this example. Use the following information:

- Right Angle: 225.2305
- Slope Distance: 57.69
- Zenith Angle: 85.4510

  After you enter this information, the screen should resemble the example below after you hear the beep.

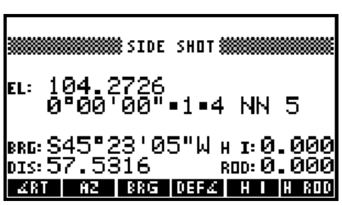


Figure 5-5 Point 4 Stored

For a double-check, do a screen plot to see the points stored.

7. **To do a screen plot, press** **RPTS**.
8. **Key in** `1.4` **and press** **ENTER**.
9. **Press** **SPLOT** **then press** **SPLOT** **again.**

The points and line should resemble the figure below.

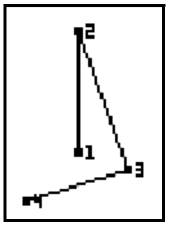


Figure 5-6 Side Shots Example

Point number 1 is where the instrument is located. Points 2, 3, and 4 are where the rodman has taken the prism. The instruments have just turned to the different points to take the distances and angles.

Store Coordinate (Enter and Assign)

KEY: SC

PRODUCT: SCE+

KEYSTROKES: SC (the J key)

The Menu key lets you enter points using coordinates and data for existing point coordinates.

Procedure

The store coordinates screen displays data for the last point stored.

The soft key menu allows you to modify point data.

Figure 5-7 Store Coordinate Menu

Store Coordinate Menu Soft Keys

Option	Function
N	Use this key to enter a new north coordinate. Key in the value and press N. Or press the soft key first; you will be prompted for the north value. Key in the number and press ENTER.
E	Use this key to enter a new east coordinate. Key in the value and press E. Or press the soft key first; you will be prompted for the east value. Key in the number and press ENTER.
EL	(SCE+) Use this key to enter a new elevation. Key in the value and press EL. Or press the soft key first; you will be prompted for the elevation. Key in the value and press ENTER.
NOTE	(ACE +) Press NOTE; you will be prompted to enter a description. Key in the note (up to 128 characters; alpha will be automatically turned on). When you are finished, press ENTER.
STORE	Use this key to store the north and east coordinates, elevation, and note as a new point; the point will automatically be stored as the next number indicated on the display.

Store Coordinate Menu Soft Keys

Option	Function
RCLPT	This soft key lets you recall and view the data for any point in the current job.

Example 2 – Inputting Points While Traversing

In this example, you will learn how to use ***SMI*** to traverse, inverse, compute area, check closure, traverse from an existing point, find a missing line, and compute curve data. For an example on non-tangent curves, see *Curves* on page 280.

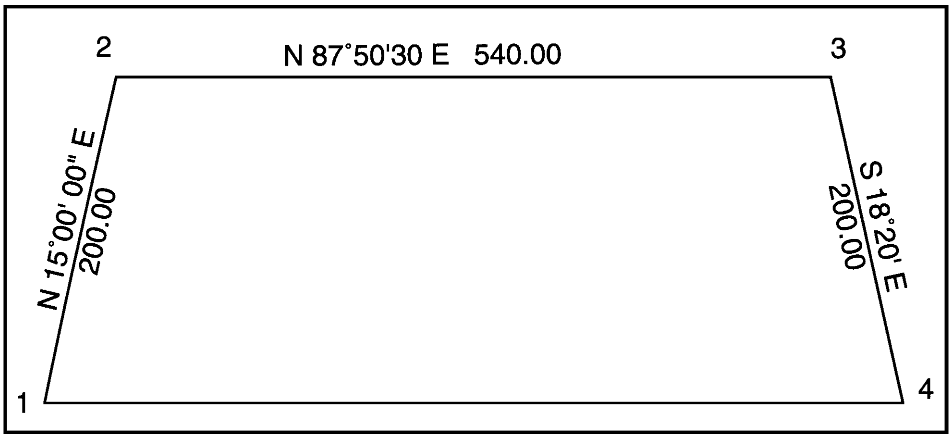


Figure 5-8 Traversing the Boundary

Start a new job, then follow the directions below.

1. **Press TRAV .**

   Notice that the numbers have not changed. The EL for elevation has been added with an elevation of 0.0000 if you started with the default job of JOB:1. If you started a new job, the standard default elevation of 100.0000 will show above the backsight. The BRG (bearing) appears, showing the last backsight angle taken. Below that is the last DIS (distance) taken. (All are zeros now because no information has been entered.)

   The Traverse Menu soft key functions are explained in the following tables.

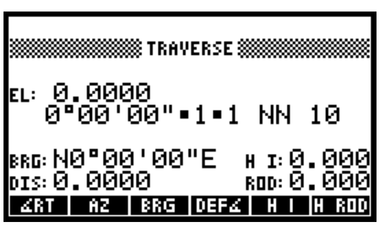


Figure 5-9 Traverse Menu – Page 1

Traverse Menu – Page 1 Soft Keys

Option	Function
∡ RT	Right angle
A Z	Azimuth

Traverse Menu – Page 1 Soft Keys

Option	Function
BRG	Bearing
DEF ⦟	Deflection angle
H I	Height of instrument
HROD	Height of rod

After pressing NXT, the following keys display.

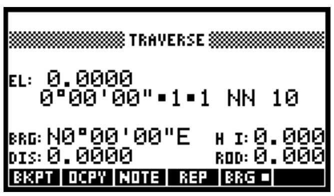


Figure 5-10 Traverse Menu – Page 2

Traverse Menu – Page 2 Soft Keys

Option	Function
BKPT	Backpoint or Backsight
OCPY	Occupied point
NOTE	A note that can be added to any point
REP	Pressing this key will repeat the last traverse shot and increment to the next point.
BRG	Indicates that it is in bearing mode. This is a toggle that gives you the following options: bearing angle BRG, azimuth angle A Z, angle right ⦟ RT, or display the Northing and Easting coordinates COOR.

2. Key in `15` **for the bearing and press BRG.**

You are prompted:

QUADRANT?

The North East quadrant is 1, so key in `1` and press Enter.

North West = Quadrant 4	North East = Quadrant 1
South West = Quadrant 3	South East = Quadrant 2

Figure 5-11 Quadrants

The soft keys that now appear are defined in the table below.

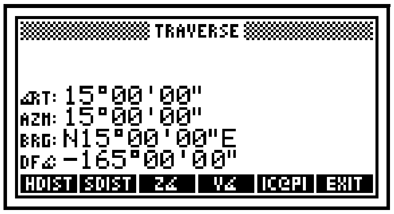


Figure 5-12 Entering the Bearing for Point 2

Traverse Menu Soft Keys

Option	Function
HDIST	Horizontal distance
SDIST	This is used for slope distance and is pressed when using zenith angles.
Z ∠	Zenith angle
V ∠	Vertical angle
IC@PI	Insert curve @ point of intersection: This soft key will open up another menu (see *Insert Curve at Point of Intersection While Traversing* on page 283).
EXIT	Exits the data input sections and takes you back to the Traverse main menu.

3. Key in `200` for the distance and press HDIST .

You are prompted:

CHANGE IN EL?

The number 0 will be blinking.

Press the ENTER key to accept 0 for this example.

✎ *If you have Elevations turned off, this prompt will not occur.*

Point 2 is stored.

Note the changes in the screen. The backsight has changed to 1 instead of the angle 0°00'00".

Because you are traversing, the occupied point has changed to 2 and the last number stored is now 2, as well. The next number is 3. The BRG: is 15°00'00" and the DIS: is 200, the last numbers you manually entered.

At a glance, the ***SMI*** screen shows the backsight is 1, you are sitting at 2, and waiting to shoot 3 with an Elevation of 0.

Turn off Elevations before you enter any more points because you will not be using them for this example.

4. Press SETUP , then ↰ 3.

The Z flag at the top of the screen disappears, and the message WON'T STORE ELEVATIONS confirms that the flag is off.

5. Press TRAV .

Note that the elevation information (EL, H I, and ROD) is missing from the screen.

Figure 5-13 Entering the Horizontal Distance for Point 2

6. **Key in `87.5030` and press BRG.**
7. **You are working the North East quadrant, so key in `1`.**

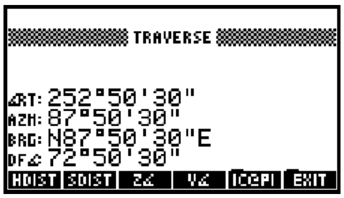


Figure 5-14 Entering the Bearing for Point 3

8. **Key in `540` and press HDIST.**

   Point 3 is stored.

Figure 5-15 Entering the Horizontal Distance for Point 3

9. **Key in `218.20` and press BRG.**

✎ *This is not a mistake. This is a shortcut for entering the quadrant number. The 2 in front of the 18.20 is for quadrant 2. Note that you were not prompted for the quadrant.*

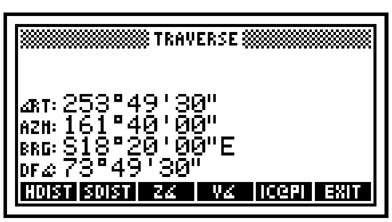


Figure 5-16 Entering the Bearing for Point 4

10. **Key in `200` and press HDIST.**

Point 4 is stored.

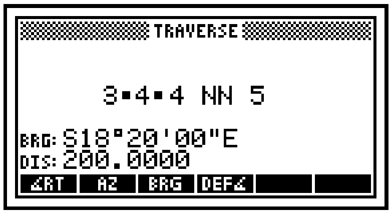


Figure 5-17 Entering the Horizontal Distance for Point 4

Inverse

To inverse between 4 and 1: (The azimuth and bearing between points 4 and 1 are unknown. If you inverse between the two points, the azimuth and bearing will be provided.)

1. Key in `4` SPC `1` **and press the** `P-P` **key.**

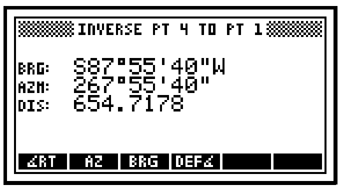


Figure 5-18 Inversing from Point 4 to Point 1

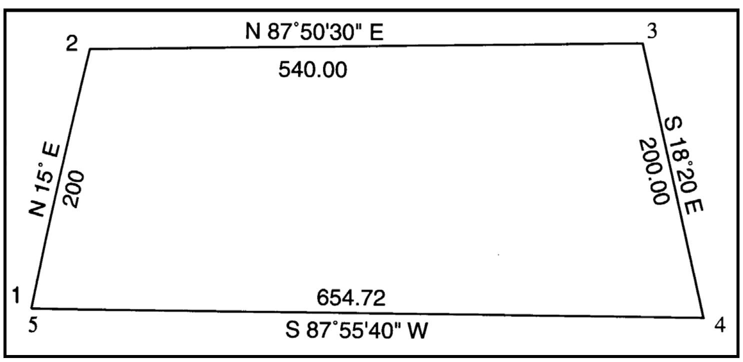


Figure 5-19 Inverse Example

Traverse from point 4 to point 5:

2. Press TRAV**.**

3. Key in `87.5540` **and press** BRG**.**

You are prompted to enter a quadrant number.

4. Key in `3` **(quadrant 3) and press** ENTER**.**

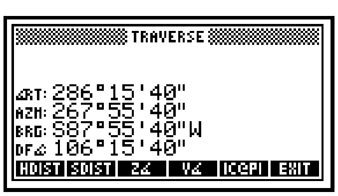


Figure 5-20 Entering the Bearing for Point 5

✎ *You could have also keyed in 387.5540, skipping the screen asking for the quadrant number.*

5. **Key in** `654.72` **and press HDIST .**

Figure 5-21 Entering the Horizontal Distance for Point 5

Check the Error

SMI can compare the beginning points and ending points of your traverse to see if the traverse closes.

To check the error from 5 to 1, key in 5 SPC 1 and press the **P-P** key. In this example, the two points' distance is the difference of 0.0022.

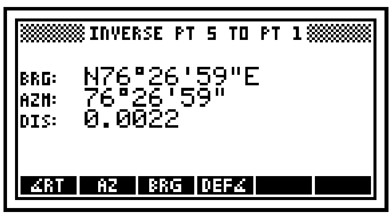


Figure 5-22 Checking the Error from Point 5 to Point 1

Random Points Menu

To check acreage, square feet, perimeter, and precision:

1. **Press RPTS .**

   The soft keys that now appear here move the cursor around. Experiment with them after entering some numbers to see what happens.

2. **Key in** `1.5` **SPC** `1` **(The period in 1.5 means "through." Points 1 through 5 will be calculated. The second "1" after the space closes the loop back to the Point of Beginning.) and press ENTER .**

3. **Press** **PREC**.

This will also show the acres, square feet and "PER," which is the perimeter. The other soft keys here are explained in *Random Points* on page 329.

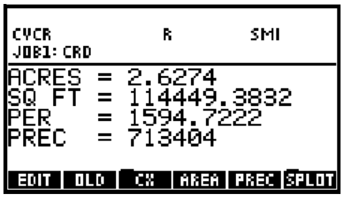


Figure 5-23 Checking the Acreage, Square Feet, Perimeter, and Precision

Compass Rule Adjustment

Whatever the distance error is in, the traverse will be evenly dispersed through the legs or points of the traverse, making the precision perfect. It is very important that the last point in the random point file should be the accepted point. The second-to-last traverse point in the file should be the point shot to the accepted point at the end of the traverse.

To perform a compass rule adjustment, press **NXT** **CR**. The display will show "Done"; press **ON** or **CANCEL** to clear that message. Notice that the precision is now "perfect."

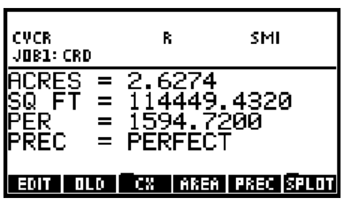


Figure 5-24 Compass Rule Adjustment

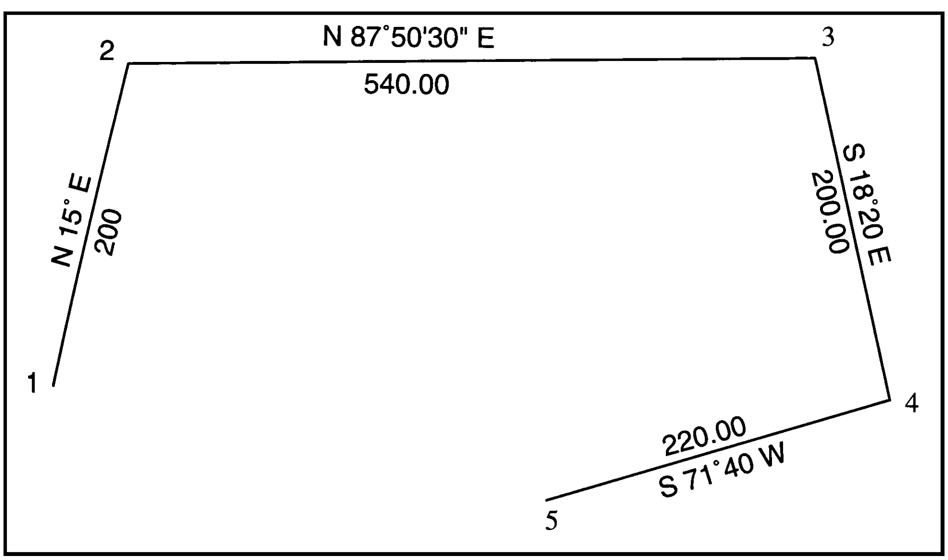


Figure 5-25 Performing a Compass Rule Adjustment

Correcting an Error or Changing a Traverse Point That Has Been Stored

Now make a change in the boundary. A new corner has been agreed upon as S 71° 40 W 220 feet from point 4, as shown in Figure 5-25 on page 53. To eliminate the old point 5, which is near 1, and store the new point 5, reoccupy point 4 and traverse the new line to point 5:

1. **Press SETUP, key in** 5**, and press ➦ ENTER for Next Number (NN).**

   This sets the next number, or NN, to 5 so that whenever the next point is stored, it will be stored at point 5.

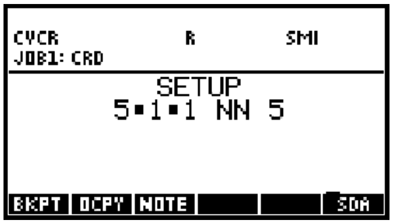


Figure 5-26 Setting Point 5

2. **Press SETUP 4 OCPY.**

   The display will now read 5-4-1 NN 5. (Remember that the middle number is the occupied point, or where the instrument is set up.)

3. **Press 3 BKPT to make 3 your backsight.**

   The display will now read 3-4-1 NN 5.

4. **Press TRAV.**

5. **Key in** 71.40 **and press BRG. Key in** 3 **(quadrant number) and press ENTER.**

✎ *You can use the shortcut by keying in 371.40 and skip the screen asking for the quadrant number.*

6. **Key in** 220 **and press HDIST.**

   Since point 5 was already stored, the data collector will beep and prompt:

   POINT 5 USED

   OVERWRITE POINT?

7. **Press ENTER to overwrite point 5.**

Figure 5-27 Traversing to Point 5

✎ *If you get a prompt that says POINT 5 USED OVERWRITE POINT? and you wish to store at another point number, key in the point number and press* ENTER*. If you do not wish to overwrite the point, press* ON *and* ENTER.

Find the Bearing and Distance from Point 5 to Point 1

To find the bearing and distance from point 5 to point 1, key in 5 [SPC] `1` and press the **P-P** key.

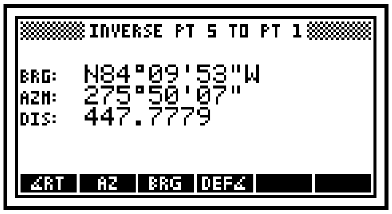


Figure 5-28 Finding the Bearing and Distance for Point 6

Enter Bearing and Distance

To enter the bearing and distance from point 5 to 1 (that you found in the previous step) and store at 6:

1. **Press [SETUP], key in** `5`**, and press** **OCPY** **(if you are not occupying that point already).**
2. **Press [TRAV], key in** `484.0952`**, and press** **BRG**.

✎ *You can go the long way and key in `84.0952` on this screen then `4` for the quadrant number on the next screen.*

3. **Key in** `447.78` **and press** **HDIST**.

   Point 6 is stored.

Find the Error from Point 6 to Point 1

To find the error from 6 to 1, key in 6 [SPC] `1` and press the **P-P** key.

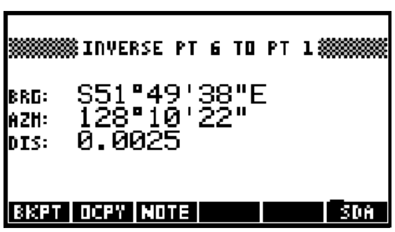


Figure 5-29 Finding the Error from Point 6 to Point 1

Find the New Acreage

To find the new acreage:

In the random point file you will list the point numbers of the boundary where the closing point and the first point with the “perfect” coordinates will be listed last.

1. **Press [RPTS].**

   You will see the data last entered.

2. **Press the [ON] key to clear the old data.**
3. **Key in** `1.6` [SPC] `1` **and press [ENTER].**

   All points from 1 through 6 are defined by 1.6.

Display the Acres, Square Feet, and Precision

To display the acres, square feet, and precision:

Press PREC .

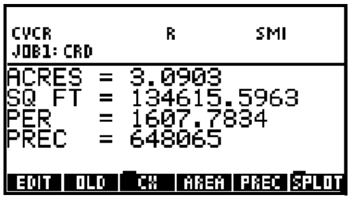


Figure 5-30 Displaying the Acres, Square Feet, and Precision

Insert a Curve

Using the previous example, a curve will be inserted at point 5 as the PI (point of intersection) with a tangent distance of 110 feet.

First find the delta at the PI at point 5 and use CAR (Compute Angle Right) to find the deflection angle.

1. **Press** MORE **,** CAR **, key in** 4 SPC 5**, and press** BKAZ **.**

   This gives you the back azimuth when occupying 5 and looking back to point 4.

2. **Key in** 5 SPC 1 **and press** FSAZ **.**

   This gives you the forward azimuth when occupying 5 and looking at point 1.

   The delta angle is 24° 10' 08".

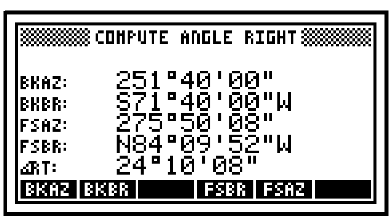


Figure 5-31 Finding the Delta Angle at the PI at Point 5

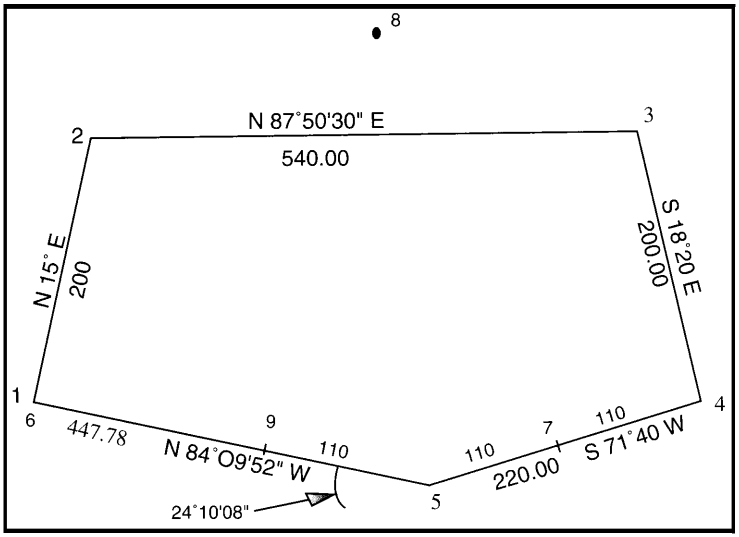


Figure 5-32 Delta Angle

To occupy 4 and traverse from 4 toward 5 for 110 feet to the PC:

3. **Press** SETUP **. Key in** 4**, press** OCPY **, key in** 3**, press** BKPT **, then press** TRAV **.**

4. **Key in** 4 SPC 5 **and press** AZ **.**

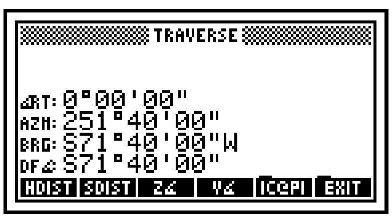


Figure 5-33 Entering the Azimuth Between Points 4 and 5

5. **Key in** `110` **and press** HDIST **.**

   This stores point 7. It is the PC, or Point of Curvature.

Figure 5-34 Entering the Horizontal Distance Between Points 4 and 5

To compute the radius point and PT point:

1. **Press** **(CURVE - the S key).**

   This will bring in a new soft key menu. See *Curves* on page 280.

2. **Key in** `110` **and press T (for Tangent).**

3. **Key in** `24.1008` **and press** [△] **(for Delta).**

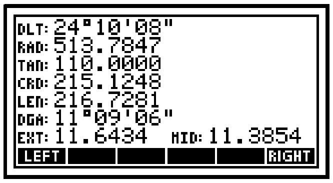


Figure 5-35 Entering the Tangent

4. **Press** RIGHT**.**

   The angles shown after RAD (Radius), TAN, and CRD (Chord) are the azimuths from the radius point to the PC (point of curvature), the azimuth along the tangent from the PC to the PI, and the azimuth along the chord from the PC to the PT.

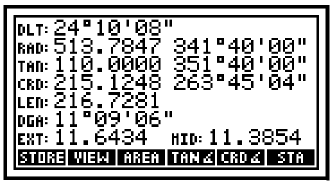


Figure 5-36 Entering the Delta

5. **Press** STORE**.**

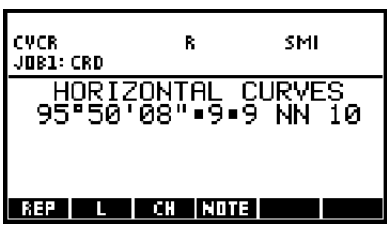


Figure 5-37 Horizontal Curves

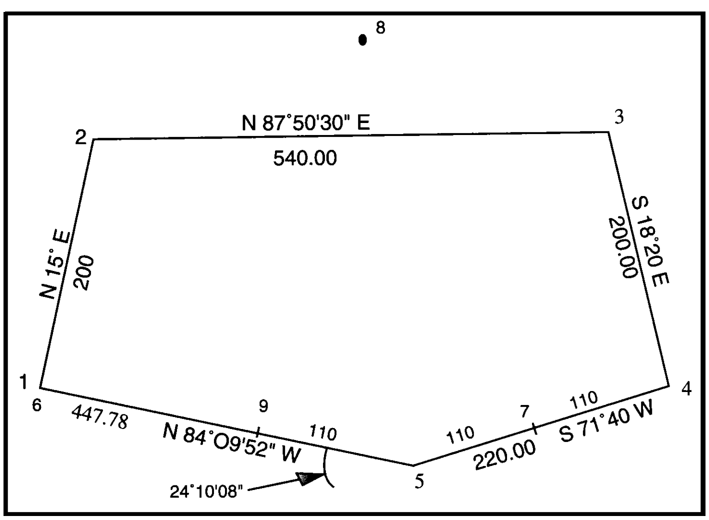


Figure 5-38 Radius Point/PT Point Example

Check Point 9

To check to see if point 9 is correct, key in 5 SPC 9 and press the **P-P** key.

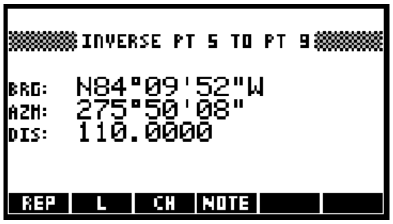


Figure 5-39 Checking Point 9

To find the new acreage:

1. **Press** RPTS**.**
2. **Press** ON **to remove old information in the** RPTS **list.**
3. **Key in** `1.4` SPC ↱ — **(the minus key)** 7 SPC 8 SPC 9 ▶ **(the R key – to move the cursor off the " marks)** 6 SPC `1`**.**

   The display should look like this: `1.4 “7 8 9” 6  1.`
4. **Press** ENTER**.**
5. **Press** PREC**.**

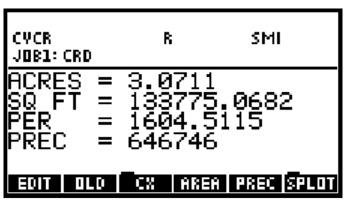


Figure 5-40 Finding the New Acreage

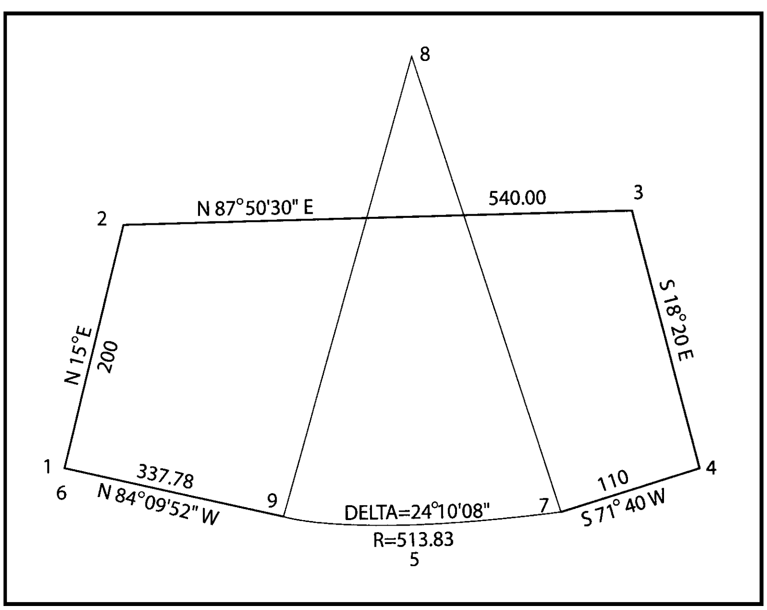


Figure 5-41 Northern Point Computation

You will now cut a lot off the west side of this parcel. First compute a point on the north side parallel to the west side, using point 9 on the south side.

6. Press ⋊ (Intersect - the T key).

This displays the Intersect menu. See *Intersections* on page 301 for more information.

7. To define the first line, key in 9 **and press PT1 (for point #1).**

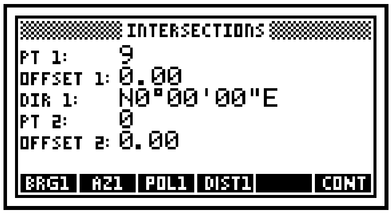


Figure 5-42 Defining the First Point on the First Line

8. Key in 1 SPC 2 **and press AZ1 (for azimuth #1).**

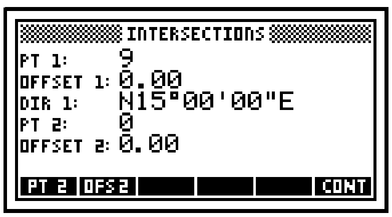


Figure 5-43 Defining the Second Point on the First Line

Define the second line.

9. Key in 2 **and press PT2.**

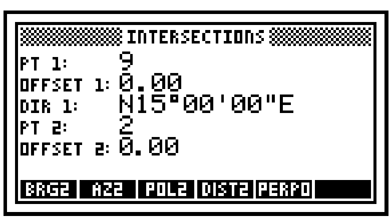


Figure 5-44 Defining the First Point on the Second Line

10. Key in 3 **and press POL2 (point on line).**

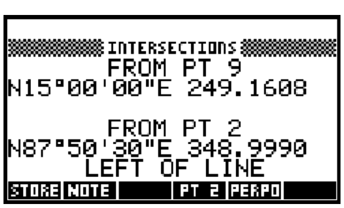


Figure 5-45 Defining the Second Point on the Second Line

11. Press STORE.

Copy JOB1

To copy JOB1 to a job named EXAMPLE, complete the following steps.

1. **Press JOB.**

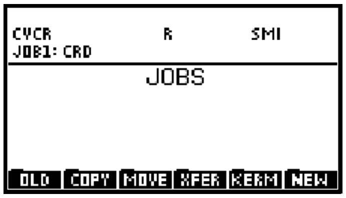


Figure 5-46 Jobs Screen

2. **Press COPY.**
3. **Highlight the job you want to copy. If this is the only job you have in the data collector, it will already be highlighted; press ENTER.**
4. **Type the new job name:** `EXAMPLE` **and press ENTER.**

   If you are using a RAM card, you will be prompted for the destination (or location) of the job :48M or :CRD. It is best to choose :CRD. You will now have two of the same jobs with different names.

   You will now be working the job you copied. Any changes you make will be made to “EXAMPLE”, not JOB1.

View Coordinates

✎ *A more detailed explanation of this menu is covered in View on page 377.*

To view the coordinates:

1. **Press VIEW.**

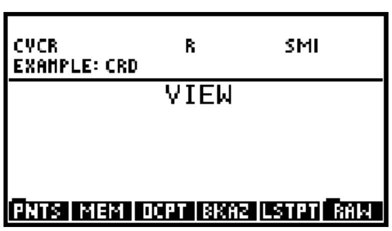


Figure 5-47 View Screen

2. **Press PNTS.**

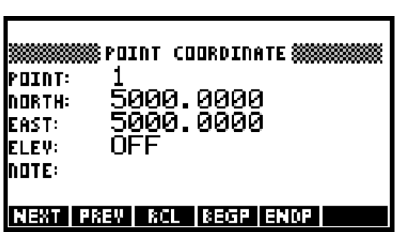


Figure 5-48 Point 1 Coordinates

3. **Press NEXT (the soft key, not the L key).**

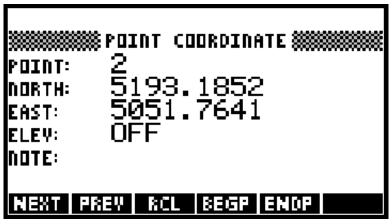


Figure 5-49 Point 2 Coordinates

4. **Press NEXT.**

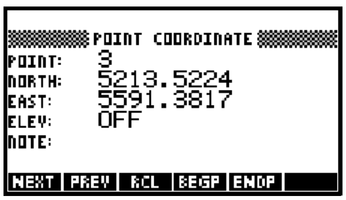


Figure 5-50 Point 3 Coordinates

As you can see, viewing coordinates is simple.

Inverse by Coordinates

The ***SMI*** cards allow you to inverse using coordinates. This will be illustrated by inversing from point 2 to 3 using the coordinates of these points as shown in *View Coordinates* on page 61. This operation will inverse between two coordinate pairs without storing them.

1. **Key in** `5193.1852` **and press ENTER.**
2. **Key in** `5051.7638` **and press ENTER.**
3. **Key in** `5213.5222` **and press ENTER.**
4. **Key in** `5591.3807` **and press ENTER ↰ and the** `P-P` **key.**

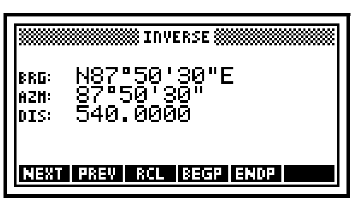


Figure 5-51 Inversing by Coordinates

✎ *The soft keys at the bottom do not change when this program is used. The soft keys are the same as the last soft keys. In this case, you happened to be in the* VIEW *menu, so you are still there.*

If you do have the points stored, as you do here, it is much easier to inverse by point number.

Key in 2 SPC 3 and press the P-P key.

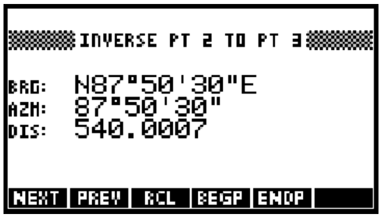


Figure 5-52 Inversing from Point 2 to Point 3

Note that the information is the same, except at the top, where the display shows the points used in the inverse. Note also that inversing by point number is much easier and faster, and you are much less likely to make an error.

✔ ***The only time to inverse by coordinates is when the coordinates are not stored by point number, and when you do not wish to store them.***

Transformation

Under RPTS is a CX program called Transformation because it can be used to rotate, translate, and scale coordinates. You can rotate, translate, or scale or any combination of these operations at the same time.

How to do all of the above at the same time:

The State Plane Coordinates in meters for point 3 are:

North: 12,573,465.122

East: 7,442,381.498.

The State Plane direction from point 3 to point 4 is S 19°23'30" E.

The EXAMPLE job is in feet. You will convert it to meters. The scale factor for converting from feet to meters is 0.3048006096 (U.S. foot) or 0.30480000 (International foot).

Rotate to the State Plane Direction, Translate to the State Plane Coordinates, and Scale from Feet to Meters

You are now in the copied job that was called EXAMPLE. This rotation, translation, and scaling will leave JOB 1 intact.

1. **Determine all of the points that need to be transformed. Key in a large point number – larger than any point in the job – and press ←, FAP (the ENTER key).**

   If this function sees a point number on the stack, it determines if a point is stored at that location. If it is stored, it searches forward to the first free point. If it is not stored, it searches backward until it finds the first free point after a stored point.

2. **Key in `500` and press ← ENTER (FAP finds the first available point).**

   This gives a Next Number of 11. This means the last number used was 10. So the points you will transform are from point 1 to point 10.

3. **Press RPTS. Press ON to remove the old random point file.**

   Here you define all of the point numbers that will be translated. It is OK if you define points that have not been stored. They will be ignored.

4. **Key in** `1.10` **and press** ENTER **(points 1 through 10 will be transformed).**

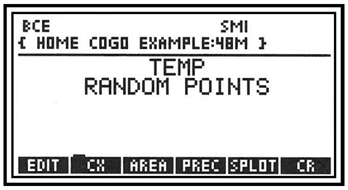


Figure 5-53 Temp Random Points Screen

5. **Press** CX**. (** CX **is the name of the Transformation program).**

   If not using a ***BCE*** card and Elevations are turned off, you will see the message `Will Erase Elevations`. This indicates that the point transformed while Elevations are off will be given an elevation of 0.

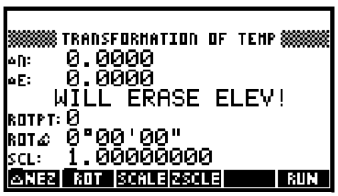


Figure 5-54 Transformation Screen

6. **Press** △NEZ**.**

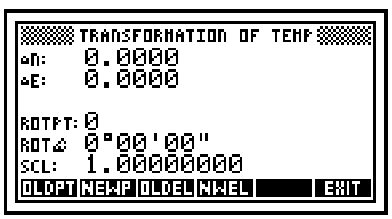


Figure 5-55 Transformation of Points

7. **Key in the old incorrect point number (**`3`**) and press** OLDPT**.**

8. **Press** NXT**.**

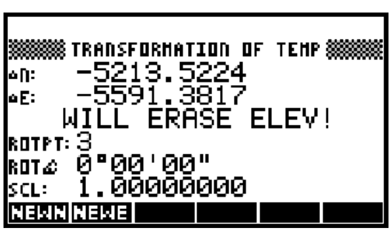


Figure 5-56 Coordinates of Point 3

9. **Key in the new north coordinate (**`12,573,465.122`**) and press** NEWN**.**

10. Key in the new east coordinate (`7,442,381.498`) and press NEWE.

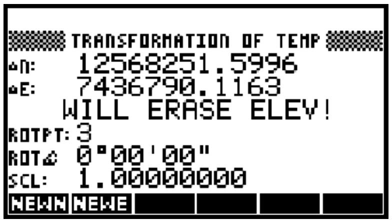


Figure 5-57 New Coordinates of Point 3

11. Press NXT EXIT and ROT (for Rotation).

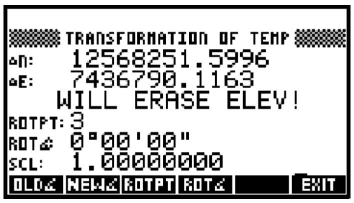


Figure 5-58 Exiting Transformation Screen

12. Key in `3` **SPC** `4` **(the two points that define the old incorrect direction) and press OLD∡.**

13. Key in `19.2330` **and convert to an azimuth by pressing ↱ S-E (the 2 key).**

14. Press NEW∡.

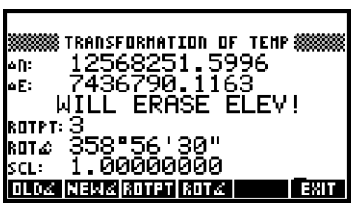


Figure 5-59 Converting to Azimuth

15. Press EXIT.

16. Press SCALE.

A scale factor will multiply all distances in the random point file by whatever you set it to be. The number 1 is the default scale factor.

✎ *Note the program will put an asterisk " * " before the distance to indicate that there is a scale factor being applied when you inverse any point in that point file.*

17. Key in `.30480060960` **and press** ENTER **.**

This will be the new scale factor.

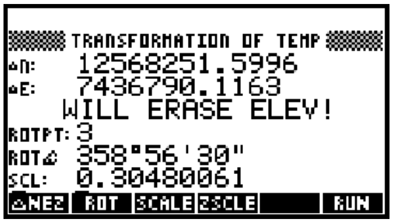


Figure 5-60 Entering New Scale Factor

18. Press RUN **.**

The display will then show DONE. Press Cancel or the ON key to clear that message.

19. Now press VIEW **, key in** 3**, and press** PNTS **.**

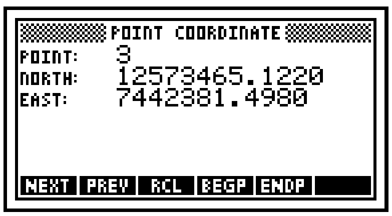


Figure 5-61 Viewing the Coordinates of Point 3

20. Key in 3 SPC 4 **and press the** P-P **key.**

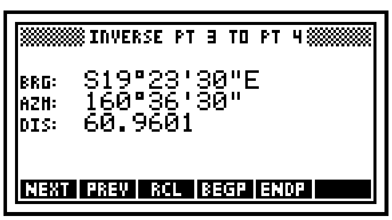


Figure 5-62 Inversing from Point 3 to Point 4

The new direction is correct. The distance is in meters.

Staking Points

Still using the same illustration, you will now be shown how to occupy 7, backsight 4, and stake points 1, 2, 3, and points along the curve from 7 to 9.

1. **Press** SETUP **, key in** 7**, and press** OCPY **.**
2. **Key in** 4 **and press** BKPT **.**
3. **Press** STAKE **. Key in** 1 **and press** FSPT **(for Foresight point, which is the point to be staked).**

The display now shows at a glance that you are sitting at 7, backsighting 4, the right angle to turn, and the distance to shoot to stake point 1.

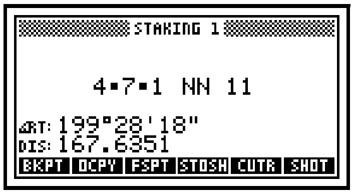


Figure 5-63 Staking Point 1

4. Key in 2 **and press** FSPT **.**

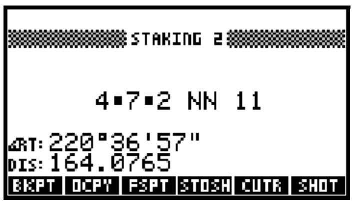


Figure 5-64 Staking Point 2

5. Key in 3 **and press** FSPT **.**

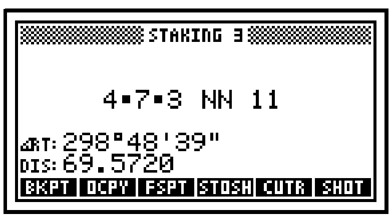


Figure 5-65 Staking Point 3

✎ *The above distances are in meters, since you performed the transformation, and may differ slightly from what you are showing on your screen.*

Change to Meters Mode

Press CHG NXT MODE FEET (the Feet soft key will toggle to METR and the display will show METERS MODE).

You now are in Meters mode.

Compute the area in Meters mode.

1. Press RPTS **.**

2. Press ON **to clear the old data.**

3. **Key in** 1.4 SPC "(↱ —) 7 SPC 8 SPC 9" ▶ SPC 6 SPC 1 ENTER PREC.

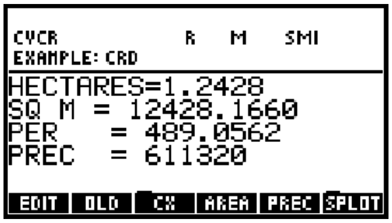


Figure 5-66 Computing the Area in Meters Mode

Now return to JOB1 and work in the Feet mode.

4. **Press** JOB OLD JOB1 ENTER CHG NXT MODE METR.

   Notice that even though the job changed, the program was still working in Meters mode.

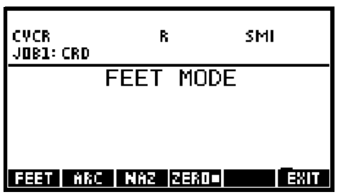


Figure 5-67 Feet Mode Option

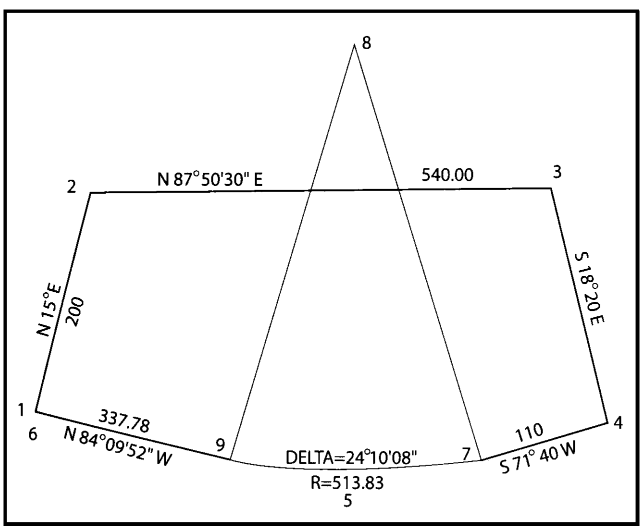


Figure 5-68 Area Computations

5. **Press** EXIT **to leave this menu.**

Stake the Curve at 50-Foot Intervals

1. **Enter SETUP 7 OCPY 4 BKPT.**

2. **Press (CURVE - the S key). Key in** `24.1008` **and press (the A key). Key in** `513.83` **and press R.**

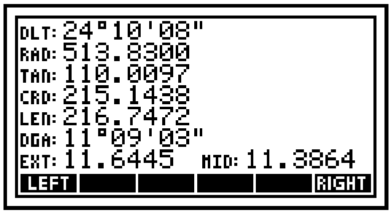


Figure 5-69 Setting the Delta and Radius

3. **Press RIGHT.**

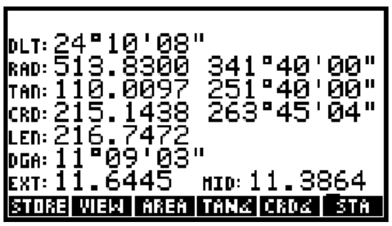


Figure 5-70 Choosing the Side

4. **Key in** `0` **and press STA.**

5. **Key in** `50` **and press INC for Increment (the increment is now 50).**

   Note the default increment is 100.

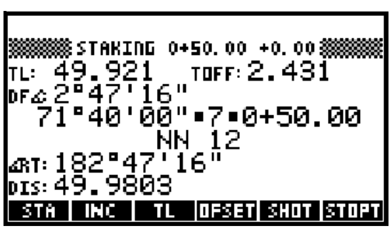


Figure 5-71 Setting the Interval Increment to 50

6. **Press INC.**

   When you do this, the program advances 50 feet up the line, giving you the angle and distance to stake.

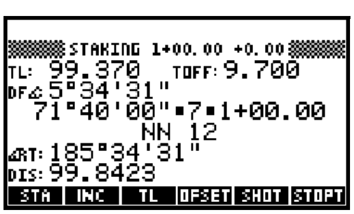


Figure 5-72 At Station 1+00

7. Press INC .

Again, it is 50 feet up the line.

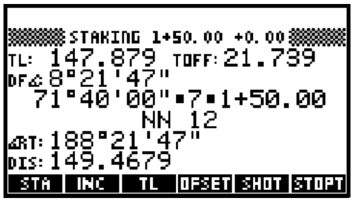


Figure 5-73 At Station 1+50

✎ *The Curve Stakeout program increments to the PT then starts over again. At any time, you can enter an offset distance and stake points on an offset from the centerline. To stake at an offset, just key in the offset distance and press* OFSET*. If the offset is to the left side of the curve, key in the offset distance and press the* +/− *key. Do not use the* — *(minus) key.*

You can also give a tangent length and get a tangent offset; an angle right, as well as an offset distance, is displayed.

✎ *You must occupy the PC or PT and backsight a point on the tangent. If you have the* ***Construction Five*** *program, you do not have to be on the PC or PT – you can do this routine from any location.*

Working with Elevations

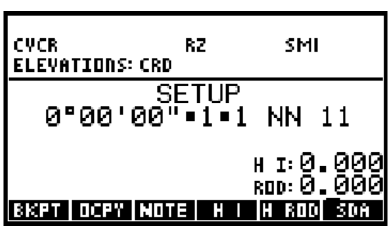


Figure 5-74 Flag Z

Note the flag Z at the top of the setup screen. This flag indicates that Elevations are on. This flag can be toggled on or off from the CHG menu. The shortcut is ↰ 3 to toggle flag Z on and off.

Since Elevations are on, the HI and ROD values are displayed for trig leveling purposes. Note also that when a job is created, the default back azimuth is 0.00 00.

Following are some examples of working with elevations. When the points were stored, Elevations were not turned on because the elevation information was not provided.

An assumed elevation will now start on one point and use this point as a reference to store elevations on other points using trig leveling with ***SMI*** surveying software.

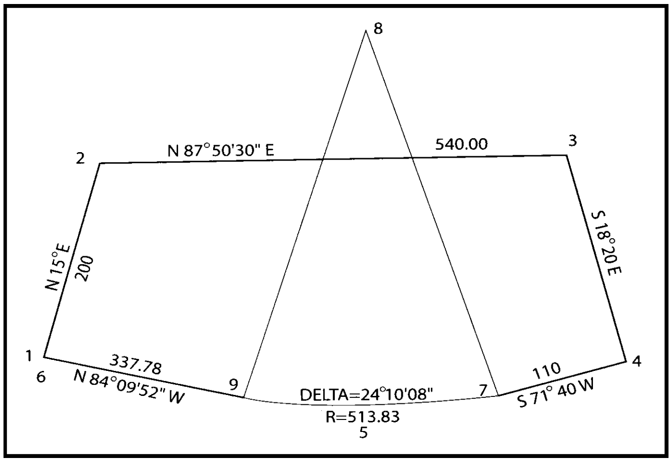


Figure 5-75 Elevation Points

Store an Assumed Elevation at Point 3

1. **Press [SC] (Store Coordinates).**

   This is the J key on the overlay.

2. **Key in** 3 **and press** **RCLPT** **(Recall Point).**

3. **Key in** `100` **and press** **EL** **(this turns Elevations on).**

✎ *This will turn Elevations on if they were off before.*

Figure 5-76 Turning on Elevations

4. **Key in** 3 **and press** **STORE**.

   You are prompted:

   POINT 3 USED

5. **Press** **ENTER** **to overwrite.**

Figure 5-77 Storing an Elevation at Point 3

Use Benchmark

Even though it is not normally necessary to enter an HI and HROD, since you are asked to bring an elevation to the occupied point, it will be necessary to enter the HI and HROD to bring the elevation to the occupied point.

1. **First, measure the HI and HROD and enter these values into the *SMI* software.**

   The HI = 5.25 and the HROD = 4.85.

2. **Press SETUP. Key in** `5.25` **and press HI. Key in** `4.85` **and press HROD.**

3. **Take a reading on the prism on point 3.**

   In Manual mode, use the angles and distance below from point 7 to point 3:

➥ Horizontal Angle: 298°48'40"

➥ Zenith Angle: 87°50

➥ Slope Distance: 228.30

4. **Press SETUP NXT B M. Key in** `228.30` **SPC** `87.50` **SPC** `298.4840` **ENTER. Depending on which product you have in your data collector, you may not have to press NXT to find the B M key.**

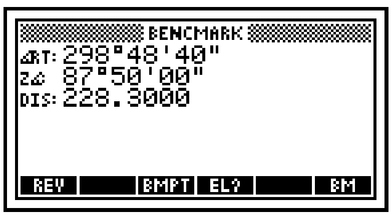


Figure 5-78 Setting the Distance and Angle from Point 3 to Point 7

5. **Key in** `3` **and press BMPT.**

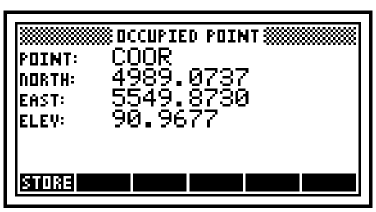


Figure 5-79 Backsighting to Point 3

Point 3 had an elevation stored. If an elevation was not stored at point 3, you could have keyed in 100 (the elevation of point 3) and pressed E L?.

6. **Key in** 7 **and press** STORE**.**

You are prompted to overwrite the point, but overwriting the point will not change the north and east coordinates. It will only insert the correct elevation at point 7. Press ENTER to overwrite.

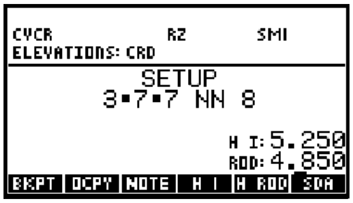


Figure 5-80 Setting Point 7

✎ *If you see an angle here as your backsight, do not worry – it is just the angle of point 3. Sometimes the point number will show as your backsight, and sometimes the angle will.*

You can now take side shots to the prism and collect north, east, and elevation values. If the rod height does not change, the elevations of the foresight points will be good elevations. If you wish to take side shots several hundred feet away and want the elevations to have high accuracy, you should use TRIG (SETUP , NXT , NXT , TRIG). TRIG takes a side shot like the Side Shot function, except that it prompts for a REV (reverse reading) which means (averages) the zenith angles. Direct and reverse are meaned and the vertical circle error of the instrument is nullified.

Trig (Trigonometric Leveling)

KEY: TRIG

PRODUCT: SCE+

KEYSTROKES: SETUP NXT NXT TRIG

OVERLAY: The number 8 key

Pressing the TRIG key takes a single horizontal angle and slope distance on a point, but unlike SIDS , TRIG requires a reverse reading on the point where the zenith angles are meaned, thus taking out the vertical circle error of the instrument, which gives a more accurate elevation.

Procedure

The first shot should be done with the instrument in face 1 position (direct); the second shot assumes face 2 where the scope is reverse positioned (flopped).

If you are using an electronic instrument, the measurement will be made automatically; otherwise, you will be prompted to enter the appropriate data: slope distance, zenith angle, and angle right (separate each value with a space).

Manual Entry

Once TRIG is pressed, enter the data for the face 1 data. Enter the slope distance, zenith angle, and the angle right separated with a space between each and press ENTER . REV will now appear in the soft key menu, indicating that you should take the second shot. Press REV , key in the zenith angle in face 2, and press ENTER . The angle right, mean zenith angle, and slope distance will be displayed along with the vertical circle error. To store the coordinates and meaned elevation as a side shot, press STORE .

Electronic Entry (Using DCE or Above)

If you are using an electronic instrument, the measurement will be performed automatically. The data collector will display an arrow symbol beside the angle error if the vertical angle tolerance is exceeded. The data will be displayed (average zenith angle and error). Press **STORE** from the soft key menu to store the point if you are satisfied with the results.

Principles That Should be Considered When Doing Trigonometric Leveling

Trig leveling is becoming a more accepted method of running levels. An article in the *POB* magazine indicated that trig leveling was more accurate than conventional leveling. It is certain that trig leveling is faster in almost all cases, and with proper equipment and proper procedures, trig leveling can be more accurate. It should be noted that trig leveling can be performed in the course of storing north and east coordinates with little or no extra effort.

Some available software programs have problems performing good trig leveling work. With proper procedure and current total stations, trig leveling can be performed dependably and accurately. You should strongly consider using SMI's ***DCE*** card, which interacts with today's electronic total stations, if you are serious about trig leveling. If you are doing construction stakeout work, SMI's ***CVCE*** card is recommended.

Following are some principles that should be considered when doing trig leveling:

1. **For accurate trig level work, when distances are greater than 300 feet, use direct and reverse. This means or averages the zenith angles and takes out the vertical circle index error of the instrument. This can be accomplished using TRIG in the Setup menu.**
2. **Use the Earth's curvature and refraction formula. *SMI* defaults with this turned on, and there is no reason to turn this off. Some instruments allow you to turn this feature on or off in the instrument. That does not matter. *SMI* gets the raw angles and distances from the electronic total stations. Therefore, whatever your instrument setting, leave *SMI's* EC (Earth's curvature) turned on.**
3. **Use the same rod height to do the foresight as to do the backsight. This will eliminate "measure up" errors.**
4. **Use a benchmark away from where the instrument is occupying. When you use an elevation under the instrument, this introduces "measure up" errors.**
5. **On extremely long shots, use "Mean Reverse Reciprocals." This takes a direct and a reverse from both ends of the line and means the results. This not only takes away the error of the vertical circle of the instrument, it also takes away the error of the Earth's curvature and refraction formulas. SMI introduces a program that addresses this need in the *ACE* card. It is called Mean Back Sight (MBS). It means the elevation at the end of a line which has been reduced based on a direct and reverse reading. This is achieved by a direct and reverse to the backsight from the end of the line to the beginning of the line, then meaning the two elevations.**
6. **Remember that BM (benchmark) brings an elevation to the instrument just like a level gets an HI (height of instrument) from a backsight reading. SIDS, TRIG, and SHOTS send an elevation to the point just like FS and find the foresight elevation using levels.**

Think of trig leveling as adding another dimension to the north and east coordinates where the instrument performs the function of a level. Just as the HI of the instrument is important in levels to carry the elevation to the foresight point, the same is true with trig levels. When you are running levels do you ever measure down to find the elevation under the level? No. You could, but it would introduce an error. The same is true when doing trig levels. You can measure down. There is even a place to put it in the software called HI. This introduces a measuring error of perhaps a hundredth or so. Normal trig leveling does not require that you measure the distance from the ground or the axis of the instrument and enter it as the HI.

There are times this is important; one is when working with tripods rather than prism rods. The other is when performing mean reverse reciprocals. Most often, it is not necessary to know the elevation under the instrument.

One Procedure for Trigonometric Leveling

1. **Occupy and backsight a point. Press SETUP, key in the occupied point number, and press OCPY. Key in the backsight point and press BKPT.**
2. **Zero the instrument on the backsight point.**
3. **Take a reading on a benchmark. The benchmark can be the backsight point or any other point with a known or assumed elevation. Press SETUP NXT B M and the instrument will take a reading or prompt for the distance and angles from the instrument.**
4. **You now have an option of one of the following:**
   - A. **Key in the known elevation of the benchmark and press E L?.**
   - B. **Key in the point number of the benchmark that has the elevation and press BMPT.**
   - C. **Flop the scope and press REV. This takes a reverse reading on the benchmark. You are now ready to do A or B above.**

✎ *The C option should be used when you need high accuracy and when the distances are longer than 300 feet.*

Note that in this procedure, the height of instrument and height of rod values were not discussed. When you do not need the elevation of the point under the instrument, or you already have the elevation of the point under the instrument, you do not need to enter height of instrument and height of rod readings.

✔ ***You should be careful not to change the height of instrument and height of rod values after doing a benchmark. If you need to boot the rod, enter the difference in rod height using the HROD key.***

Predetermined Area

There are two basic types of predetermined area: The Hinge method and the Slide method. Using the example from *Standard COGO*, which begins on page 42, and *Basic Surveying*, which begins on page 42, both will be illustrated in the following sections.

The Hinge Method

In Figure 5-81 on page 76, you will be shown how to hold point 9 and create a point on the line between points 2 and 3 that produces a 1.5 acre parcel on the west side of the property.

➥ The points of this tract should first be stored (see *Standard COGO* on page 42 and *Basic Surveying* on page 42). Make sure that points 9, 1, 2, and 3 are stored.

➥ Place the point numbers in the RPTS file. The first point should be the hinge point. The last two points should define the line on which the new point is to be placed.

1. **Press RPTS.**
2. **Press ON to clear the old data.**
3. **Key in** `9` **SPC** `1.3` **and press ENTER.**

4. **Press NXT NXT and HINGE.**
5. **Type** `1.5` **and press ACRES.**
6. **Press STORE to store the point at the next number position (or key in the point number before pressing STORE).**

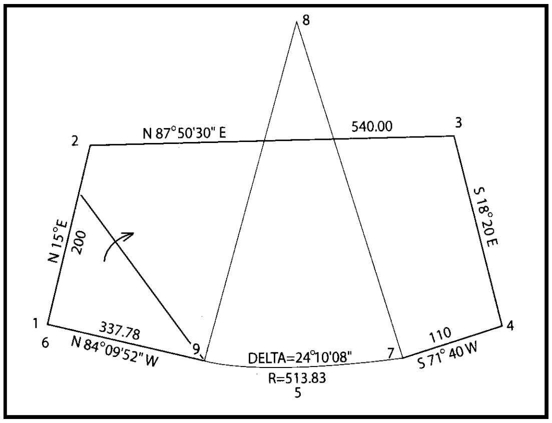


Figure 5-81 Predetermined Area Example

Check Location of Points Using Screen Plot

1. **Press RPTS.**
2. **Key in** `1` **SPC** `2` **SPC** `10` **SPC** `9` **SPC** `6` **then press ENTER.**
3. **Press SPLOT.**
4. **The LINE key will toggle on and off drawing lines. Press it now to toggle off drawing lines. (The PT# soft key will do the same thing with the point numbers but do not press it now – you will want to see the point numbers.)**
5. **Press SPLOT.**

   Remember that this will only show the points that are in the random points file, even though there may be more points in the job.

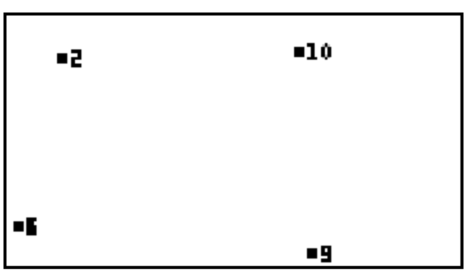


Figure 5-82 Screen Plot

   Points 1 and 6 are very close together, so 6 looks distorted. Point 10 is the one that was created to create the 1.5-acre area.

6. **Press ON to return to the screen plot screen.**

The Slide Method

Now you will be shown how to create a 1-acre tract on the west side; however, the bearing on the east side of the 1-acre lot will be N 15°00' E. This will create two more points on the defined line and slide them in or out to create the exact acreage given.

✎ *You cannot slide on a curve.*

1. Press [↰] (the [SPC] key).

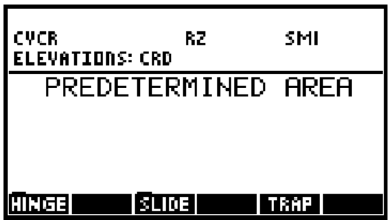


Figure 5-83 Slide Option

2. Press SLIDE.

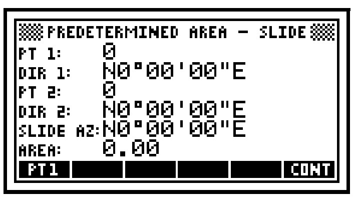


Figure 5-84 Predetermined Area – Slide Screen

3. Key in 1 **and press PT1 for point 1.**

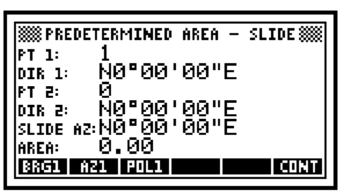


Figure 5-85 Point 1

4. Key in 1 **[SPC]** 9 **and press AZ1 for azimuth 1.**

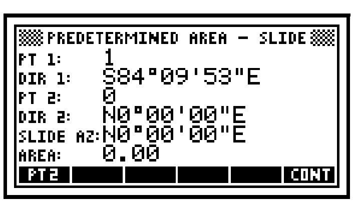


Figure 5-86 Azimuth 1

5. **Key in** `2` **and press** **PT2** **for point 2.**

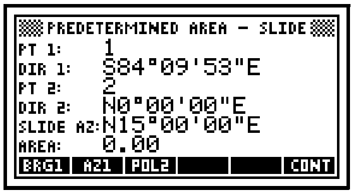


Figure 5-87 Point 2

6. **Key in** `2` SPC `3` **and press** **AZ2** **for azimuth 2.**

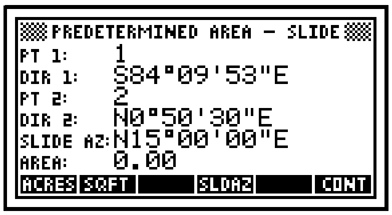


Figure 5-88 Azimuth 2

7. **Key in** `15.00` **and press** **SLDAZ**.
8. **Key in** `1` **and press** **ACRES**.

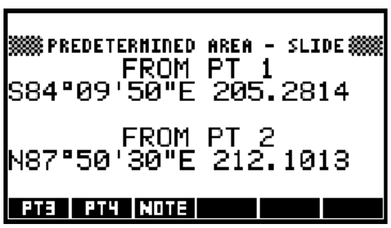


Figure 5-89 Displays Resultant Distances

9. **Key in** `13` **and press** **PT3**, **key in** `14` **and press** **PT4**.

   If the next number is 13, keying in the point number first is not necessary.

   This stores points at the computed corners.

10. **Check the area.**
11. **Press** RPTS.
12. **Press the** ON **key to clear out the old data.**
13. **Key in** `13` SPC `1` SPC `2` SPC `14` **and press** ENTER.
14. **Press** **AREA**.

    You should see ACRES = `1.0000`. You can also check to see the points location by pressing **SPLOT** again.

Sunshots

The Sunshots routine lets you take a sunshot or calculate a previous sunshot. This function is available on all of SMI's programs.

The Sunshots routine uses the local hour angle method with built-in ephemeris, which requires the use of Greenwich Mean Time (GMT). This method is generally accepted as the most accurate method of determining north from the sun.

✎ *GMT, as used in this manual, is equivalent to UT1 time. National Bureau of Standards Time, WWV, and WWVH announce UTC time and the double ticks to adjust to UT1 time. UT1 time is based on the Earth's rotation. When double ticks are immediately after the tone, add one tenth of a second per double tick. Subtract one tenth of a second per double tick when the double ticks are nine seconds after the tone.*

✔ ***It is absolutely essential that you use a solar filter when taking readings on the sun. Without a filter, you will only get two attempts at a sunshot: one with the right eye, the other with the left eye – and your surveying days are over!***

✎ *Also note that the sun will ruin a diode in a total station EDM unless you have installed a sun filter in front of the lens.*

Benefits of the Local Angle Hour Method

- Greater accuracy is possible.
- Observations are possible during more of the day; in the winter months, observations can be obtained from sunup to sundown for most of North America.
- It is not necessary to read vertical or zenith angles.
- Parallax and refraction do not affect your readings.
- Readings can be made faster and more easily than with other methods.

This Local Angle Hour program was developed by Charles Elam, of Lincolnton, Georgia. He tells of a 28.14 - mile traverse with 81 traverse stations and 20 solar stations to control direction. His angles had a 3-second accuracy and his closure was better than 1 in 100,000.

Some Facts About Elam's Method

- He gets 3-second accuracy with a 1-second theodolite.
- He uses the sun to control his direction.
- He isolates his angle errors using the sun.
- He uses Grid North, which does not vary as the observation point changes east and west (True, or Astronomic North, does vary as the observation point moves east and west).
- He notes that the trailing edge method is at least as accurate (if not more so) than Roelof's Prism.
- He uses four direct and four reverse sightings.

About SMI's Sunshots Routine

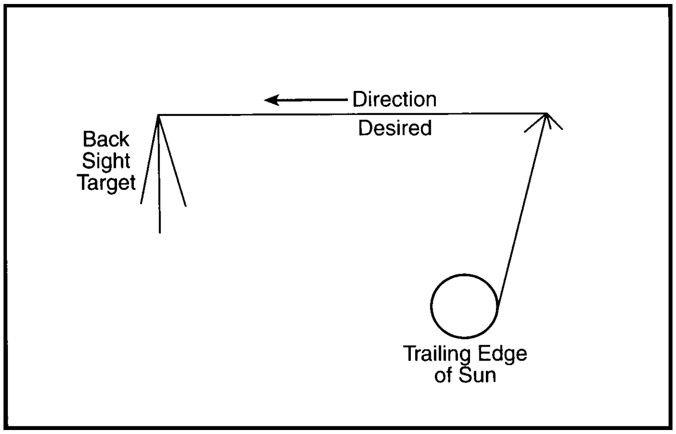


Figure 5-90 Sunshots Illustration

The Sunshots program is used to determine the direction of a line. It can be used to determine True (Astronomic) North or Grid North, based on a State Plane grid system.

Both True North and Grid North are preferred over Magnetic North, as Magnetic North is in a constant state of change. In the South, for example, it is now changing at a rate of 1° in six years (normal rate of change is approximately 1° in 20 years).

At any point along a line of Earth's longitude (pole to pole), Astronomic (True) North does not change. However, running east and west, True North lines converge at a rate of about 1 minute per mile. This value increases as you move north, and decreases as you move south. Since most of the work is confined to small areas, this does not create a serious problem – until you start tying projects together or get a job that covers a longer distance ranging east and west.

State Plane systems have been defined to solve this problem. A State Plane Coordinate system includes large areas (sometimes an entire state) which use the True North of one longitudinal line; all other north-south lines are parallel to it. Thus, in this system, north-south lines are parallel.

The Sunshots routine is designed to give the azimuth from State Plane North, or azimuth, from True North. If you store the constants from your State Plane system in the data collector, it will maintain those values until you modify or clear them. Whenever you take a sunshot, it gives the azimuth in State Plane values. If State Plane values are not stored, it will give the azimuth in Astronomic, or True North.

Two common State Plane grid systems are used: the Lambert system and Transverse Mercator system. If you are in the Mercator system, you only need to key in one constant. The Lambert system requires two constants. These constants are listed in *State Plane Grid Constants*, which begins on page 405.

Southern and Eastern Hemisphere Sunshots

If your position is south of the path of the sun and you are using the center of the sun as the option, the ephemeris should work fine. However, if you are using the trailing edge of the sun, you should choose LEAD as your option for the leading edge of the sun. When you are south of the equator, the latitude should be entered as a negative number. When you are east of Greenwich, England, the longitude should be entered as a negative angle from Greenwich.

As far as it can be determined, there is no known time limit to the ephemeral data, which should continue to work well into the twenty-first century.

Getting Started with Sunshots

Press SUN (the Y key).

Figure 5-91 Sunshots Menu 1

The Sunshots menu presents soft keys that help define the sunshot; press NXT to scroll the soft key menu screens.

Sunshots Menu 1 Soft Keys

Option	*Function*
DATE	This key is used to enter the current (or desired) date. The format is MM.DDYYYY (for example, October 23, 1998 would be entered as 10.231998). If a date is not entered on the stack when the key is pressed, the program will use the current date in the calculator (the HP 48 has a running clock to maintain date and time – please refer to your HP 48 owner's manual for more information).
TIME	This key is used to enter time of day (military time, or a 24-hour clock, is used). The format is HH.MMSS (for example, 2:32:15 p.m. would be entered as 14.3215). ✎ *If a time is not entered on the stack when the key is pressed, the program will use the exact time (as maintained by the calculator) when the key is pressed.* ✎ *The Sunshots program requires Greenwich Mean Time (UT1 time).* ✎ *For Eastern Standard Time, add five hours to the local time. For Daylight Savings Time, add four hours.– for Central Time, add six hours, for Mountain Time, add seven hours, and for Pacific Time, add eight hours.* ✎ *The easiest method is to listen to WWV (broadcast from Hawaii and Colorado) and get the current UTC time. It is desirable that the time be accurate to 1/10 of a second. Being off by one second could affect azimuth accuracy by 7 - 20 arc seconds.* ✎ *For more accurate UT1 time, it is desirable to factor double ticks into the UTC time given. A double tick represents one tenth of a second; for example, if you get two immediate double ticks after the time, add two tenths of a second to the UTC time stated. For three double ticks nine seconds after the UTC time, subtract three tenths of a second to get the UT1 time.* For more help, see also *Setting Time on Your HP 48 Data Collector* on page 90.
BSCIR	This key is used to enter the backsight circle reading.
CSUN	This key is used to enter the circle (horizontal angle) to the sun.
RUN REP	This key is used to perform the calculation using the current values displayed on the screen. If one or more sunshots have already been made, REP appears as the soft key instead of RUN. The resulting average circle to the sun is put in the display.
TCR	This key does three things: T = Time; C= Circle to the sun; R= Run, taking the results and performing the calculation.
SHOW	This key shows the results of RUN or AVG.

Sunshots menu 2 allows you to enter latitude, longitude, and other key variables, as described below.

Figure 5-92 Sunshots Menu 2

Sunshots Menu 2 Soft Keys

Option	Function
LAT	This key is used to enter the latitude of the point of observation.
LONG	This key is used to enter the longitude of the point of observation. ✎ *You should be able to achieve sufficient accuracy if you scale the latitude and longitude from a USGS quadrangle map. The accuracy should be +/- 300 feet.*
TRAIL CNTR LEAD	This toggle key is used to select the trailing edge, center, or leading edge of the sun for pointing. The default is set to TRAIL.
C. L.	This key is used to enter the longitude constant.
Z. C.	This key is used to enter the zone constant.

Both the longitudinal constant and zone constant should be zero for computing Astronomic North. Refer to *State Plane Grid Constants*, which begins on page 405, for entering longitude and zone constants for your area. When these constants are entered, the Sunshots program will automatically give you State Plane Grid North, rather than Astronomic North.

This Sunshots program has a built-in ephemeris accurate to normally within +/- 10 arc seconds. However, under worst-case conditions, assuming the user does everything perfectly, it is possible to be off by 42 arc seconds.

Controlling Direction During a Large Traverse

For large traverses, a desirable way to control direction would be to take a sunshot at each fifth traverse point. While the errors in the sunshot can be up to 42 seconds, if sunshots are taken over a period of one to five days, the variation in consistency should not exceed one to three arc seconds.

As mentioned earlier, when traversing east and west for 1 mile, the Astronomic North from the sun will converge approximately one minute. Therefore, when surveying large boundaries with great east/west movement, it is better to use State Plane Grid North requiring longitudinal constant and zone constant. This keeps north parallel throughout the survey.

With careful observations, you should get a consistency of readings within approximately two to four arc seconds.

Leveling the Instrument

In taking sunshots, leveling of the instrument is critically important, especially as the sun gets higher in the sky. More dependable readings can be taken when the sun is close to the horizon.

Readings on the Trailing Edge of the Sun

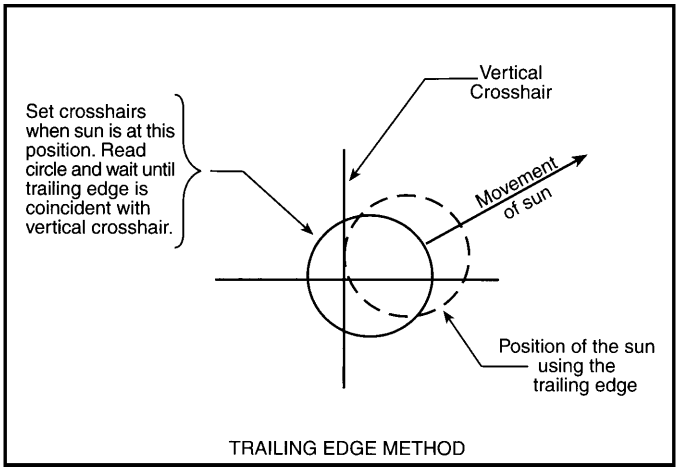


Figure 5-93 Trailing Edge Method Diagram

When taking a reading on the trailing edge, move the vertical crosshair slightly into the sun and, at the instant the vertical crosshair passes the trailing edge, press **TIME**.

✎ *The rest of the data can be entered before or after the time, but all data must be entered (except the optional longitude constant and zone constants) before* **RUN** *is pressed.*

For repeated readings, you only need to re-establish **TIME** and **CSUN** readings; backsight circle is optional.

If the instrument is flopped, the backsight circle should be reread, as well as time and circle to the sun.

If an electronic instrument has been chosen (you must be using SMI's ***DCE*** or above program card), backsight circle and **CSUN** angles will be brought in electronically.

Important Information about Sunshots

SMI's built-in ephemeris is accurate to +/- 10 seconds, assuming your data is correct. In a worst case situation, accuracy may fall to +/- 42 seconds. This is why it is important to periodically verify the time accuracy of your data collector.

(Generally, over a period of two to three days, time is consistent within one to two seconds.)

How important is time accuracy to your calculations? If the time entered is one second off, the angle error may be as much as +/- 7 seconds. (You can test this by entering your data at a certain time, then entering it again after adjusting your time by one second.)

The best time to take sunshots is early in the morning or late afternoon, when the sun is closer to the horizon. The worst time is when the sun is greater than 45° from horizontal.

Please also note that Earth's curvature and refraction do not seem to affect the accuracy of the angle. Therefore, a low angle is most desirable.

How to Avoid Sunshot Problems

If you take consecutive sunshots spaced a few minutes apart and your resulting angle tends to drift in a certain direction, this is an indication that the date, time, latitude, or longitude is incorrect.

The steeper the sunshot angle, the more critical it is for your instrument to be precisely level.

Sunshot Example

This is an example using a 10-second theodolite and a Casio wristwatch for reading the time.

The location for this sunshot is northeast Tennessee. The latitude of the instrument position is 36°33'39" and the longitude is 82°34'11".

A backsight reading was taken on a church steeple and it was set at 0.0000". The data collector was set to Greenwich Meridian Time. Readings were taken to the nearest half second and recorded the time and horizontal circle reading to the sun.

The date was 17 November 1994; the time was a little after 4:00 p.m. Eastern Standard Time – just past 21 hours Greenwich Meridian Time. Using the time and circle readings to the sun, the Grid Azimuth was computed from the instrument to the church steeple.

The data for November 17, 1994:

On the HP 48, the clock should be set to 24h mode and decimal point to fix 6.

EST	*Circle Reading to the Sun*	*GMT*
4:0649	92°55'35"	21:0649
4:0718.5	93°00'50"	21:0718.5
4:0750.5	93°06'23"	21:0750.5
4:0819.5	93°11'20"	21:0819.5

✎ *If you are manually keying in the data for this example, select MAN1 from the Instruments menu. (If you are in the field with an instrument selected, the program will automatically pull the data from the instrument.)*

Determining Astronomic Azimuth

1. **Press [↱] [SUN].**

   The Sunshots menu displays.

2. **Enter the date (November 17, 1994) using the format MM.DDYYYY; key in `11.171994`.**

   Even though this example is old, it will still work in the program.

3. **Press DATE.**

   The date now appears in the display.

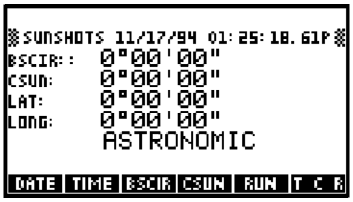


Figure 5-94 Date Displayed

4. **Now enter the latitude and longitude for your position. These keys are on the second soft menu screen, so press NXT.**

   Latitude and longitude are entered using the format DD.MMSS. Use a decimal to separate degrees from the minutes and seconds.

5. **Enter the latitude (36°33'39") by keying in** `36.3339` **so that it displays on the command line.**

6. **Press LAT.**

   The latitude appears in the display.

Figure 5-95 Latitude Displayed

7. **Enter the longitude (82°34'11") by keying in** `82.3411`**, and pressing LONG.**

   The longitude appears in the display.

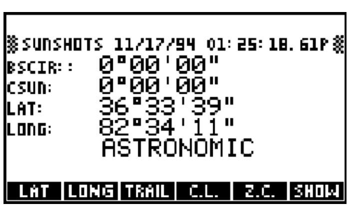


Figure 5-96 Longitude Displayed

8. **Press NXT to return to the first soft menu screen.**

Time

Enter the Greenwich Meridian Time (GMT) for this observation (21:06 and 49 seconds) by keying in `21.0649` and pressing TIME. Even though you need to enter the time in military time, it might show up on the screen with a P for PM or A for AM in Standard Time. It depends on what your data collector settings are.

The time will be shown in the data collector's display.

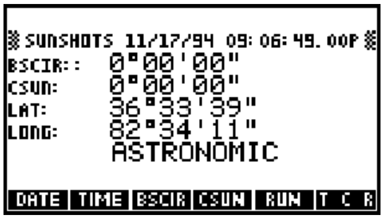


Figure 5-97 Time Display

Horizontal Circle to the Sun

CSUN is simply the horizontal angle to the sun.

✎ *If you are using electronic data collection with an instrument selected, and press* CSUN*, the horizontal angle to the sun will be collected automatically.*

You may enter the circle reading to the sun and time in any order.

1. **Press CSUN. (CSUN is different than most soft keys. It requires that you press the soft key before typing the number.)**
2. **Enter the circle reading to the sun (92°55'35") by keying in** `92.5535`**.**

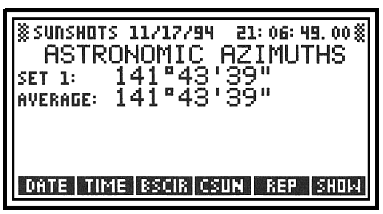


Figure 5-98 Horizontal Circle to the Sun

Run

1. **Press RUN.**

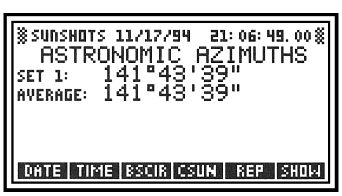


Figure 5-99 Astronomic Azimuth Computation

The program will compute the Astronomic Azimuth from the instrument to the backsight.

Also note that the RUN key has changed to REP (repeat). This simply allows you to repeat the calculations for further readings to be figured into the average.

Now enter the second set of readings: a circle reading to the sun of 93°00'55" taken at 21:0718.5 GMT.

2. **Key in** `21.07185` **on the command line and press TIME.**
3. **Press CSUN. (CSUN (CSUN is different than most soft keys. It requires that you press the soft key before typing the number.)**

4. **Press CSUN and key in `93.0050` and press ENTER.**

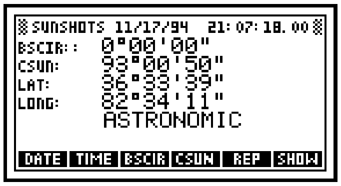


Figure 5-100 Entering the Circle Reading to the Sun

5. **Press REP.**

   You will see:

   ASTRONOMIC AZIMUTHS

   SET 2: 141° 43' 31"

   AVERAGEI 141° 43' 35"

   The program displays the new Astronomic Azimuth calculated, as well as the new average.

Finish this exercise with the remaining readings.

The third reading (93°06'23") was taken at 21:0750.5 GMT.

6. **Key in `21.07505` and press TIME.**
7. **Press CSUN, key in `93.0623`, and press ENTER. (CSUN is different than most soft keys. It requires that you press the soft key before typing the number.)**
8. **Press REP to begin the calculations.**

   The display will show the Astronomic Azimuth for reading 3, as well as the average for the three readings:

   ASTRONOMIC AZIMUTHS

   SET 3: 141° 43' 31"

   AVERAGE 141° 43' 33"

The fourth reading (93°11'20") was taken at 21:0819.5 GMT.

9. **Key in `21.08195` and press TIME.**
10. **Press CSUN, key in `93.1120` and press ENTER. (CSUN is different than most soft keys. It requires that you press the soft key before typing the number.)**
11. **Press REP.**

    The display will show the Astronomic Azimuth for reading 4, and the average for the four readings:

    ASTRONOMIC AZIMUTHS

    SET3: 141° 43' 35"

    AVERAGE 141° 43' 34.

Determining Grid Azimuth

Take the same data used to compute Astronomic Azimuth, except now you will calculate Grid Azimuth.

As indicated earlier in this chapter, Grid Azimuth requires State Plane grid constants. This data is provided in *State Plane Grid Constants*, which begins on page 405, listed by zone. The State Plane grid constants for the example in Tennessee are as follows:

Central Longitude: 86°00’00”

Zone Constant: 0.585440

First, it is necessary to enter these values.

Enter Values

1. **Press SUN to start the Sunshots menu again.**

   This will clear the previous results and change the REP soft key back to RUN.

2. **Press NXT to scroll the Sunshots soft key menu to the second screen. Enter the central longitude onto the command line by keying in `86.0000` (the zeroes after the decimal point are optional).**

3. **Press C. L. .**

   The display will show the central longitude. Note that the last values entered are still kept in the memory. That means you do not need to re-enter the date, time, or latitude/longitude for this example.

   Next, enter the zone constant.

4. **Key in `0.585440`.**

5. **To enter the value, press Z. C. .**

   The display will now show both central longitude and zone constant.

   Next, re-enter the four circle readings to the sun (and their respective times).

Reading #1

Reading #1 was 92°55’35” taken at 21:0649 GMT.

1. **Key in `21.0649` and press TIME .**

2. **Press CSUN , key in `92.5537`, and press ENTER.**

3. **Press RUN .**

   You will see:

   GRID AZIMUTHS

   SET 1:   139° 43’ 09”

   AVERAGE: 139° 43’ 09”

✎ *Since you entered the Tennessee State Plane Grid Constants, the display shows the Tennessee State Plane Grid Azimuth.*

✎ *Also note that, just as with our previous example, the* RUN *soft key has changed to* REP *(“repeat”), allowing you to take additional readings to compute an average Grid Azimuth.*

Reading #2

Reading #2 was 93°00’50” taken at 21:0718.5 GMT.

1. **Key in** `21.07185` **and press** TIME.
2. **Press** CSUN**, key in** `93.0050`**, and press** ENTER.
3. **Press** REP.

   You will see:

   GRID AZIMUTHS

   SET 2: 139° 43’ 01”

   AVERAGE: 139° 43’ 05”

Reading #3

Reading #3 was 93°06’23” taken at 21:0750.5 GMT.

1. **Key in** `21.07505` **and press** TIME.
2. **Press** CSUN**, key in** `93.0623`**, and press** ENTER.
3. **Press** REP.

   You will see:

   GRID AZIMUTHS

   SET 3: 139° 43’ 01”

   AVERAGE: 139° 43’ 04”

   The display will show the Grid Azimuth for this reading, as well as an updated average Grid Azimuth reflecting the three readings.

Reading #4

Reading #4 was 93°11’20” and was taken at 21:0819.5 GMT.

1. **Key in** `21.08195` **and press** TIME.
2. **Press** CSUN**, key in** `93.1120`**, and press** ENTER.
3. **Press** REP.

   You will see:

   GRID AZIMUTHS

   SET 4: 139° 43’ 05”

   AVERAGE: 139° 43’ 04”

✎ *Note that the average Grid Azimuth did not change between the third and fourth readings. This is because the readings were so close that they had little effect on the average.*

As you can see, the Sunshots routine is a fast and relatively simple way to calculate the direction of a line.

Setting Time on Your HP 48 Data Collector

If you are working with sunshots, it is of particular importance that your data collector be set to the correct time.

1. **To set or change the current time in your HP 48, turn *SMI* off (α).**

   You will see the Time key underneath the overlay. It is actually the 4 key.

2. **Press 4.**

   This opens the Time menu window.

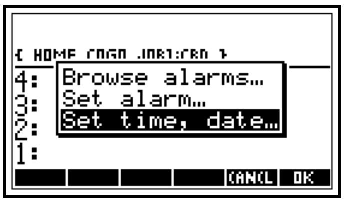


Figure 5-101 Time Menu Window

3. **Press the ▼ key to scroll down to select the** `Set time, date . . .` **option.**

4. **Press OK to accept the menu choice.**

5. **Press ▶ to highlight the desired time or date field. Once the field is highlighted, key in the appropriate value (hour, minutes, seconds, etc.); the value will appear on the command line. Press ENTER to accept it and place it in the field.**

✎ *In the “time format” field (AM, PM, or 24-hour), press the +/− key to toggle between your choices.*

6. **Press OK when you are finished.**

   This enters the changes you have made and exits the Time menu.

How to Check the Current Time

For taking sunshot readings using ***SMI***, it is essential that you accurately set your time to Greenwich Mean Time. This generally is broadcast from the Naval Observatory in Washington, DC.

You may call the US Naval Observatory’s Master Clock for a recorded time announcement. Time is broadcast in universal time and EST (adjust for your local time zone) and includes a beep every five seconds for accurate time synchronization.

US Naval Observatory Master Clock:

(202) 762-1401

An Example of Setting and Adjusting Time

1. **Turn off *SMI* or USER.**

2. **Press QUIT .**

   This completely exits ***SMI*** and makes all HP 48 functions available.

Turn on the Date and Time Display

1. **To turn on the HP 48 clock display, press MODE or the I key.**

   The Calculator Modes menu displays.

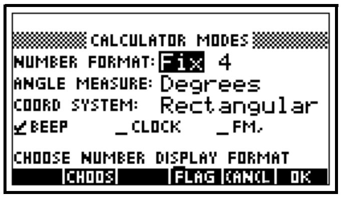


Figure 5-102 Calculator Modes Menu

2. **Press ▼ (the Q key) three times, ◀ (the P key) once and press the C key to select the Clock option.**

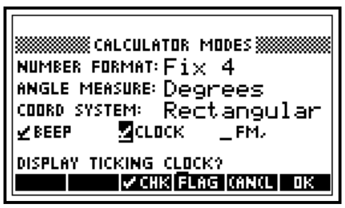


Figure 5-103 Clock On

3. **Press the OK key (the F key).**

   This will allow you to see the date and time at the top of the display at all times.

Set the Date

1. **Press ↰ 4 to get to the Time soft keys.**

   Suppose the date is November 26, 1998.

2. **To enter this date, key in `11.261998` and press →DAT (the B key).**

   You will see the 11/26/98 date on the display at the top.

Set the Time

When you call the US Naval Observatory Master Clock, you will hear something like this: “(202) 762-1401; U.S. Naval Observatory Master Clock at the tone,

Eastern Standard Time, 9 hours, 2 minutes, 45 seconds,

Universal Time 13 hours, 2 minutes, 50 seconds.”

Key in approximately 1 minute ahead of the Universal Time, such as 13.0350. When the time gets to 13 hours, 3 minutes, 50 seconds, at the tone press →TIM.

You will see the time displayed at the top of the HP 48 display.

Adjust the Time

To adjust the time, listen to the time clock to determine if you are within the correct second.

Adjust the Clock in One-Second Increments

1. **To set the clock forward one second, press [↰] 4 (TIME) and [↰] [NXT].**

   You will see CLKA on the soft key.

2. **Type** `8190` **and press [ENTER] several times. Press CLKA once for each time you wish to move the time one second ahead.**

3. **If you need to move the clock back a few seconds, press [+/–] to change the 8190 to a negative number and press [ENTER] a few times. Press CLKA for each second you wish to subtract.**

Adjust the Clock in One-Tenth-of-a-Second Increments

1. **To set the clock forward one tenth of a second, press [↰] 4 (TIME) then [↰] [NXT].**

   You will see CLKA on the soft key.

2. **Type** `819` **and press [ENTER] several times.**

   Each time you press CLKA, the time will move forward one tenth of a second.

3. **If you need to move the clock back a few tenths of a second, press [+/–] to change the 819 to a negative number and press [ENTER] a few times.**

4. **Press CLKA for each tenth of a second you wish to subtract.**

ADVANCED COGO

CHAPTER

6

This chapter is for users of the following cards:

- ➥ Advanced COGO
- ➥ Data Collection
- ➥ Construction Five
- ➥ GPS/Robotic

In this chapter:

Key Definitions

Key	Function
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
Hard Keys	Hard key functions are imprinted on each key itself. The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card. **Hard keys are represented in this manual as black lettering on a gray, rectangular background.**
Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

Stake to a Point

1. **Press SETUP, key in the occupied point number, and press OCPY.**
2. **Key in the backsight point and press BKPT.**
3. **Press STAKE, key in the point to be staked, and press FSPT.**

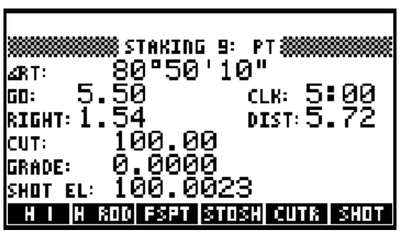


Figure 6-1 Stake to a Point Example

The angle to turn and the distance from the instrument will be shown.

✎ *DCE+: If you have the Turn to Foresight (FS) option turned on in the Robot menu and your instrument has servo motors, the instrument will turn to the foresight.*

As you take sample readings using a prism on a pole, the screen will show two options that the rodman needs to walk to find the point:

➥ **Go or Come**: This option will give you the Go or Come distances and Right or Left distances until you feel OK about the position.

(That is the rodman's right, not the instrument's right.)

➥ **CLK**: This option shows a clock direction in which the rodman should walk for a specific distance. The clock direction assumes that toward the instrument is 12:00. For example, five o'clock for 5.72 feet means that the rodman should walk away from the instrument and slightly to the instrument man's left for 5.72 feet.

If Elevations are on, you will be given Cut or Fill values, as well.

Stake Points Example

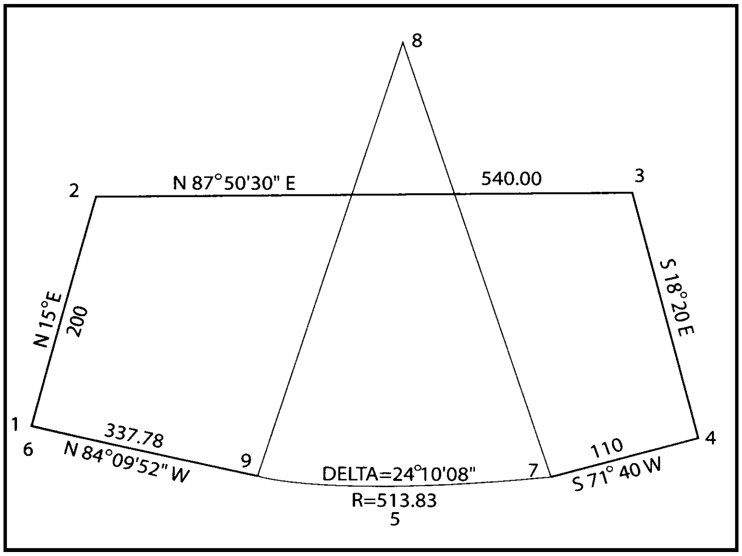


Figure 6-2 Stake Points Illustration

This example will have the instrument set up on point number one, backsighting point 2. To do this, press **SETUP** 1 **OCPY** 2 **BKPT**.

How to stake out point number 9:

1. **Press STAKE.**
2. **Key in** 9 **and press FSPT.**

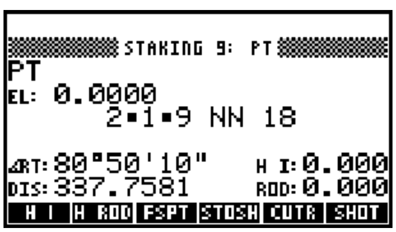


Figure 6-3 Staking Point 9

This shows the exact distance and angle to travel to reach point number 9 from point 1 backsighting 2.

3. **Send the rodman to the approximate position and press SHOT. Actually, you have two options here: if you are using an *ACE* or *SCE* program, the easiest thing to do is turn your instrument to the appropriate angle. Have your rodman line up in the sights, then press HDIST or SDIST. This will provide you with a Go or Come distance. Since it is required to press the NXT key to find the SHOT key, it is on the next menu of the *ACE* and *SCE* programs; it takes fewer keystrokes to use HDIST or SDIST. But for this example, you will use the SHOT key.**
4. **After pressing SHOT, key in the information from the instrument.**

✎ *If you have the **DCE** or **CVCE** program, and you are hooked up to a total station, the information in the gun will automatically transfer to the data collector. But if you are just using the **SCE** or **ACE** program, the information will have to be entered manually.*

Figure 6-4 Slope Distance, Zenith Angle, Angle Right

The information displayed includes the Slope Distance, Zenith Angle, and Angle Right separated by a space.

5. Key in `332.2500` SPC `90` SPC `81.0550` **and press** ENTER**.**

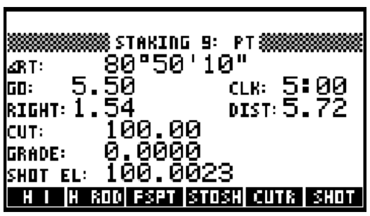


Figure 6-5 Rodman Options

The screen now shows two options that the rodman needs to walk:

➥ **Go or Come/Left or Right**: This example shows that the point is 5.5 feet away from the prism and 1.54 feet to the right. (That is the rodman's right, not the instrument's right.)

➥ **CLK**: This example shows the direction the rodman should walk – 5 o'clock is shown, with a distance of 5.72 feet. Use whatever makes sense to your rodman.

This routine can be done as many times as necessary to position the prism on top of the point desired by simply pressing SHOT.

Notice that Cut and Grade were not discussed. That is because a zenith angle of 90 (or flat) was used. A different zenith angle or elevation will be used with the same distance and angle right to show the cut and fill features of the Stake routine.

6. Press STAKE `9` FSPT**.**

7. Press NXT**, then type the elevation at which you want the point being staked to be (in this example, key in** `100`**) and press** FSEL **for foresight elevation.**

✎ *If you were staking out the foundation of a warehouse, you would want the elevation to be the same as the point you are occupying at the instrument. The elevation of the occupied point in this example is 100 feet.*

8. **Press NXT until you see SHOT, then press SHOT. Enter the same distance and angle right, but make the zenith angle 91.3007, by entering** `332.2500` **SPC** `91.3007` **SPC** `81.0550` **then press ENTER.**

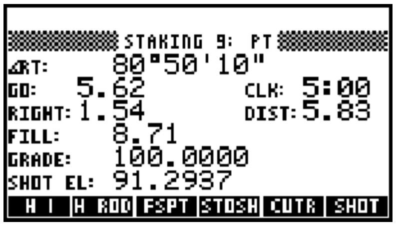


Figure 6-6 Point 9 Staked

FIELD DEFINITIONS

Fill: This field shows that 8.71 feet of earth will need to be added to the point to bring the elevation where it needs to be.

Grade: This field shows what the point needs to be.

Shot El: This field shows the current elevation of the prism.

✎ *If the elevation exceeded 100 feet, in the place of Fill would be the word Cut to show how much dirt would need to be removed to make the elevation correct.*

Notice also that the distances are slightly different than the example where the point was already flat. The program compensates for the slope of the ground as well.

Stake to a Line

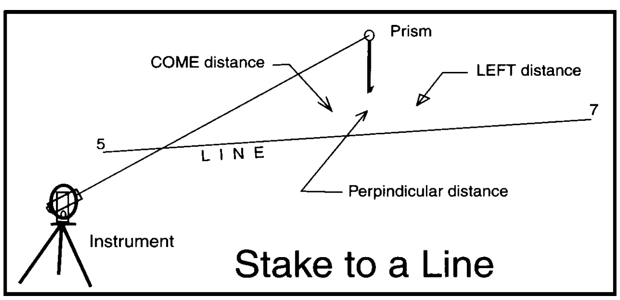


Figure 6-7 Stake to a Line

1. **Press SETUP, key in the occupied point number, and press OCPY.**
2. **Key in the backsight point and press BKPT.**
3. **Press STAKE, key in a point number, press SPC, key in another point number that is on the line to be staked, and press FSPT.**

   As you take sample readings using SHOT, you will be given Go or Come distances, Right or Left distances, and perpendicular distances (PERPO) until you feel OK about the position. If Elevations are on, you will be given Cut or Fill values based on the slope between the points.

✎ *Another way to start the Stake to a Line routine is to press* STAKE NEXT NEXT STKL.

Stake to a Curve

1. **Press SETUP, key in the occupied point number, and press OCPY.**
2. **Key in the backsight point and press BKPT.**
3. **Press STAKE, key in the PC SPC <radius point>, SPC, PT of the curve to be staked, and press FSPT.**

   If the PC is point 7, the radius point is point 8, and the PT is point 9, the display should read: 7 8 9. Press FSPT. As you take sample readings using SHOT, you will be given Go or Come distances, Right or Left distances, and perpendicular distances (PERPO) until you feel OK about the position. If Elevations are on, you will be given Cut or Fill values based on the slope along the curve from the PC to the PT.

Stake to a Curve Another Way

KEY: STKC

PRODUCT: ACE or above

KEYSTROKES: STAKE NXT NXT STKC or STAKE FSPT

This procedure allows you to take shots and find out how close you are to a curve. It also interpolates the elevation along the curve between the PC and PT points to create a grade elevation at any point along the curve.

Procedure

STKC prompts for the PC, RP, and PT. Enter the point numbers separated by spaces and press ENTER.

You are now ready to take a shot near the curve.

Once you press SHOT and the measurement is taken, you will get a screen display similar to the figure below.

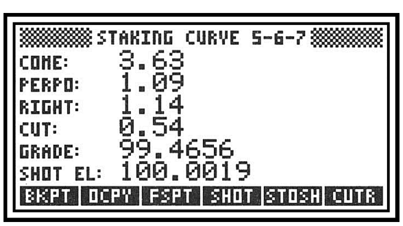


Figure 6-8 Stake to a Curve Measurement

This screen indicates that the curve you are staking is defined by points 5, 6, and 7. The first shot is 1.09 feet away from the curve (PERPO). To stake the curve, the rodman can move toward the instrument 3.63 feet or move 1.14 feet to his right. The grade is the elevation on the curve perpendicular to the shot. The rodman should measure over 1.14 feet to his right as he faces the instrument, and the instrument man should take another reading.

The keys in the Stake to a Curve menu work just like the keys in the main Stake menu (STAKE). See *Stake* on page 354 for more information about these soft keys.

Stake to Points in the Random Points File

1. **Press RPTS, key in the point numbers you wish to stake, and press ENTER.**
2. **Press STAKE and ➦ FSPT.**

   You will be given the angle and distance to get to the first point in the Random Points file.
3. **Press SHOT to take sample readings.**
4. **When finished staking the first point, press ➦ FSPT to stake the next point in the Random Points file. To increment backward in the Random Points file, use ↰ FSPT.**

Staking Shortcuts Using the RPTS Menu

There are a couple timesaving functions in the Random Points file (RPTS) that are designed to automate the staking routine. One is the Note Search function in the RPTS menu and the other is the STAK key in the RPTS menu. These functions can be used separately or in conjunction with each other to make the staking of points more streamlined. In this example, you will use them in conjunction with each other.

✎ *This function searches the points entered in the Random Points file and builds a new Random Points file based upon the note you want to stake.*

STAK

The STAK function searches the Random Points file for points within a given distance from the occupied point. The resulting Random Points file can be sorted by distance or direction (angle).

As an example, suppose that you want to stake all the IPS (Iron Pin Set) points in sequence from your occupied point 4. You should go to the RPTS menu and enter the points or range of points to be staked. In this example, you will enter a range of points and let the software pick out the IPS points.

1. **Press the RPTS key and enter `1.10`, then press the ENTER key.**
2. **Press the NXT key twice and then NOTE.**

   You are prompted for the note to search for.
3. **Type `IPS` and press ENTER.**
4. **Press the RPTS key again.**

✎ *Note that the Random Points file has been changed to include only (1,2,8,9, and 10), the points that have the note IPS.*

Next you will stake all the points within 500 feet of the occupied point.

5. **Press the RPTS key and press the ENTER key, since you already have the IPS points listed.**
6. **Press the NXT key twice and then STAK.**

   You are prompted to enter the maximum distance to stake.
7. **Key in `500` and press ENTER.**

   You are prompted to choose whether to sort by distance or angle.

8. **Answer** YES **to “**`Sort by Distance Instead of Angle`**.”**

   If you want to sort by angle, answer `NO` and it will begin with the point closest to the last staked angle. Since you are staking using the Distance mode, the program will stake the points in order of their distance away from the occupied point. In this example, your new Random Points file will be (8,9,10,1, 2).

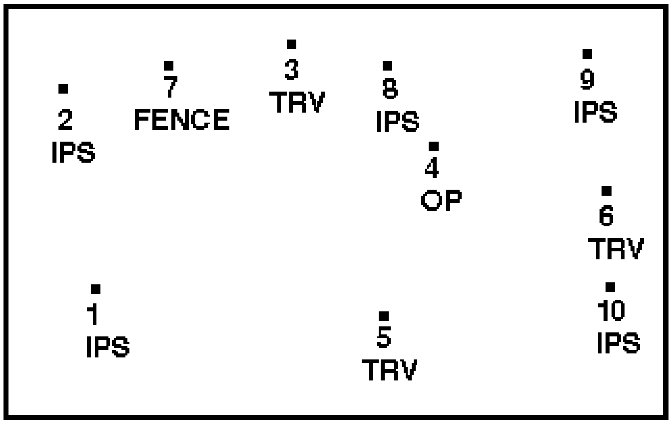


Figure 6-9 Stake Points Example

Find Points Within a Range

Find the points that are within a certain range of the occupied point and stake them.

1. **Press** RPTS **and key in the points through which you want to search.**

   Blank points will be ignored.

2. **Press** ENTER NXT NXT **and** STAK **.**

   You are prompted for the maximum distance to stake.

3. **Key in a distance (e.g.,** `300`**) and press** ENTER **.**

   You are prompted:

   `Sort by Distance Instead of Angle`

4. **For Distance, press** YES **; for Angles, press** NO **.**

5. **Press** RPTS **.**

   You will see the points that were within the specified distance.

6. **Press** ON ON **to exit. You are ready to press** STAKE **and use** FSPT **to stake each point.**

Staking by Station (STA) and Offsets

Located in the Stake menu, press **STAK** **NXT** **NXT** then **LINE** and **CURVE**. (Depending on the program you are running, you might only have to press **NXT** once to see the **LINE** and **CURVE** keys.)

It is possible to stake individual lines and curves by station and offset without a ***CVC*** (***Construction Five***) program. The ***CVC*** program adds the ability to define a series of lines, curves, and spirals in horizontal control, vertical control, and templates. See *Construction Five*, which begins on page 151, for information on how to use the ***CVC*** program.

Line Stakeout

Press **STAKE** **NXT** **NXT** and **LINE**. You are prompted for the Beginning Point (BegPT), Beginning Station (BegSTA), and Ending Point (EndPT). Enter these values separated by a space and press **ENTER**.

The very top of the screen will show the station and offset. Below is shown the elevation, backsight, occupying point, station, then the next number. To stake it out, follow the distance and right angle information.

Curve Stakeout

Press **STAKE** **NXT** **NXT** or **STA** in the third Curve menu. You will be prompted for the Radius, Delta, and Beginning Station (BegSTA). Remember to enter each piece of data separated by a space and press **ENTER**.

Note that if the curve is going to the left, the radius will need a "-" in front of it.

The information on the display will resemble that given for *Line Stakeout* above.

Multiple Sets of Angles to Multiple Points

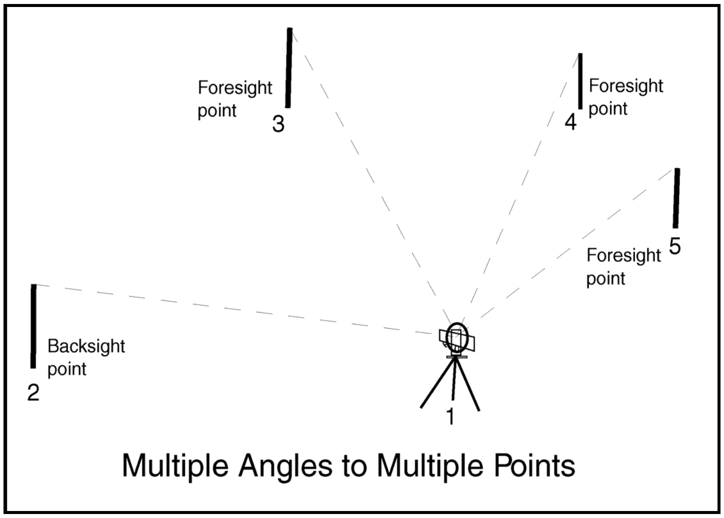


Figure 6-10 Multiple Angles to Multiple Points

Press SETUP NXT and **SHOTS**.

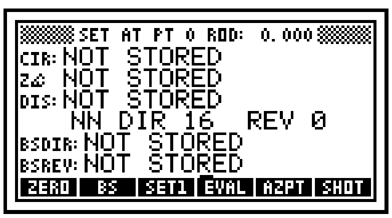


Figure 6-11 Shots Menu

With ***SMI's Advanced COGO*** and above, there are two methods of taking multiple angles. This increases accuracy by averaging multiple shots.

Multiple Angle Method 1

1. **Set up on a known point.**
2. **Enter the Shots menu found under SETUP NXT. Or use the shortcut: ↱ ← (backspace).**
3. **Zero on the backsight and press BS.**

✎ *In Manual mode, you will be prompted for the Zenith and Right Angles.*

4. **Turn to each foresight point and press SHOT.**

✎ *In Manual mode, you will be prompted for the Slope Distance, Zenith Angle, and Right Angles or Circle. Remember to enter these numbers separated by a space.*

You can have one or many foresight points.

5. **Flop the scope and take reverse readings (by pressing SHOT) as you return to the backsight, where you press BS.**

   Example: If you shot the points in the order of backsight point, 6, 7, 8, after you flop the scope, your reverse order should be 8,7,6, backsight.

Multiple Angle Method 2

1. **Set up on a known point.**
2. **Enter the Shots menu found under SETUP NXT. Or use the shortcut ↱ ← (backspace).**
3. **Zero on the backsight and press BS.**
4. **Flop the scope and press BS again.**

✎ *In Manual mode, you will be prompted for the Slope Distance, Zenith Angle, and Right Angles or Circle. Remember to enter these numbers separated by a space.*

5. **Turn to each foresight point and take a shot in the reverse and direct positions before you go to the next foresight point. You may be prompted to key in a point number before you press SHOT.**

✎ *The **SMI** software detects whether the instrument is direct or inverted automatically.*

6. **Press SET1 and it will increment to SET2.**
7. **Repeat Method 1 or 2.**
8. **Take all of the sets you desire; go to any set by keying in a set number and pressing the SET key (1, 2, 3, etc.).**
9. **To evaluate the set, press EVAL.**
10. **In the EVAL menu, press SHOW and the angles to each point will be displayed. Press SHOW again to see the angles for the next point. To see a specific point number, key in the point number before pressing SHOW.**
11. **To find the error, press ERROR. Press ERROR again to see the error for the next point. To see a specific point number, key in the point number before pressing ERROR.**
12. **Reshoot any point in any position of any set by keying in the proper set number and pressing the SET key (1, 2, 3, etc.), turning the instrument to the proper face position (direct or reverse) and keying in the proper point number before pressing STPTS.**
13. **When satisfied with the results, press STORE in the EVAL menu.**

    The meaned point(s) will be stored as side shots. If you wish to traverse to one of the stored points, key in the point number and press ↱ PTRA (the R key). If there is only one point being stored, you will be asked to indicate whether it is a side shot or traverse point.

If some readings have been taken but not stored, pressing SETUP NXT SHOTS will not clear the old values. To clear old values, press SETUP NXT ↱ SHOTS.

Once the points have been stored, pressing SETUP NXT and SHOTS clears the old shots data. If you wish to retain shots data in variables after shots are stored, press SETUP NXT ↰ SHOTS.

This is a very time-consuming process if you do not have a ***DCE*** or above program. Upgrade today from your ***SCE*** or ***ACE*** program and make work easier.

Shots Routine Using an Instrument

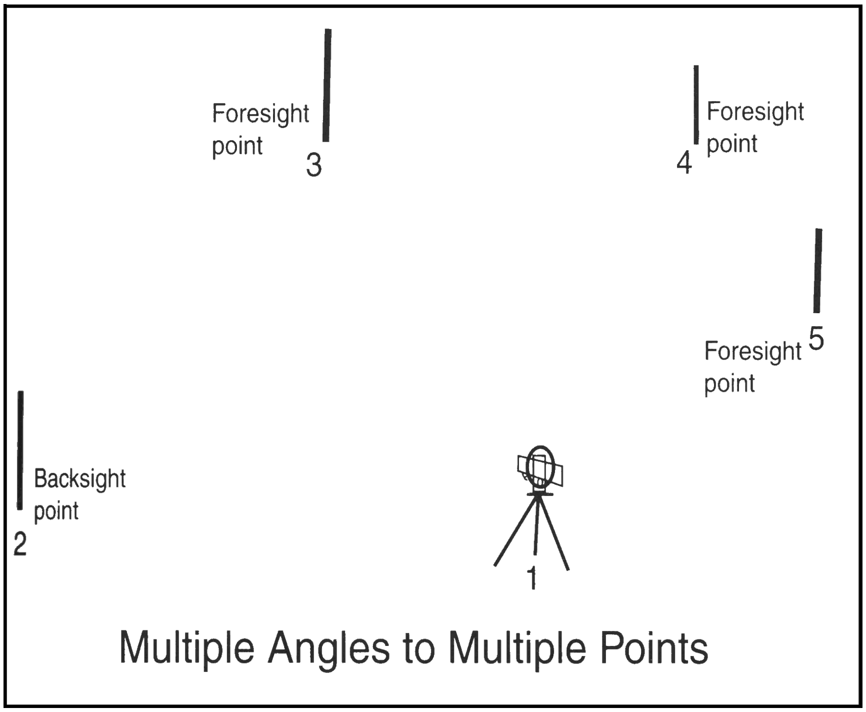


Figure 6-12 Multiple Angles to Multiple Points

In the above illustration, you are occupying point 1, backsighting point 2, and taking readings on points 3, 4, and 5. It is assumed that you have created a job and points 1 and 2 are stored.

1. **Press SETUP 1 OCPY 2 BKPT.**
2. **Press NXT SHOTS.**
3. **With the instrument in the direct position, sight the instrument on the backsight point (2).**
4. **Zero the instrument (optional).**
5. **Press BS (if you zeroed on the backsight point, this is optional).**
6. **Sight the instrument on point 3 and press SHOT.**
7. **Sight the instrument on point 4 and press SHOT.**
8. **Sight the instrument on point 5 and press SHOT.**

✎ *The minimum number of foresight points is one. For example, you could have stopped at point 3 in this example. There is no limit to the number of foresight points that can be used. Press* SHOT *on each point until you are finished. You are using three foresight points in this example.*

9. **Reverse the scope, sight the instrument on point 5, and press SHOT.**

10. **With the instrument reversed, sight the instrument on point 4 and press SHOT.**

11. **Sight the instrument on point 3 and press SHOT.**

12. **Sight the instrument on point 2 and press BS.**

    You have finished set 1. To take another set, key in 2 and SET1, or just press SET1 and the soft key will increment to SET2. You are now ready to repeat the steps for set 1.

13. **Point the instrument in the direct position and sight the instrument on point 2 and press BS.**

14. **Sight the instrument on point 3 and press SHOT.**

15. **Sight the instrument on point 4 and press SHOT.**

16. **Sight the instrument on point 5 and press SHOT.**

17. **Reverse the scope, sight the instrument on point 5, and press SHOT.**

18. **With the instrument reversed, sight the instrument on point 4 and press SHOT.**

19. **Sight the instrument on point 3 and press SHOT.**

20. **Sight the instrument on point 2 and press BS.**

    You have taken two sets. If you wish to take more sets, repeat the procedure described above, except the next set will be set 3, then set 4, etc. You will stop at set 2 in this example.

21. **To evaluate the set, press EVAL.**

22. **Press SHOW.**

    The angles to each point will be displayed.

23. **To see a specific point number, key in the point number before pressing SHOW. To find the error, press ERROR.**

24. **Reshoot any point in any position of any set by keying in the proper set number and pressing the SET key (1, 2, 3, etc.), turning the instrument to the proper face position (direct or reverse) and keying in the proper point number before pressing SHOT.**

25. **When satisfied with the results, press STORE.**

    The meaned point(s) will be stored as side shots. If you wish to traverse to one of the stored points, key in the point number and press ↱ PTRA (the R key).

    If some readings have been taken but not stored, pressing SETUP NXT SHOTS will not clear the old values.

    To clear old values, press SETUP NXT ↱ SHOTS.

26. **Once shots have been stored, pressing SETUP NXT and SHOTS clears the old shots data. If you wish to retain shots data in variables after shots are stored, press SETUP NXT ↰ SHOTS.**

Additional Flexibility of the Shots Program

- Pressing the **SHOT** key then **SET** takes multiple direct sets without taking reverse readings.
- Zero the instrument on the backsight without taking a backsight reading.
- When taking multiple sets to multiple points, you will be prompted with the set you are on and the point number to be read next for direct and also for reverse.
- When you store the point or points and go back to the Shots program, the variables will be zeroed out; however, if you press ← **SHOTS**, ***SMI*** leaves the variables unchanged, even though the points have been stored.

Storing Elevations at Known North and East Points

A new feature in ***SMI's*** surveying cards beginning with the ***Advanced COGO*** card, is **STOEL** (storing remote elevations). It is found under STAKE and NXT.

The STOEL function is valuable for getting elevations on points in remote or hazardous places.

This program was suggested by Jirimiah Conkle of Westerville, Ohio, who expressed a need for finding elevations on a highway with heavy traffic, and for locating elevations on buildings. Jirimiah computes x and y points along the edge of pavement or the centerline of pavement, then he suggests using STOEL to store the elevations of these points. He has found this method of storing elevations with point numbers to be highly accurate.

Conditions Necessary to Use the STOEL Function

A point must be stored – north and east coordinates are all that is necessary to be stored with the point. STOEL works in ***SMI's*** Stake program. The purpose is to store an elevation with the coordinates using the horizontal crosshair on the instrument.

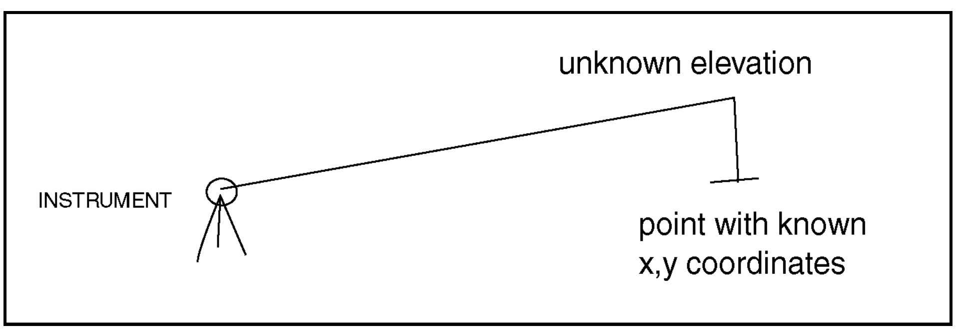


Figure 6-13 Establishing Unknown Elevation from Point with Known Coordinates

In the above illustration, the unknown elevation can be established by pointing the horizontal crosshair on the desired point if the following conditions exist:

1. **The instrument must be occupying a known point stored in the current job or a stored or unstored free station.**
2. **A good elevation must be at the instrument. One of the following methods can be used for a good elevation at the instrument:**
   A. **If the instrument point has a good elevation stored with the point number under the instrument, you can measure up from this point and enter this distance as the HI value in *SMI* under SETUP.**

B. **The best way to get a good elevation at the instrument is to take a benchmark reading on a prism at a benchmark. For this to work properly, measure the distance from the bottom of the prism rod to the center of the prism and enter this value as the HROD under SETUP in *SMI*. See *Benchmark Menu* on page 253 for more information.**

✎ *You can now get the elevation of a stored north and east point with or without a prism.*

How to Get the Elevation of a Point with a Prism

1. **Use the same prism that you used to shoot the benchmark.**
2. **Set the prism over the point and press STAKE.**
3. **Key in the point number of the point at which you want the elevation stored.**
4. **Press FSPT and turn to the prism at the point.**
5. **Press NXT and STOEL.**

   This stores the correct elevation of the point.

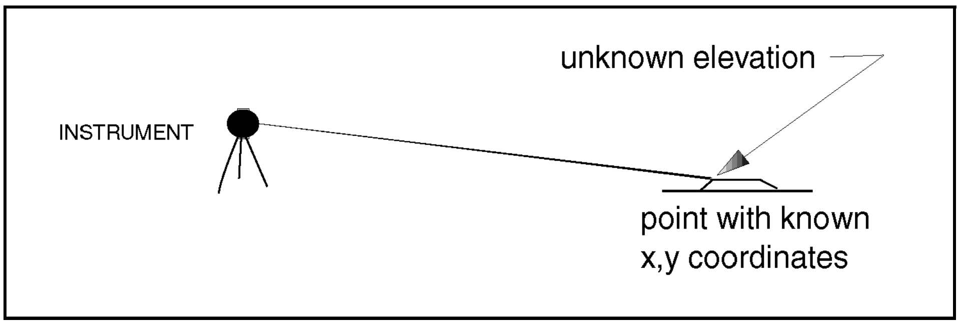


Figure 6-14 Storing the Correct Elevation of a Point

How to Get the Elevation of a Point without a Prism

1. **Measure and enter the HROD.**
2. **Shoot a benchmark.**
3. **Press STAKE.**
4. **Key in the point number of the point at which you want the elevation stored, then turn the angle specified.**
5. **Press FSPT.**

   SMI displays the angle to turn to the point.
6. **Turn the horizontal angle to the point.**
7. **Move the horizontal crosshair to the desired place for the elevation to be stored.**
8. **Press NXT and STOEL.**

   This stores the elevation of the crosshair position with the coordinates of the point.

Free Station Resection Explanation

Free Station Resection establishes an occupied point based on sighting two known points referred to as points A and B. The program works as though you were occupying A, backsighting B, and traversing to a third point (the instrument position). Therefore, the more accurate position should be A.

Point B can be considered a good backsight point from A (on the line from A). If the Scale option is used, a scale factor is applied, giving A and B equal weight. If you are using State Plane Coordinates, the instrument position is a State Plane Coordinate and future shots from this free station position will be stored as State Plane Coordinates.

✎ *The lowest card available with 2PFS is ACE V6. References to slope staking or station and offset or cross-sections may only be available in **Construction Five**.*

SMI's Resection program has always been a true Free Station program with a high degree of accuracy, without a need to be concerned with the strength of the triangles. However, just as you would not want a short backsight, you would want to avoid too short a distance been the two control points from which you are free stationing.

Free Station Resection Example

Go to the field and arbitrarily level your instrument over an unknown position in view of points 1, 3, and 5 (the PI), which are existing points.

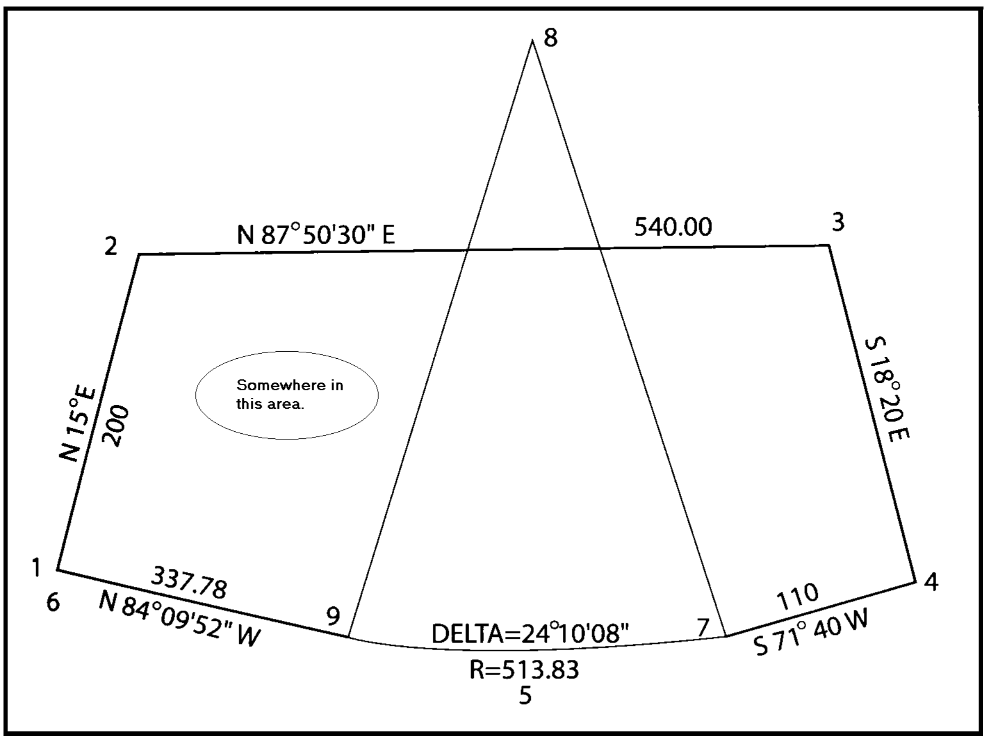


Figure 6-15 Free Station Resection

1. **Sight the prism at point 1. This will be the Direct A shot. Key in `1` and press [➦] [DEL] (shortcut for [2PFS]) and press [A DIR]. If you are prompted for "`POINT A`," key in `1` and press [ENTER].**

   Here are the field angles and distance (in the circled area in the drawing above) from the instrument to point 1 where the prism is sighted:

   Slope Distance: 202.47

   Zenith Angle: 89°30'

   Circle: 0°00'00"

2. **Key in** 202.47 SPC 89.30 SPC 0 **and press** ENTER.

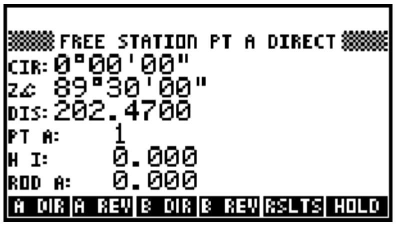


Figure 6-16 Free Station Point A

Now the rodman takes the prism to point number 3.

3. **Key in** 3 **and press** B DIR.

   This is the B Direct information from the gun while shooting the prism at point number 3.

4. **Key in the instrument data:** 426.30 SPC 90.45 SPC 180.1303 ENTER.

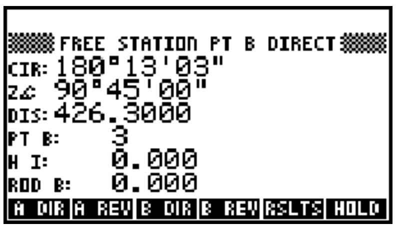


Figure 6-17 Free Station Point B

5. **Press** RSLTS.

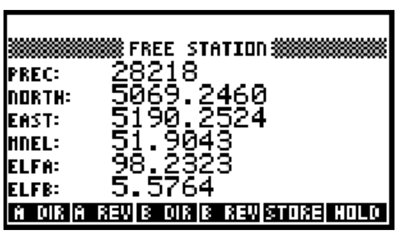


Figure 6-18 Free Station Precision

You see a good precision (PREC: 28218).

✎ *The precision is the distance between the control points divided by the error. With a precision of 28218 you would expect to be off 1 foot if you travelled 28218 feet.*

✎ *The higher this number is, the more precise your work is. If you see a small precision such as from 1 to 10, you did something wrong. Less than 1000 means that the work is not very good. Greater than 10000 is normally acceptable. Greater than 40000 is great. Greater than 100000 is luck.*

If the NN is 15, press STORE, and point 15 will be stored. Or key in 15 before pressing STORE, which ensures that the coordinates will be stored at point 15.

✎ *Storing the free station point number is optional. Even if you do not store the point, the coordinates are still occupied by **SMI** so that you can stake or collect from this instrument position. However, if the point is not stored by point number, when you traverse, occupy another point, or perform a free station resection again, the free station coordinates are lost. In many instances, you will not want to clutter your point numbers with free station points. The purpose of free stationing is not normally to find the instrument position, but to use the instrument position to collect or stake other points.*

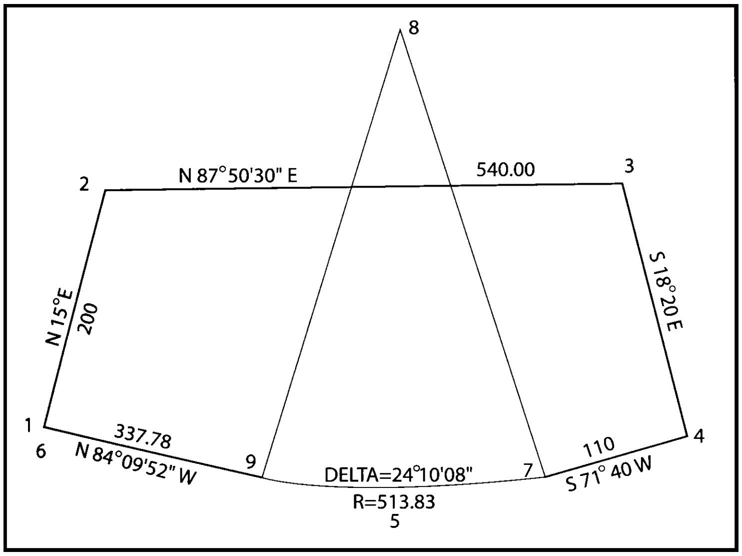


Figure 6-19 Free Station Illustration

Using Points 1 and 5 as Control Points

Keep the old reading to A (point 1) and give B a new point number and new data.

To reenter the program without losing the previous data entered, press **NXT**. Now enter new information for B.

✎ *If you leave the program and go back by pressing* **NXT** *then* **2PFS**, *the previous data entered to the points is lost. However, the point numbers that define A and B are not lost.*

1. **Key in** `5` **and press** **B DIR**.
2. **Key in** `279.82` **SPC** `89.10` **SPC** `24.13` **and press** **ENTER**.
3. **Press** **RSLTS**.
4. **Press** **STORE**.

   Point 16 will be stored.

   Check the inverse between 15 and 16.
5. **Key in** `15` **ENTER** `16` **and press the** `P-P` **key.**

   You get .0007 ft., which is very close.

Free stationing to a third point is a good way to check the first two points. Another way to check for a good instrument position is to stake to a known point.

✔ ***When doing free station resection, it is possible to reverse points A and B and still get a great precision. If this happens, your instrument position will not even be close. For this reason, check yourself by staking to a third point or resecting to a third point.***

Mean points 15 and 16 just for practice:

1. **Press** RPTS.
2. **Key in** `15` SPC `16` **and press** ENTER.
3. **Press** NXT.
4. **Press** MEAN.
5. **Press** STORE.

   The mean will be stored at point 17. This is the point you will want to use if you need to access points 15 or 16.

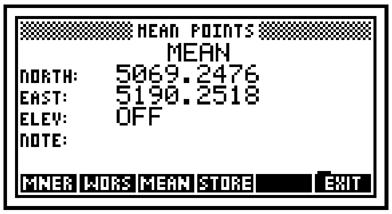


Figure 6-20 Mean Points Screen

✎ *You can also stake to a point, a line, or a curve from the free station point. This means that you will not have to set up on a known point to do your staking work. This will save you the time of setting up your instrument right over a point that might be difficult to find in the first place.*

Data Collection

CHAPTER

7

This chapter is for users of the following cards:

- Data Collection
- Construction Five
- GPS/Robotic

In this chapter:

Key Definitions

Key	Function
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
Hard Keys	Hard key functions are imprinted on each key itself. The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card. **Hard keys are represented in this manual as black lettering on a gray, rectangular background.**
Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

SMI Works with all Current Electronic Total Stations

SMI works with all current instruments and almost all discontinued models. ***SMI*** does not work with two older Nikon instruments: DTM1 and DTM5, since these were not equipped with standard serial ports. ***SMI*** does not work with some Topcon ET1 models. ***SMI*** requires a special “old style cable” to work with Topcon’s GTS3, which has no serial port. This special cable works with the battery port.

Various electronic total stations can be selected in the ***SMI*** software under SETUP NXT NXT and INST. Most instruments allow the user to choose between Fine and CRS modes (SETUP NXT NXT INST). The shortcut for both the instruments and the Fine and Coarse modes is ↱ × (multiplication key). When you enter this menu, the instruments are listed under the manufacturer’s name. To find your specific model, press the NXT key until your make appears on one of the soft keys.

The electronic total station list includes:

- **Topcon**: all electronic models with serial ports fall under one of these:

  GTS3, GTS4, CTS-1, or ET-1

  Some older Topcon GTS3B instruments did not have a standard serial port. For these you will need what ***SMI*** refers to as an “Topcon old style cable.”
- **Lietz**: all electronic models with serial ports fall under one of these:

  Lietz or Sokkia
- **Nikon**: NIKN selects all current electronic models with serial ports.
- **Leica**: all electronic models with serial ports fall under one of these:

  WILD1, WILD2, 2002, OLD TC, TC, REFL, and TCM
- **Zeiss**: all electronic models with serial ports fall under one of these:

  Z46R, ELTA3, ELTA4, ELTRL, and ELT50
- **Geodometer**: all electronic models with serial ports fall under one of these:

  GEO, GEO4, G420, RPU
- **Pentax**: all electronic models with serial ports fall under one of these:

  PENT, PNT2, 2WAY
- **Trimble**: All electronic models with serial ports fall under one of these:

  TTs, 3300, 3600, 5600

Many times, a driver will work with more than what is listed here. Experiment a little if your specific model is not listed here. If you have experimented with many different drivers and still are unable to get your instrument to function, please call the SMI office and ask for technical support.

Other:

- **Kern**: KERN selects all KERN electronic models with serial ports.
- **HP 3820**: 3820 selects each HP 3820 model.
- **Laser Atlanta**: LASER selects each Laser Atlanta model.
- **Criterian:** CRIT selects each Criterian model.

GPS and Robotic Instruments Require the GPS/Robotic Surveying Card

SMI is the only supplier at this time of HP 48 software for GPS real-time kinematic dual frequency receivers. SMI is also the only supplier of HP 48 software for robotic total stations.

GPS Works with SMI

GPS receivers supported at this time include Allen Osborne, Leica, Ashtech, and Javad. The goal is to work with all GPS units.

DCE Plus GPS/Robotic

Currently, SMI supplies a special GPS/robotic card that includes all COGO and data collection capabilities. That is, it contains all COGO functions, plus it works with the electronic total stations and stores raw data.

CVCE Plus GPS/Robotic

SMI also supplies a special GPS/robotic surveying card that contains all ***SMI COGO***, ***Data Collection*** and ***Construction Five*** features.

See *Robotic Functions*, which begins on page 195 for further information and documentation regarding SMI's GPS/robotic surveying cards.

Electronic Data Collection

In previous chapters, you were given examples where [SIDS] [TRAV] and [SHOT] were pressed and you were prompted for Slope Distance, Zenith Angle, and Angle Right.

This chapter is devoted to SMI's ***DCE*** surveying card and ***CVCE*** surveying card capabilities. When you are in the field with these cards, and you have selected the instrument you are using, press [SIDS] [TRAV]. You will automatically get the Slope Distance, Zenith Angle, and Horizontal Angle from the instrument as though you had keyed in these values.

✎ *To select your instrument, press [SETUP] [NXT] [NXT] [INST] and choose the manufacturer, then choose the model (or use the shortcut to the instruments: [↱] [×] (multiplication key).*

Flag i Indicates Whether the Instrument is Active

Flag i is displayed to the left of SMI if you have chosen an instrument. If you have chosen your instrument and wish to enter data manually, it is not necessary to switch to MAN1. You can press [←] 5. This toggles to MAN1 mode. When you do this, the “i” flag will disappear.

Now go through a trial run with your ***DCE*** card. Using a sample surveying job, you will learn how to:

- Create (and back up) a job
- Turn on/off Elevations, notes, and raw data
- Select an instrument
- Traverse points
- Take side shots
- Check distance and angle closure
- Perform angle and compass rule adjustments
- Compute area
- Rotate and translate coordinates

Your ***SMI*** surveying card stores points and coordinates by job. This feature lets you keep multiple jobs stored in your data collector at the same time.

Before you try this example, you should have already installed your ***SMI*** surveying card (see *Getting Started*, which begins on page 17).

Create a New Job

1. Press [JOB].

You will see the following screen.

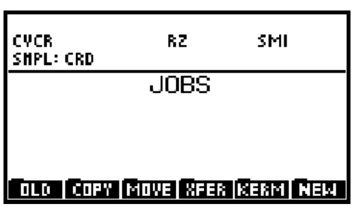


Figure 7-1 Jobs Screen

2. From the soft key menu, press NEW.

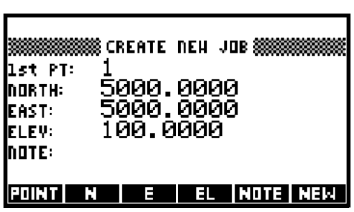


Figure 7-2 Create New Job Screen

You will now have the option of changing the beginning point number or coordinates of point 1 in the new job. Elevations are on, so you could change the elevation of point 1. Whether notes are on or not, you can give a note for point 1. Some surveyors like to give the job name for the note for point 1 so that whenever the ASCII point list is printed, you know the job name from the first point description.

As an example, you will change the east coordinate to 10000 and you will put a note of YOUNG for point 1.

3. Key in `10000` **and press** **E**.

4. Press **NOTE**, **key in** `YOUNG`, **and press** **ENTER**.

The screen will look like the figure below.

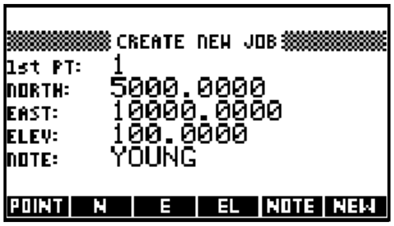


Figure 7-3 Point 1 Note

By pressing **NOTE**, alpha was turned on and you were prompted for a note.

✎ *If you are willing to accept the default coordinates and no note entry for point 1, you simply press* **JOB** **NEW** **NEW**.

5. Press **NEW**.

The display will show NEW JOB? and the cursor will flash at the bottom left of the display.

Note that the alpha symbol appears at the top of the display. This indicates that pressing a letter key will type the actual alpha character, instead of the function assigned to that particular key.

Letters G-Z are labeled in red on the overlay to the right of their corresponding keys. To type letters A-F, use the soft keys above the overlay.

6. For your sample job, type `YOUNG` **and press** **ENTER**.

You will see:

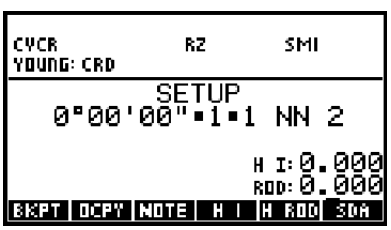


Figure 7-4 Setup Screen

Note that YOUNG:CRD indicates the job name and CRD indicates that the YOUNG job is being stored in the RAM card memory. If no RAM card is installed, you would see YOUNG:48M, indicating the job is stored in the data collector's memory.

Also notice that the setup screen also includes the display:

`0° 00'00"-1-1 NN 2.`

The first number, 0° 00'00" is the back azimuth, or back point. Normally, it will be the backsight point number. The second number, 1, is the occupied point number. The third number, 1, is the last point stored or staked.

At this stage, you have no backsight point or foresight point stored. Thus, your backsight is set to 0 degrees, and your foresight is the same number as your occupied point.

NN 2 means next number 2, indicating that the next point number to be stored will be point 2.

Notes, Elevations, and Raw Data

When you installed your ***SMI*** surveying program, the notes and prompts were not activated. This means that your data collector will not prompt you for a reference note for each point stored. To turn this function on, press CHG. This first page of the Change menu is where you can toggle off and on the flags at the top of the display screen. Or you can press the Shift Left shortcuts.

At the Change/Default menu, you will see raw, elevation, and notes shown as soft keys.

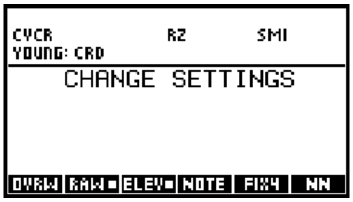


Figure 7-5 Change Settings Screen

These are toggle keys; to turn on an option, press the appropriate soft key. A highlighted box will appear in the soft key to indicate that the function has been selected, or turned on. To toggle the function off, press the key again.

OVRW, **RAW**, and **ELEV** are two-way toggles, but **NOTE** is a four-way toggle. Each time you press this soft key, you get a different soft key. It toggles as follows: **NOTE** / **AUTO** / **LNTE** / **NTBL**.

For example, press **NOTE**. The soft key will change to **AUTO**:

PROMPTING OFF, WILL STORE LAST NOTE.

Press **AUTO** and you get **LNTE**. The display will read:

PROMPTING WITH LAST NOTE.

Press **LNTE** and you get **NTBL**. The display will read:

PROMPTING WITH NOTE TABLE

Press **NTBL** and you get **NOTE**. The display will read:

PROMPTING OFF, WON'T STORE LAST NOTE

Shortcuts to the Above Functions

- Use 2 to toggle raw data on or off.
- Use 3 to toggle Elevations on or off.
- Use 4 to toggle note options.

(See *Overlay Shortcuts* on page 19 for a complete list of shortcuts to functions.)

For this example, leave on PROMPTING WITH LAST NOTE.

The display includes flags (next to USER / SMI) to indicate which of the following data collection features are selected and currently active:

O - will not warn before overwriting a point

R - raw data on

Z - Elevations on

N - notes on

I - (for instrument) electronic data collection selected

If the above number is not displayed next to SMI, this means the feature is not selected.

Selecting Your Instrument

1. Press SETUP NXT NXT and then the INST soft key or use the shortcut ↱ × (multiplication key).

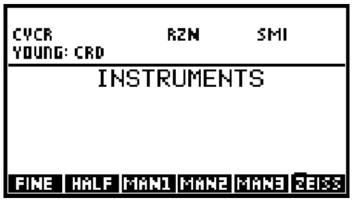


Figure 7-6 Instruments Screen

At the instruments screen, the soft keys allow you to choose manual data entry (MAN 1 or MAN 2) or the specific instrument you will be using.

2. You can press NXT to scroll through the soft key menu for additional instrument choices.

Figure 7-7 Instruments Screen with Additional Soft Keys

First, choose the brand name. This will take you to a submenu of the types of instruments. Find your instrument. If one choice does not work for your instrument, try another. In some cases, you may need to change the baud rate or parity in your instrument. See *Instrument Configuration*, which begins on page 383, for more information.

For example, to select Topcon, press TOPCO and GTS3 . To select Nikon, press NIKN . If you see a delay time, press ENTER .

✎ *If a `delay time` prompt appears, the number that appears is the default and it is always best to press* ENTER *to accept the default.*

When the instrument is selected and ***SMI*** returns to the setup screen, you will notice that i appears at the top of the display. This indicates that an instrument has been selected for electronic data entry.

Your ***SMI*** program supports almost all of the electronic instruments on the market today.

Connect the Data Collector to Your Instrument

Connect the instrument cable to the data collector or hard case and you are ready to begin collecting data. This is how job data is transferred between your electronic instrument and your data collector.

Trial Run with Data Collection

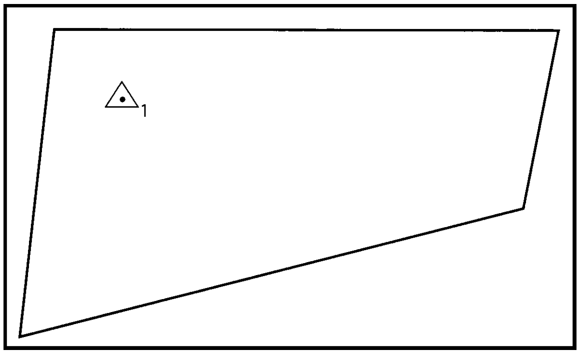


Figure 7-8 Data Collection Example

This practice example was conducted in the field using the ***DCE*** card, an HP 48, and a total station. The HP 48 screens in this section show the actual data collected and the points stored. Please use this data as a working reference only to help you become familiar with the operation of your program card; of course, your field results will be unique to your job.

If you would like to follow this example using the actual raw data that was gathered, switch from electronic to manual data entry by pressing 5 so you will be in Manual mode and the "I" at the top of the display is not there; then key in the raw data (found later in this chapter) for each point.

Establish and occupy your first point

1. **Set up your instrument in the field over a known point, identified as point 1. (Or mark a point with a hub and tack.)**
2. **Next, point the instrument at a backsight point and zero the instrument. For most instruments, you can zero the instrument from *SMI* using SETUP NXT and ZERO (or use a shortcut by pressing then the 0 number key).**
3. **This is an optional step. It places the backsight bearing in the raw data. Press SETUP NXT NXT BKBR (back bearing) soft key.**

   If you know the direction to the backsight, key it in. In this example, assume that direction to be S 15' W. So, key in 15 and press ENTER.

   The display then prompts you with: QUADRANT?

   Key in the quadrant number – in this case, 3 (for SW) – and press ENTER.

   The display will then return to the setup screen.

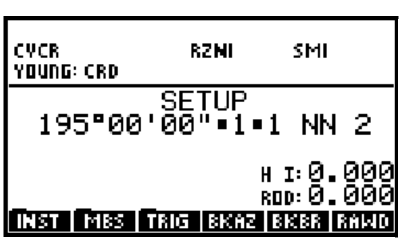


Figure 7-9 Setup Screen

Next, take a shot on the backpoint (point 2).

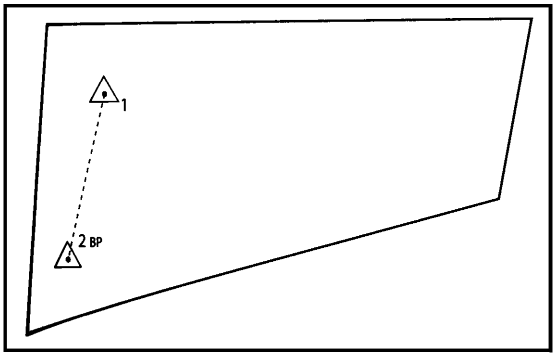


Figure 7-10 Taking a Shot on the Backpoint

4. **Put the rodman at point 2; mark point 2 with a hub and tack (or nail) and point the prism.**
5. **To take a side shot, press SIDS (the H key).**

   The display will read:

   `MEASURING`

   The instrument will take the reading and prompt with: `NOTE FOR POINT 2.`

   You may use up to 256 characters for your note. This may include an abbreviated description or a code to help you identify this point. This is where you might enter a code that your PC program needs to perform an auto-draw function. See the note tables in the ***Transfer Version 7*** manual for a better description of this feature.

6. **For manual entry, you will need to key in the following after pressing SIDS:**

   `0` ∆ RT

   `93.2535` Z∆

   `96.22` SDIST

7. PT **for point will already be on the display. If you press the backspace key (◀) twice, this will be removed. Now key in** BKPT **(or any note you wish) and press ENTER.**

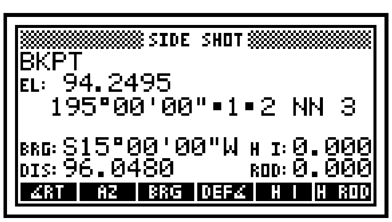


Figure 7-11 Taking a Shot on the Backpoint

The program will return to the side shot screen with point 3 shown as the “next number” to be stored.

Turn to the next point (to be stored as point 3).

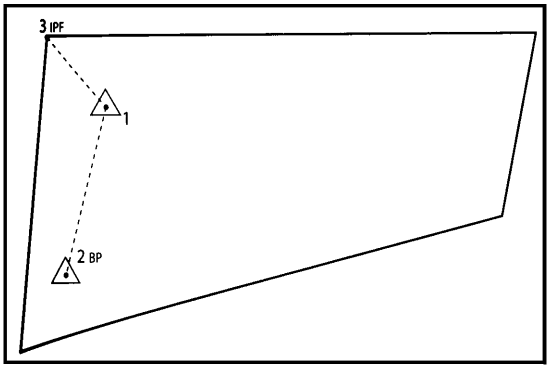


Figure 7-12 Turning to the Next Point

The next point is an iron pin on the corner of the property; shoot this as a side shot. Put the rodman on point 3 and point the prism.

8. Press SIDS (side shot).

The instrument will take the reading and prompt with: NOTE FOR POINT 3. Notice that the last note put in the program is the one that appears now – "BKPT." That is because the Note program is set to "Prompt with last note."

9. For manual entry, press SIDS and then the following information:

110.4355 ∡ RT

86.0755 Z∡

38.82 SDIST

10. Press ON to clear the last note on the display, or press ◀ (the backspace key) four times.

11. Now key in IPF ("iron pin found") and press ENTER.

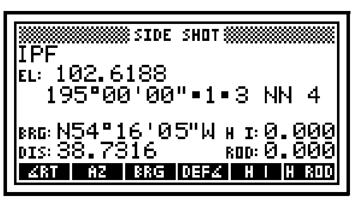


Figure 7-13 IPF Results

The display will show the results in the side shot screen, with NN (next number) now set to point 4. Note that the description you entered now appears in the upper-left corner of the display for this point.

Next, shoot a point on the fence line as a side shot (to be stored as point 4).

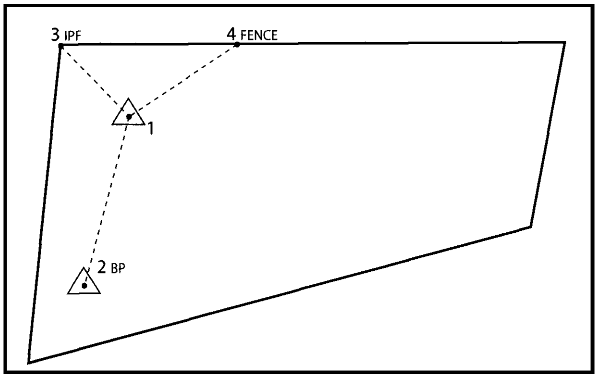


Figure 7-14 Shooting a Point on the Fence Line as a Side Shot

12. With the instrument still occupying point 1, put the rodman over point 4 (a point along the fence line).

13. Point the prism and press SIDS.

The instrument will take the reading, after which the display will prompt for a description: `NOTE FOR POINT 4`.

14. For manual entry:

`225.2305` ∠ RT

`85.4510` Z∠

`57.69` SDIST

15. Press ON **to clear the display, then key in** `FENCE` **and press** ENTER.

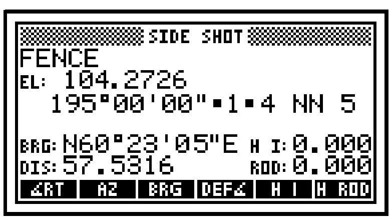


Figure 7-15 Fence Results

Note that the display shows you are still occupying point 1 with point 4 as the last point shot, and NN is now set to point 5 (195° 00” 00”-1-4 NN 5).

The example will now traverse, or move, the instrument to the next point (to be stored as point 5).

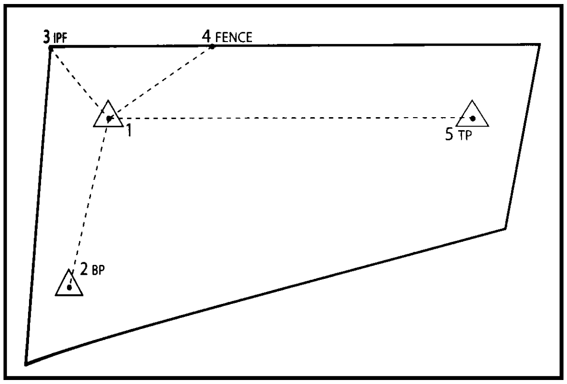


Figure 7-16 Traversing to the Next Point

16. Move the rodman to the next point (this will become point 5, the traverse point). Mark it with a hub and tack. Point the prism and press TRAV this time instead of SIDS.

The instrument will take the reading, after which the HP 48 will prompt for a description: NOTE FOR POINT 5.

17. For manual entry, press TRAV and key in the following:

248.2635 ∡ RT

90.2855 Z∡

173.95 SDIST

18. Press ON to clear the display, then key in TP **(for "traverse point") and press ENTER.**

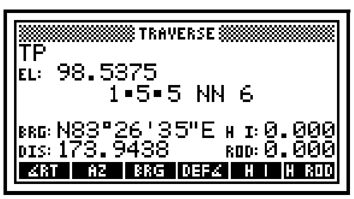


Figure 7-17 Traverse Screen

The display will return to the traverse screen, but notice that the display now shows that your occupying point is now 5, with point 5 as the last point stored. The backsight point is 1 (where the instrument used to be), and NN is point 6.

19. Move the instrument to point 5 and have the rodman move to point 1.

20. After the instrument is set up over point 5, sight the prism at point 1 and zero the instrument by pressing [↱], 0 (zero key).

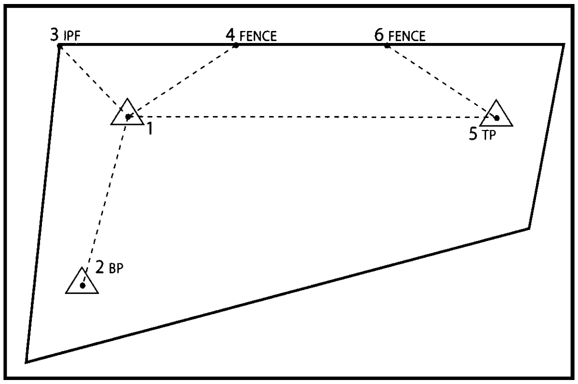


Figure 7-18 Taking Another Side Shot Along the Fence

21. Take another side shot along the fence (to be stored as point 6). Shoot a point on the fence line as a side shot.

22. Put the rodman at this point. Sight the prism and press [SIDS].

23. For manual entry, you will need to press [SIDS] to return to the Side Shot menu.

✎ *The program is still in the Traverse menu and if you key in the information below, the occupy point and backsight point will change again:*

`20.5835` **∡ RT**

`84.2735` **Z∡**

`52.46` **SDIST**

The instrument will take the reading, after which the HP 48 will prompt for a description at point 6.

24. Press [ON] to clear the display, then key in `FENCE` **and press [ENTER].**

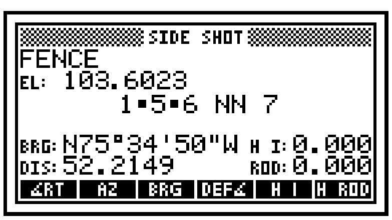


Figure 7-19 Side Shot Point on the Fence Line

The display will show the results in the side shot screen. NN now defaults to point 7.

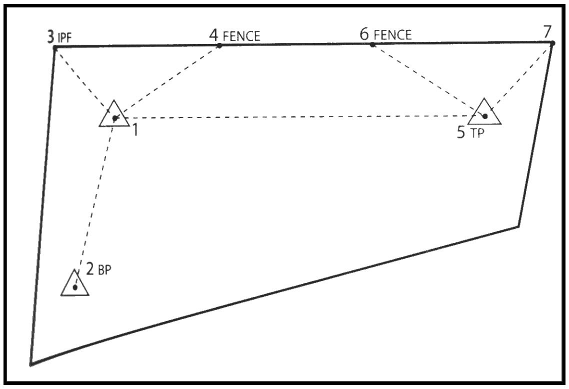


Figure 7-20 Shooting an Iron Pin Marking the Corner of the Property

25. With the instrument still occupying point 5, move your rodman to the iron pin. Point the prism and press SIDS.

26. For manual entry:

`150.3345` ∡ RT

`88.4445` Z∡

`30.13` SDIST

The instrument will take the reading, after which the HP 48 will prompt for a description.

27. Press ON to clear the display, then key in `IPF` **and press ENTER.**

The display will show the data in the side shot screen.

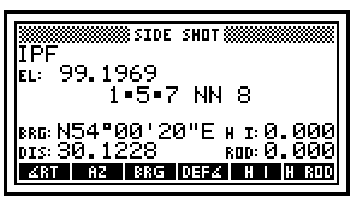


Figure 7-21 Iron Pin Marking the Corner of the Property

The screen shows that you are still occupying point 5, with point 7 as the last point stored; the NN (next number) to be stored is set to point 8.

Now do some checking. First, inverse between the first and second iron pins.

28. The iron pins are found at point 3 and point 7. To inverse between these points, simply key in `3` **SPC** `7`**.**

29. Press the P - P (point-to-point) key.

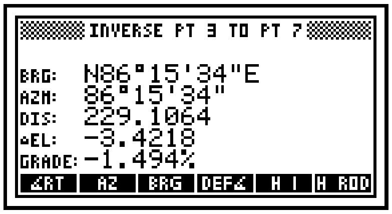


Figure 7-22 Inversing Between the First and Second Iron Pins

The display shows the inverse direction and distance from point 3 to point 7, including change in elevation and percent grade.

✎ *Since the H I and H ROD values are set to zero, the rod must be kept the same height as the instrument. Otherwise, the elevation values will not be correct. Another way to get correct elevations is to measure and enter into **SMI** the H I and H ROD values.*

Next, check to find out how far off points 4 and 6 are from the fence line by performing a perpendicular offset.

Intersections Example

1. **This exercise uses the Intersections function of your *SMI* surveying card. Press (the T key).**
2. **Key in** 3 **and press** PT1 **.**
3. **Key in** 7 **and press** POL1 **(point on line).**
4. **Since point 4 is the first point to be checked, key in** 4 **and press** PT2 **.**
5. **Press** PERPO **(perpendicular offset).**

   The display shows the distance from point 3 to point 4 (81.6621') and shows that point 4 is .4849 feet to the left of the fence line, as viewed from point 3.

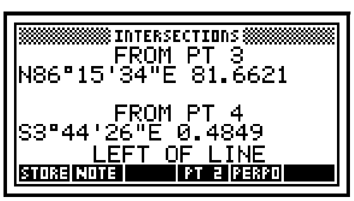


Figure 7-23 Distance from Point 3 to Point 4

Next, see how far off point 6 is from the fence line.

6. **Key in** 6 **and press** **PERPO** **.**

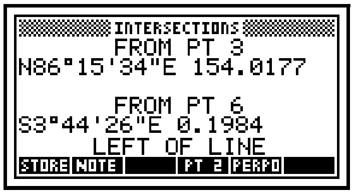


Figure 7-24 Distance from Point 3 to Point 6

The display shows the distance from point 3 to point 6 (154.0177’) and shows that point 6 is only .1984 feet to the left of the fence line.

Traverse to the next point, a corner, also an iron pin.

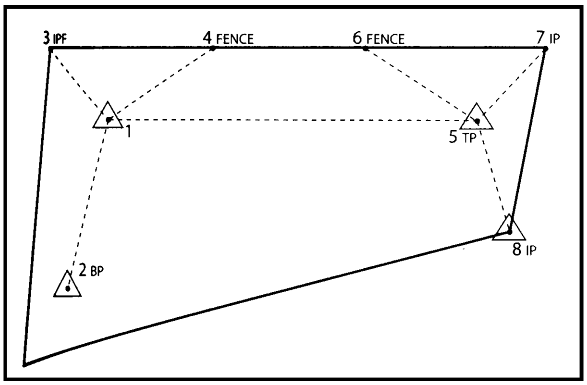


Figure 7-25 Traversing to the Next Point

7. **The instrument is still occupying point 5. Have your rodman move to the next point (an iron pin on the corner of the property), then point the prism and press** **TRAV** **.**

   The instrument will take the reading, after which the program will prompt you to type a description for point 8.

8. **Press** **ON** **to clear the display, then key in** `TP AND IRON PIN` **and press** **ENTER** **.**

9. **For manual entry, press** **TRAV** **:**

   `270.0320` **∡ RT**

   `97.4030` **Z∡**

   `69.74` **SDIST**

   The display will then return to the Traverse menu.

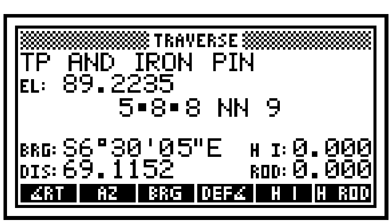


Figure 7-26 Occupying Point 8

Note that you are now occupying point 8 (with 8 as the last point stored); your backsight is to point 5.

10. Now move your instrument to point 8.

Next, traverse back to point 2.

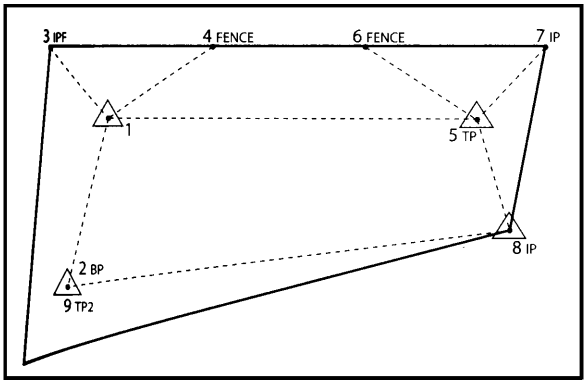


Figure 7-27 Traversing Back to Point 2

11. Move the rodman back to point 2 (this is your beginning backsight point). Point the prism and press TRAV **.**

The instrument will take the reading, after which the program will prompt for a description.

12. Press ON **to clear the display, then key in** `TP OLD POINT 2` **and press** ENTER**.**

13. For manual entry:

`264.2545` ∡ RT

`88.3305` Z∡

`210.24` SDIST

The program will display the data in the traverse screen.

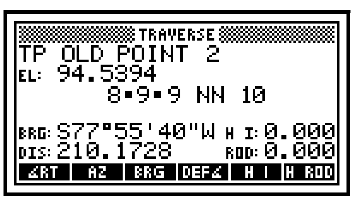


Figure 7-28 Occupying Point 9

Note that you are now occupying point 9, with point 9 as the last point stored. You are backsighted to point 8, and NN is 10.

14. Move the instrument to occupy point 9 (old point 2).

Take a side shot to the last corner (point 10).

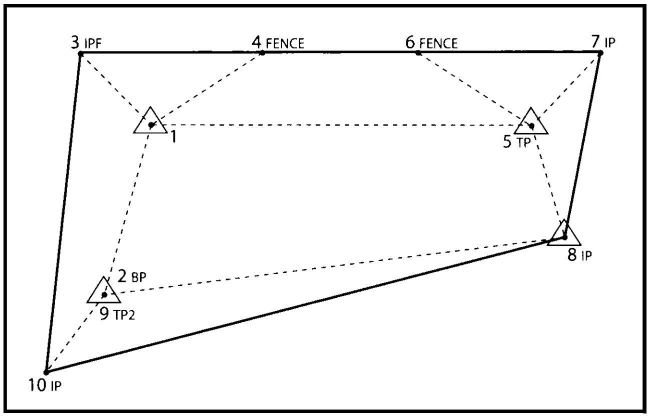


Figure 7-29 Taking the Side Shot to the Last Corner

15. With your instrument now occupying point 9, backsight on point 8 and zero the gun. Next, move the rodman to the iron pin at the corner of the property. Point the prism and press SIDS.

The instrument will take the reading. The program will prompt for a description: `NOTE FOR POINT 10`. Key in `IP` for iron pin.

16. For manual entry, press SIDS:

`131.1325` ∡ RT

`93.4255` Z∡

`40.78` SDIST

17. Press ON to clear the display, then key in `IP` and press ENTER.

The display will return to the side shot screen. The display shows that you are still occupying point 9, point 10 is the last point stored, and NN is point 11.

Figure 7-30 Taking a Side Shot to the Last Corner

Take a final side shot to point 1 (to be stored as point 11).

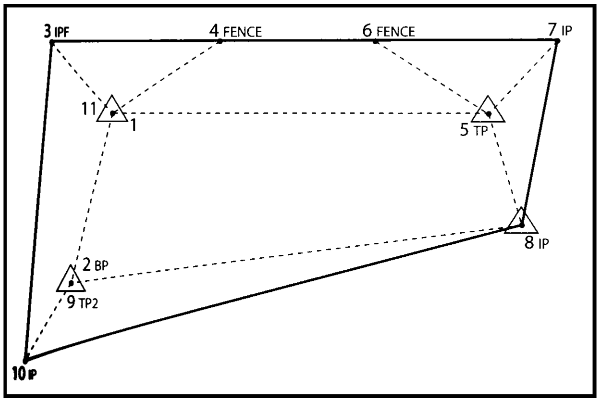


Figure 7-31 Taking a Final Side Shot to Point 1

18. For angle closure, you will want this final shot to tie in all the corners. Move the rodman to point 1. Point the prism and press SIDS.

19. For manual entry:

`297.0440` ∡ RT

`86.2055` Z∡

`96.24` SDIST

The instrument will take the reading, after which the data collector will prompt you to enter a description for point 11.

20. Press ON to clear the display, then key in `OLD POINT ONE` **and press ENTER.**

The display will show the data in the side shot screen.

Figure 7-32 Taking a Side Shot to Point 1

You are almost finished. With ***SMI***, it is also easy to check your work. You can do that now with distance and angle closure.

21. Check distance closure by inversing between point 9 and point 2. Key in 9 SPC 2 **and press the** `P-P` **key (the X key).**

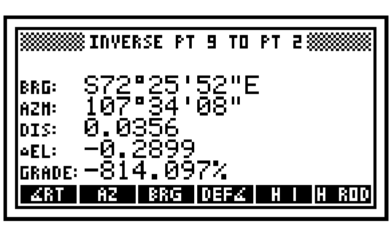


Figure 7-33 Checking the Distance Closure

Note that the distance between point 9 and point 2 is only .0356 feet. That is a good distance closure. Also note that the delta elevation is .2899 feet. This is because the rod height was not set to the same height of the instrument as surveyed.

22. You can check angle closure by inversing between points 2 and 1, and then between points 9 and 11. Key in 2 SPC 1 **and press the** P-P **key.**

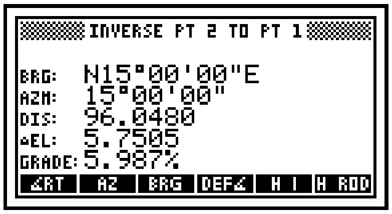


Figure 7-34 The Inverse Between Points 2 and 1

23. Now key in 9 SPC 11 **and press the** P-P **key.**

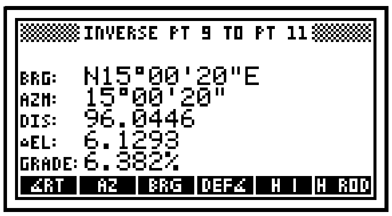


Figure 7-35 The Inverse Between Points 9 and 11

The display shows the inverse between points 9 and 11.

As you can see, the azimuths computed by the two inverses differ by only 20 seconds.

Good job!

Compute bearings and distances around the perimeter. Start with point 3 and move clockwise.

24. Press SETUP**.**

25. Key in 3 **and press** OCPY**.**

26. Key in 7 **and press** ↱ PTRA **for point traverse (the R key).**

This feature lets you traverse from the occupied point to another point in the current job.

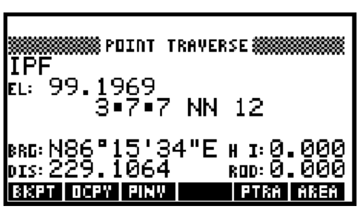


Figure 7-36 Bearing and Distance from Point 3 to Point 7

The display shows the bearing and distance from point 3 to point 7.

27. Key in 8 **and press** [↱] PTRA **, or you can press** 8 **then the** **PTRA** **soft key, since you are in the Point Traverse menu. This will save you a keystroke.**

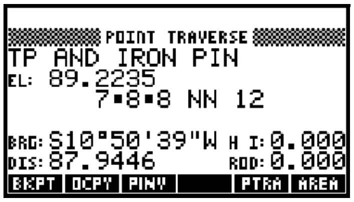


Figure 7-37 Bearing and Distance from Point 7 to Point 8

The display shows the bearing and distance from point 7 to point 8.

28. Next, key in 8 [SPC] 10 **and press the** P-P **key.**

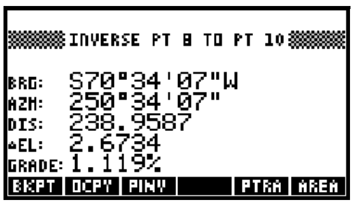


Figure 7-38 Bearing and Distance from Point 8 to Point 10

The display shows the bearing and distance from point 8 to point 10.

29. Finally, key in 3 **and press** PTRA **.**

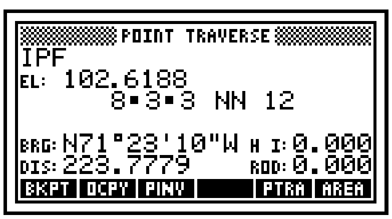


Figure 7-39 Bearing and Distance from Point 10 to Point 3

The display now shows the bearing and distance from point 10 to point 3.

Note that you can get the area now by pressing **AREA**.

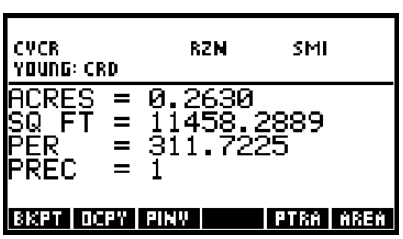


Figure 7-40 Calculating the Area

However, this is not the recommended method. To get the area, press **RPTS**. Key in 3 **SPC** 7 **SPC** 8 **SPC** 10 **SPC** 3 **ENTER** and **AREA**.

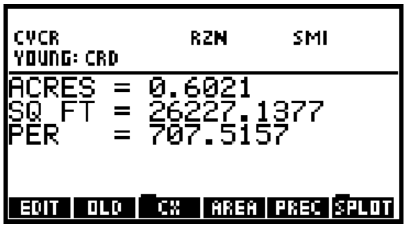


Figure 7-41 Recommended Method for Calculating the Area

The Random Point Area method is better because you can see and check your points in the Random Points file before and after you compute the area. Using PTRA makes it easy to forget to occupy the first point. This is essential because it zeros any old acreages. It is also easy to key in a wrong number using PTRA. There is no way to check it except by keying them in again.

Printout of Your Data

The data from the example was transferred to a PC using SMI's ***Transfer*** program.

Coordinates, elevations, and notes are printed by point number:

Data Printout

Point No.	***Coordinates***	***Elevation***	***Notes***
1	5000.00000, 10000.00000	100.00000	YOUNG
2	4907.22476, 9975.14095	94.24949	BKPT
3	5022.61900, 9968.55934	102.61879	IPF
4	5028.43059, 10050.01583	104.27260	FENCE
5	5019.86276, 10172.80605	98.53746	TP
6	5032.86525, 10122.23596,	103.60229	FENCE
7	5037.56610, 10197.17759,	99.19695	IPF
8	4951.19199, 10180.63179	89.22352	TP AND IRON PIN
9	4907.23551, 9975.10700	94.53936	TP OLD POINT 2
10	4871.69573, 9955.28404	91.89692	IP
11	5000.00509, 9999.97418	100.66866	OLD POINT ONE

View Function

You may also review each point using this function. The View menu key lets you view points, area, the back azimuth, or raw data. Raw data is only viewable in the ***SMI*** programs that can connect to a total station (***DCE*** or above).

View Menu 1 Soft Keys

Option	Function
NEXT	This soft key increments to the next point number.
PREV	This soft key decrements to the previous point number.
RCL	This soft key lets you recall any point number. Key in the point number and press RCL, or press RCL and you will be prompted for a point number.
BEGP	This soft key shows the values of the beginning point in the job.
ENDP	This soft key shows the values of the last point in the job.

1. Press VIEW and PNTS .

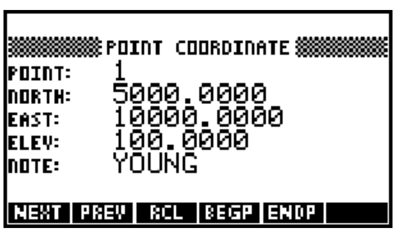


Figure 7-42 Reviewing Point 1

This shows point 1.

2. Press NEXT to see additional points.

Raw Data

Here is the raw data as stored by the ***SMI*** program:

CM Definition: SS: Side Shots; TR: Traverse; OC: Occupied Coordinates;

PC: Point Coordinates; CM: Comment; OS: Occupied Station;

TS = time stamp; e = electronic; m = manual

CM TS TUE 09/13/94 09:00:53A

PC 1 5000.00000 10000.00000 0.00000 YOUNG

SS m HI:0 HR:0 BKPT

0 1 2 BAZ:195.00000 AR:0.00000 ZA:93.25350 SD:96.220

SS m HI:0 HR:0 IPF

0 1 3 BAZ:195.00000 AR:110.43550 ZA:86.07550 SD:38.820

SS m HI:0 HR:0 FENCE

0 1 4 BAZ:195.00000 AR:225.23050 ZA:85.45100 SD:57.690

TR m HI:0 HR:0 TP

0 1 5 BAZ:195.00000 AR:248.26350 ZA:90.28550 SD:173.950

SS m HI:0 HR:0 FENCE

1 5 6 BAZ:263.26350 AR:20.58350 ZA:84.27350 SD:52.460

SS m HI:0 HR:0 IPF

1 5 7 BAZ:263.26350 AR:150.33450 ZA:88.44350 SD:30.130

TR m HI:0 HR:0 TP AND IRON PIN

1 5 8 BAZ:263.26350 AR:270.03200 ZA:97.40300 SD:69.740

TR m HI:0 HR:0 TP OLD POINT 2

5 8 9 BAZ:353.29550 AR:264.25450 ZA:88.33050 SD:210.240

SS m HI:0 HR:0 IP

8 9 10 BAZ:77.55400 AR:131.13250 ZA:93.42550 SD:40.780

SS m HI:0 HR:0 OLD POINT ONE

8 9 11 BAZ:77.55400 AR:297.04400 ZA:86.20550 SD:96.240

Make a Backup Copy of Your Job

Before continuing with additional exercises, you should make a backup copy of your job for safekeeping.

Backup copies are always a good idea. They are a way to protect your larger or more complex jobs, but they also give you a chance to experiment with computations without putting your original data at risk.

To back up your job:

1. **Press JOB COPY and choose the job you wish to copy by highlighting it using the ▲ and ▼ keys.**
2. **Press ENTER. Type in the destination name and press ENTER.**
3. **Choose whether to send the copy to :48M (HP 48 memory) or :CRD (card memory).**

   Once you copy the job and choose the place for it to be saved, you will be taken to the Setup menu of the new copied job. You can make changes without changing any data on your original job.

   For HP's only: With ***SMI*** you can copy a job from card memory to HP 48 memory, remove the RAM card, then place the RAM card into another HP 48. Now you have the same job in two HP 48's.

Adjusting Angles (Including Side Shots)

Earlier, you saw that the closing inverse from point 9 to point 11 differed by 20 seconds from the original inverse from point 2 to point 1.

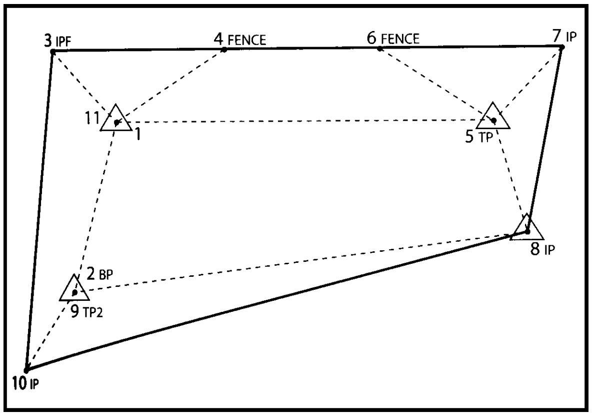


Figure 7-43 Adjusting Angles

Here is how to make an angle adjustment that will correct the discrepancy in the plat; to do this, use the Random Points file.

1. **Press** RPTS **(the N key).**
2. **If a Random Points file is shown on the command line, press** ON **to clear it. Then key in the following new Random Points file:** 2 SPC 1 SPC 3 +/− **.**

   Entering a negative number in a Random Points file indicates that the point is a side shot. To make a number negative, key in the number, then press +/− (the Y key) to change its sign.

✔ ***Do not use the* — *key.***

3. **Continue keying in** SPC 4 +/− SPC 5 SPC 6 +/− SPC 7 +/− SPC 8 SPC 9 SPC 10 +/− SPC 11 SPC 2 SPC 1 **and press** ENTER**.**

   The display will show TEMP RANDOM POINTS. This means there is now a Random Points file in the memory.

   The last two traverse points you keyed into the Random Points file (2 and 1) are used to define the direction that is assumed to be correct for the angle adjustment; the two traverse points immediately before them (9 and 11) define the error direction. (Point 10 is a side shot. Side shots are not used to define direction.)

4. **Press** NXT **to scroll the Random Points menu screen, then press the** AA **(angle adjustment) soft key.**

   The display will show CALCULATING as it adjusts the angles. It will then store the new data with your points, after which it will signal with a beep; the display will show DONE when the calculation is finished.

Now check to see how well you did, by inversing between points 9 and 11.

5. **Key in** 9 SPC 11 **and press the** P-P **key (the X key).**

   The display will show the new direction of this line; it should match the direction of point 2 to point 1.

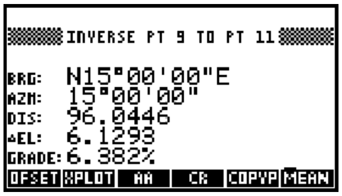


Figure 7-44 Inverse Point 9 to Point 11

The Bearing is N15.0000E now. If you do a 2 to 1 point inverse, you will notice the bearing is the same. The other information might be different, but that is okay – you only changed the bearing or angle with this function.

Angle adjustment modifies the direction "in error" (in this case, point 9 to 11) to match the direction or angle assumed to be correct (in this case, point 2 to 1) and adjusts all other angles in the plat accordingly. This allows angle adjustment using an open traverse to a set of good points.

Making a Compass Rule Adjustment

A compass rule adjustment also lets you modify the plat and it uses the Random Points file. This will affect mainly the distances of your data.

1. **Press** RPTS **.**

   The random point display will show the temporary Random Points file used in the above example. This example will be using most of the same file.

2. **Use the** DEL **soft key to move the cursor back and erase the last three points: 11 2 1 (so the cursor is flashing after the space behind the -10). Now key in the number 2. The Random Points file should look like this:**

   2 1 -3 -4 5 -6 -7 8 9 -10 2

3. **Press** ENTER **.**

   The display will show that the temporary file is now the current Random Points file.

   The last point (2) in the Random Points file is the accepted point. The traverse point immediately before it in the file is the point shot to the accepted point at the end of the traverse. In this case, that is point 9. (Point 10 is a side shot and is not used to define direction and distance of error.)

4. **To make the compass rule adjustment, press** NXT **and** CR **(compass rule).**

   The display will show CALCULATING as it adjusts the angles. It also will briefly display an angle error and adjustment. It will then store the new data with your points, after which it will signal with a beep; the display will show DONE. You can again check the results by inversing between points 9 and 1.

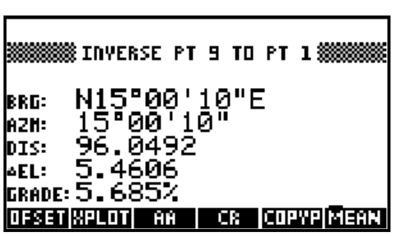


Figure 7-45 Compass Rule Adjustment

In this case, the compass rule adjustment moved point 5 a certain direction for a specific distance. It then adjusted points 6 and 7 exactly the same amount. Points 8 and 9 also were adjusted, so that point 9 became exactly coincidental with point 2.

Computing Area

You can accurately compute the area within the boundary of any plat. Try it, using the working example and the Random Points file.

1. **Press** RPTS.
2. **At the Random Points screen, press** ON **to clear the existing points on the command line.**
3. **Next, key in the points that define the boundary. In this case, you will key in the following:** `10` SPC `3` SPC `7` SPC `8` SPC `10` **and press** ENTER**.**

   The display will show ‘TEMP.R’ NOW CURRENT RPTS FILE.
4. **From the Random Point soft key menu, press** AREA**.**

   The program will calculate the data – point by point – and then display the area for the plat.

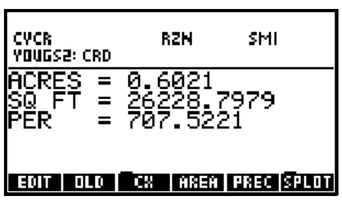


Figure 7-46 Plat Area

5. **To view a graphic representation of the plat, press** SPLOT **(screen plot) from the Random Point soft key menu, then press** SPLOT **again.**

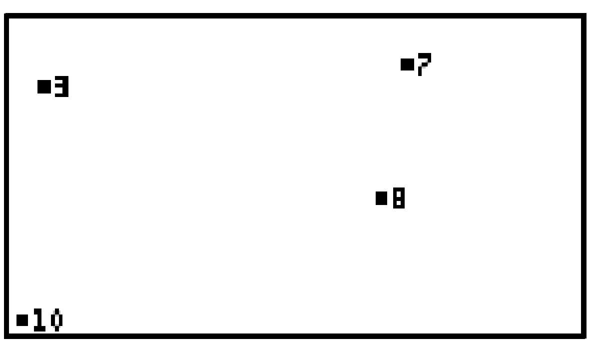


Figure 7-47 Graphic Representation of Plat

You will see the plat drawn on the display, scaled to fit in the display.

6. **Press ON to return to the Screen Plot menu. Press LINE and the message “**WILL DRAW LINES**” displays. Press SPLOT again.**

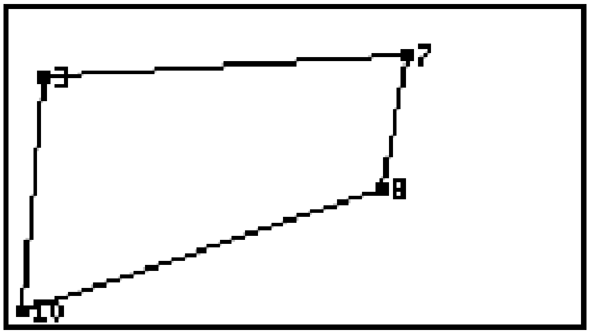


Figure 7-48 SPLOT Point Numbers

7. **Now press ON to return to the Screen Plot menu, then press PT# for point numbers. The message “**WON'T DRAW LABLES**” displays. Press SPLOT again.**

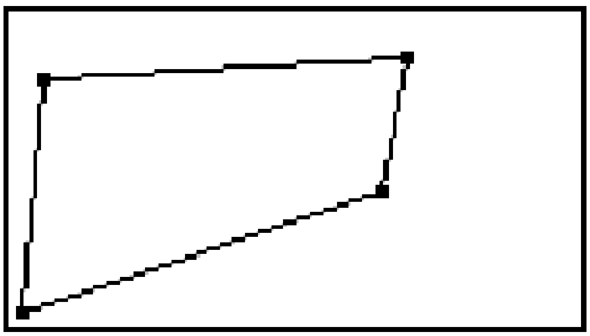


Figure 7-49 SPLOT Lines

Those are the three options from the Screen Plot menu.

Rotating Coordinates

SMI’s Rotate function is useful if you need to adjust your plat to bring it in line with a known direction, such as a deed bearing.

For example, assume you need to rotate the plat so that the boundary line defined by points 10 and 8 fits an assumed deed bearing of S87° 30’E.

Currently, the bearing of this line is N70°33’49”E.

This is how to rotate the job to fit the known bearing:

1. **Press RPTS.**

   The display will show the random point display; if a Random Points file is shown on the command line, press ON to clear it.

2. **Key in a new Random Points file to encompass all the points in the job. Key in** `1.11` **and press ENTER. (Remember that the decimal point is a shortcut to include all consecutive points between the first and last numbers.)**

3. **At the Random Point menu, press CX (coordinate transformation).**

   The Transformation menu presents a series of soft key options to help you define the rotation that will take place.

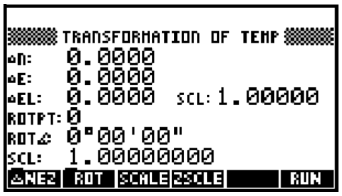


Figure 7-50 Coordinate Transformation Menu Options

4. **Press △NEZ.**

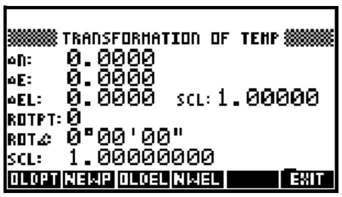


Figure 7-51 Transformation Screen

5. **First, you will define a reference starting point (or old point) and then a resulting point (or new point). The old point is point 10, so key in `10` and press OLDPT.**

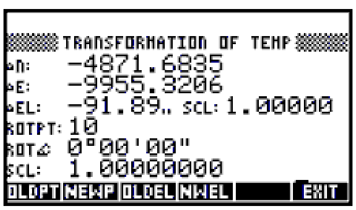


Figure 7-52 Current Coordinates and Elevation

   The screen will display the current coordinates and elevation for point 10.

   However, in this case, point 10 also is the new point, since you are simply pivoting your plat on point 10 to match the deed bearing.

6. **Key in `10` and press NEWP.**

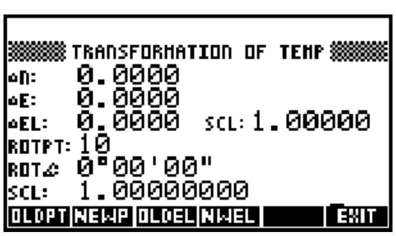


Figure 7-53 Point Recalled

   The display will show `POINT 10 RECALLED`.

7. **Enter the direction of the current line, as defined by point 10 to point 8.**

8. **Press EXIT then the ROT soft key for Rotate. Enter the direction of the current line, as defined by points 10 to 8.**

9. **Key in** `10` **SPC** `8` **and press** **OLD∡**.

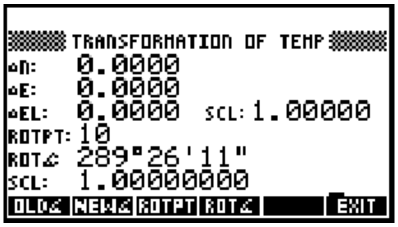


Figure 7-54 Initial Rotation Angle

The display shows an initial rotation angle of 289°26’11”; this is not yet an accurate figure, since the program requires a second direction to compute the proper rotation angle. Enter that second angle now. As indicated above, you know that the deed bearing for this line should be S87°30’E.

10. **Key in** `87.30`**.**

11. **Before pressing** **ENTER** **or any other key, that value needs to be changed to azimuth format. To change it, press** ➦ **S-E** **(the 2 key).**

    The display shows the value as an azimuth of 92.3000; now you can enter it as the second direction.

12. **Press** **NEW∡**.

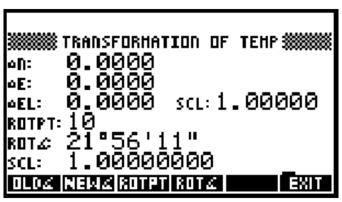


Figure 7-55 New Angle

The display now shows the correct rotation angle as 21° 56’11”.

You also can see the rotation angle (and any other adjustments). They are shown on the screen. The display gives any change that will occur in north and east coordinates, elevation, as well as rotation angle.

13. **To execute this rotation, press** **EXIT** **then** **RUN**.

    The display will show that each point is being stored, and will signal with a beep when the plat has been rotated; the display will read DONE. You can check the result by inversing between points 10 and 8.

14. **Key in** `10` **SPC** `8` **and press the** **P-P** **key.**

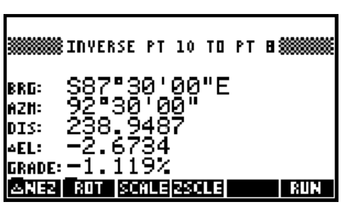


Figure 7-56 New Bearing

As you can see from the display, the line defined by point 10 to point 8 now shows the new bearing of S87°30’00”. You can also view the bearings and distances around the boundary by keying in the two points separated by spaces and then pressing the **P-P** key.

If you do a screen plot of the points that were just entered (10, 3,7 and 8), the plat now looks like this:

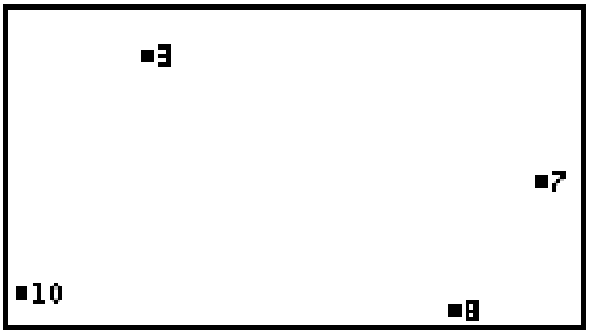


Figure 7-57 New Screen Plat

The old one was like this:

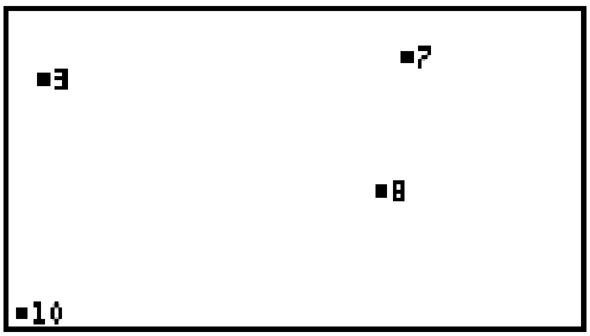


Figure 7-58 Old Screen Plat

Translating Coordinates

You can translate (as well as rotate) coordinates. Translation is useful when you want to change the actual coordinates of a point; the other points in the job will be adjusted accordingly. Here's how:

Using the points from the example above, assume you want to change the coordinates of point 10. Press VIEW, then key in `10` and press PNTS.

This shows its current coordinates of 4871.6835 N and 9955.3206 E (and elevation of 91.8969), and you would like to change them to 10000 N, 20000 E and an elevation of 850 feet.

1. Press SC for Store Coordinate.

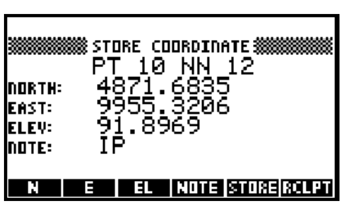


Figure 7-59 Store Coordinate Menu

The display shows the Store Coordinate menu. You also see the current values for point 10 (you can also view these values by keying in `10` and pressing RCLPT from this menu). Enter the new coordinates for point 10.

2. **Key in** `10000` **and press N. Key in** `20000` **and press E. Next, key in** `850` **and press EL.**

3. **To store these new coordinates as point 12, key in** `12` **and press STORE.**

Figure 7-60 Point 12 Stored

Note that in Figure 7-59 on page 143, the NN (next number) is point 12. That means you could have simply pressed STORE to store the new coordinates at point 12, but it is always good practice to key in a point number first when you know you want to store a specific point. The screen is displaying point 12 and its coordinates.

Now translate the plat.

4. **Press RPTS for the Random Points file.**

5. **Press ON to clear the command line.**

6. **Key in** `1.11` **and press ENTER.**

7. **From the soft key menu, press CX (transformation).**

   The transformation display shows soft keys to help you define the translation you will be performing.

   Note that the screen also shows initial transformation settings; however, these are not valid until you enter data to define the changes you will be making.

8. **Press △NEZ.**

9. **As in the earlier example, point 10 is the old reference point. Key in** `10` **and press OLDPT.**

   The display shows the existing coordinates for point 10. Now, however, you want to use point 12 as the new point.

10. **Key in** `12` **and press NEWPT.**

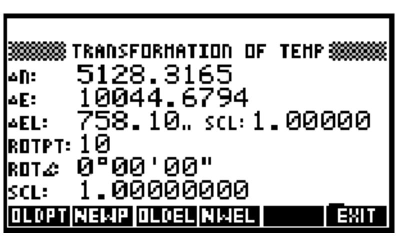


Figure 7-61 Point 12 Recalled

The display recalls point 12 and displays its coordinates. In this example, the rotation angle is 0, so you need to set the rotation angle.

11. **Press EXIT.**

12. Press ROT, key in `0`**, and press ROT∆.**

The display will show that the rotation angle has now been changed to 0.

13. To execute the translation, press EXIT and RUN.

The display will briefly show that each point is being stored, and will signal with a beep when the process is completed.

14. Press VIEW to go to the View menu. Key in `10` **and press PNTS.**

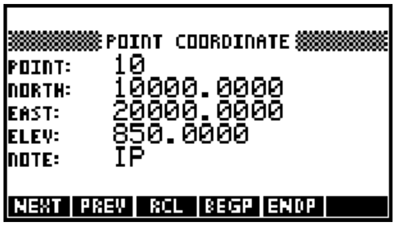


Figure 7-62 Point 10

The display shows that point 10 now has the new coordinates and elevation. The remaining points in the job have also been transformed to match point 10.

You can view each point by pressing NEXT or PREV.

Or key in a specific point and press RCL for Recall.

For example, look at point 5.

15. Key in `5` **and press RCL.**

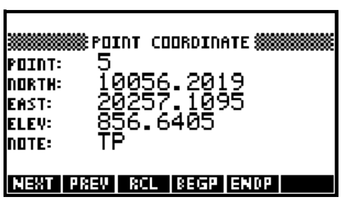


Figure 7-63 Point 5

The display shows the new coordinates and elevation for point 5. As you can see, it also has been translated to match the new position relative to the new point 10.

Note that both of the previous examples (rotation and translation) could have been done in one operation. With a little practice, you will find that CX is a flexible and powerful tool.

Separate Distance and Angle

Separate distance and angle (SDA) is in the SETUP menu. It is designed to let the surveyor:

- Measure a distance to one point and the angle to another point.
- Measure an angle and distance to a point and move that point away from the point in relation to the instrument, toward the instrument, to the right of the point, or to the left of the point a specified distance.
- Use a combination of the above options.

- Measure an angle and distance to a point and get an elevation of other points based on the horizontal crosshair position in the instrument.
- Store several points with various elevations or distances from this list using the first distance from **SDA** and last angle from **ZHA** (zenith and Horizontal Angle).

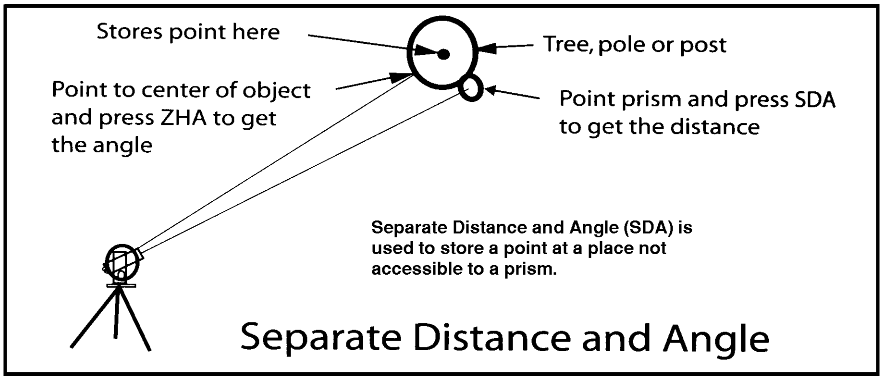


Figure 7-64 Separate Angle and Distance

One use of SDA is shown in the example above. Point the prism beside a tree or a pole and press **SDA** to get the distance, then point the center of the object and press **ZHA** to get the angle. The distance and the angle are used to compute a new point at the center of the object.

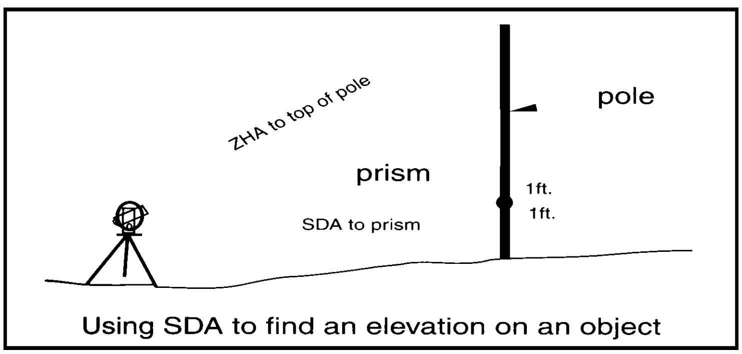


Figure 7-65 Using SDA to Find an Elevation on an Object

Another use of the Separate Distance and Angle function is illustrated above. Take a reading on a prism at the bottom of the pole using **SDA**. Turn to the top of the pole and press **ZHA**.

Whatever rod height is displayed is zeroed for the ZHA shot so that the elevation will be calculated to the horizontal crosshair, rather than be lowered by the rod height. Other points with elevations can be stored just by pointing and pressing **ZHA**.

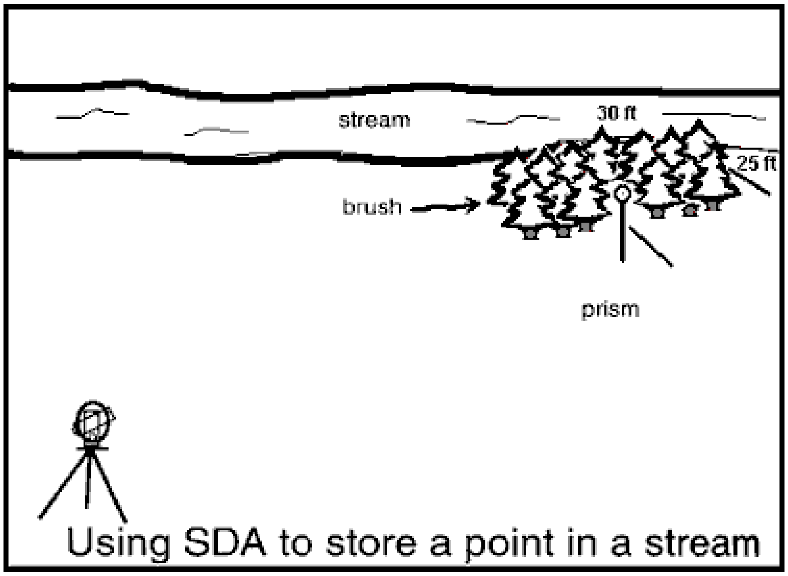


Figure 7-66 Using SDA to Store a Point in a Stream

With SMI's ***SDA***, you can add or subtract a distance to the prism point. You can also move right or left from the prism point. The illustration above shows combining a distance back and a distance left.

Procedure to Store a Point Behind and to the Left of the Prism

1. **If the instrument has been chosen, point the prism, press SETUP and SDA.**

   The instrument will take a reading.

2. **Key in** `25` **and press HD↑.**

3. **Key in** `30` **and press HD←.**

4. **Without moving the instrument, press ZHA.**

   A point will be at the break in the stream, 25 feet back of the prism, and 30 feet to the left.

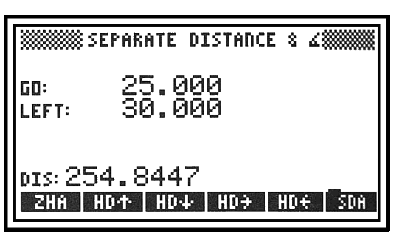


Figure 7-67 Store a Point

As you can see using SDA, a point can be stored toward or away from the instrument, or right or left of the instrument, or a combination of two of these.

Using ZHA to Store Multiple Points at an Offset or at a Distance Forward or Back

If you are only changing the prism point by distance – not by horizontal or vertical angle – you can store multiple points at varying distances without having the instrument reread the distance.

Normally, the last thing you do in an SDA operation is press ZHA. This takes the current angles from the instrument and uses them with the distance(s) entered previously.

If the horizontal and vertical angles do not change from the SDA reading, press ↰ and ZHA. This stores the point with the angles to the prism.

Example

1. **If the instrument is turned on, flag i will be set. Press ↰ 5 to turn off the instrument.**
2. **Press SETUP and SDA.**
3. **Key in** `100` SPC `89` SPC `30` **and press ENTER.**

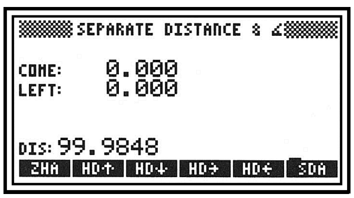


Figure 7-68 First Step of SDA Function

4. **Key in** `5` **and press HD→.**

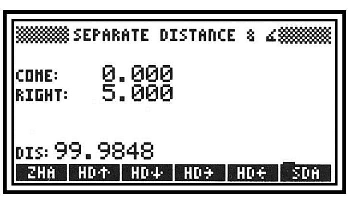


Figure 7-69 Five Feet to the Right

5. **Press ↰ ZHA.**

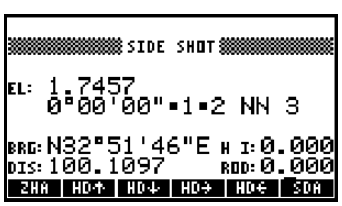


Figure 7-70 Stores a Point without Requiring Another Shot

Note that the distance was updated to account for the distance from the instrument to the point, 5 feet right of the prism. Other distances can be entered and stored using ↰ ZHA.

6. **Key in** `0` **and press HD→.**

7. **Key in `10` and press HD↑.**

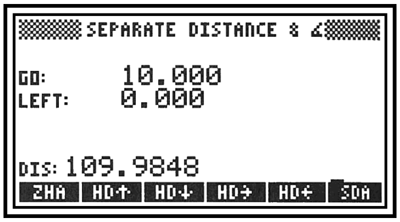


Figure 7-71 Changes in the Horizontal Distance

8. **Press ↰ ZHA.**

   When ZHA is pressed, the point is stored and the distance is updated to show the total distance.

9. **To take a normal side shot after storing one or more separate distance and angle points, just press SIDS.**

10. **Whenever you are storing points and wish to know the direction, distance, or difference in elevation or grade between the points, key in the point numbers separated by a space (SPC) and press the `P-P` key.**

✎ *All functions discussed in previous chapters are available if you have the **Data Collection** or **Construction Five** card, unless the instrument is chosen. The Horizontal Angle, Zenith Angle, and Slope Distance are automatically collected from the instrument and used in the **SMI** software.*

Before You Leave Data Collection

There is more to ***SMI's*** data collection than what you have seen in the previous examples. ***DCE*** also includes:

- stakeout
- two-point free-station resection
- sunshots
- benchmark
- trigonometric leveling
- and more

To review the features of your ***DCE*** card, see the features checklist in *SMI's Surveying Cards Features* on page 2 or go back to the chapter called *Advanced COGO*, which begins on page 93. Manually entered examples are given in the following chapters: *Standard COGO*, which begins on page 41 and *Advanced COGO*, which begins on page 93.

Information on individual functions may be found in *Quick Reference of Menus and Functions*, which begins on page 241.

Azimuth Surveying

There are a few azimuth surveyors around. Certainly, azimuth surveying has some definite advantages. For one thing, you always know the direction. When you close the traverse loop, you immediately know your angle closure.

A few years ago when a lot of computations were not so easy, the field reduction process was much simpler.

You can survey in azimuths with the SMI surveying software, if you wish. Simply go to the Change menu and press 0 (zero). This soft key is a toggle between Angle Right surveying (zero backsight), Directional Theodolite surveying, and azimuth surveying. When you are set to azimuth surveying, if you are occupying a point and you have chosen your instrument (and you instrument allows two-way communication), the ***SMI*** software will send the back azimuth to the instrument when you key in the back azimuth, back bearing, or back point. You may then turn to a point and press **SIDS** or **TRAV** and store the point.

You may have noticed that most examples in this user guide deal with zeroing on the backsight and turning Angles Right. Even though you may be accustomed to running azimuths, you may want to consider switching to Angle Right. Here's why:

- With the ***SMI*** surveying software, you can have your display set to azimuth so that you can keep up with your direction.
- Generally, it is much easier to zero the instrument on the backsight, rather than set the back azimuth on the instrument.
- With ***SMI*** software, when you finish your boundary loop, you can easily check your angle closure and distance closure.
- With ***SMI*** software, your computations are automatic, so working in angles right does not increase computation time for field book reduction.
- If you wish to turn multiple angles, it is much more feasible when turning angles right.
- If you like the idea of turning directly to a line azimuth when using azimuths, that is a nice plus; but, with ***SMI*** surveying software, you can use Stake to get the correct Angle Right to turn and distance to go.

SMI surveying software does not require that you switch from azimuths to Angles Right. However, these are some reasons to consider it.

CONSTRUCTION FIVE

CHAPTER 8

This chapter is for users of the following cards:

- ➥ Construction Five
- ➥ GPS/Robotic with Construction Five

In this chapter:

Key Definitions

Key	Function
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
Hard Keys	Hard key functions are imprinted on each key itself. The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card. **Hard keys are represented in this manual as black lettering on a gray, rectangular background.**
Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

SMI Software Features and Examples

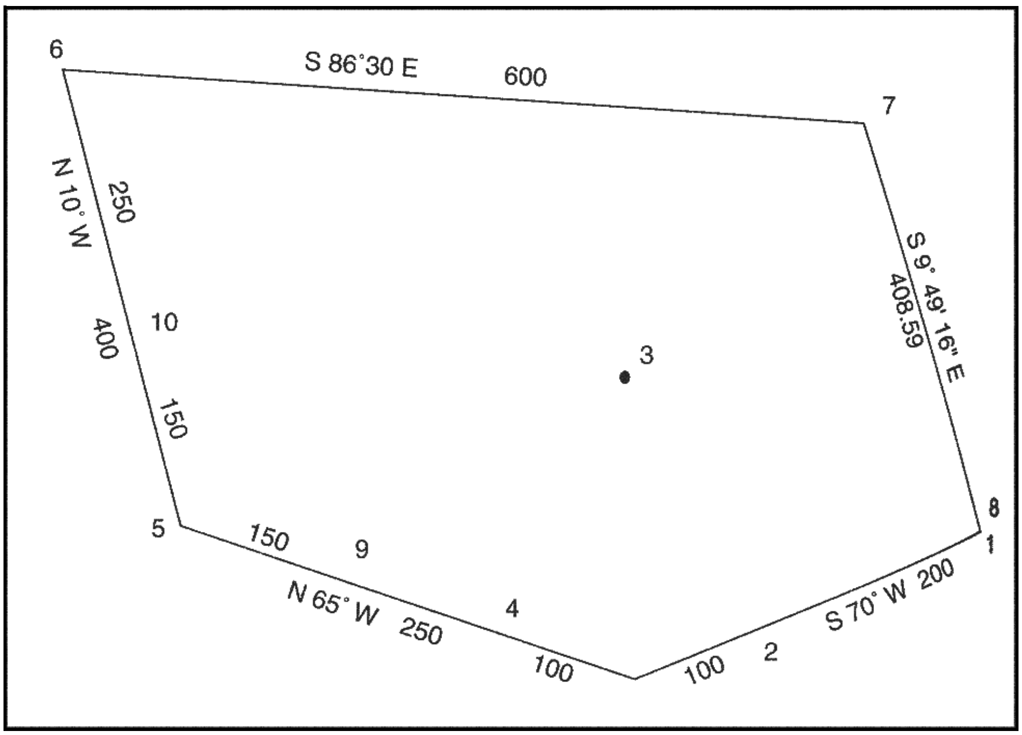


Figure 8-1 SMI Software Features Demonstration Example

In the example above, there is a simple curve from 2 to 4. For now, the above sketch will be used to illustrate several features of the ***SMI*** surveying software to store the boundary points.

Create a Job Called HARVICK

1. **Turn off all flags: raw data (↰ RAW), elevations (↰ ELEV), notes (↰ NOTE), and instrument (↰ MAN).**

2. **Press JOB NEW NEW key in** `HARVICK`**, and press ENTER.**

Figure 8-2 Creating a Job Called HARVICK

Traverse the Boundary from Point 1 to Point 7

1. **Press TRAV, key in** `70`**, press BRG, key in** `3` **(quadrant number), and press ENTER.**

2. **Key in** `200` **and press HDIST.**

Figure 8-3 Storing Point 2

Point 2 is stored.

3. **Press (the S key).**

4. **Key in** `45` **and press △ (the A Key).**

5. **Key in** `100` **and press T (tangent).**

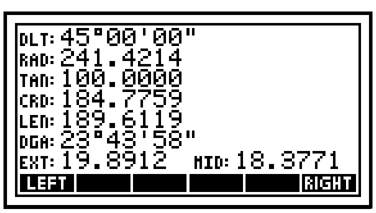


Figure 8-4 Entering the Delta and Tangent for the Curve

6. **Press RIGHT, then press STORE.**

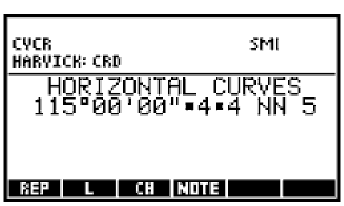


Figure 8-5 Storing the Horizontal Curves

7. **Press** TRAV .

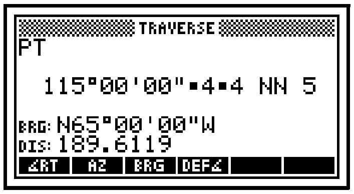


Figure 8-6 Bearing and Distance

8. **Press** AZ .

   You will see 295 (the forward tangent). This is the azimuth of the above bearing.

9. **Press** ENTER.

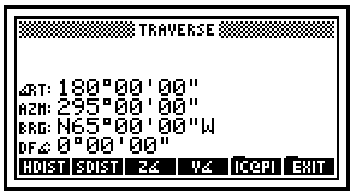


Figure 8-7 Azimuth of Bearing

10. **Key in** `250` **and press** HDIST .

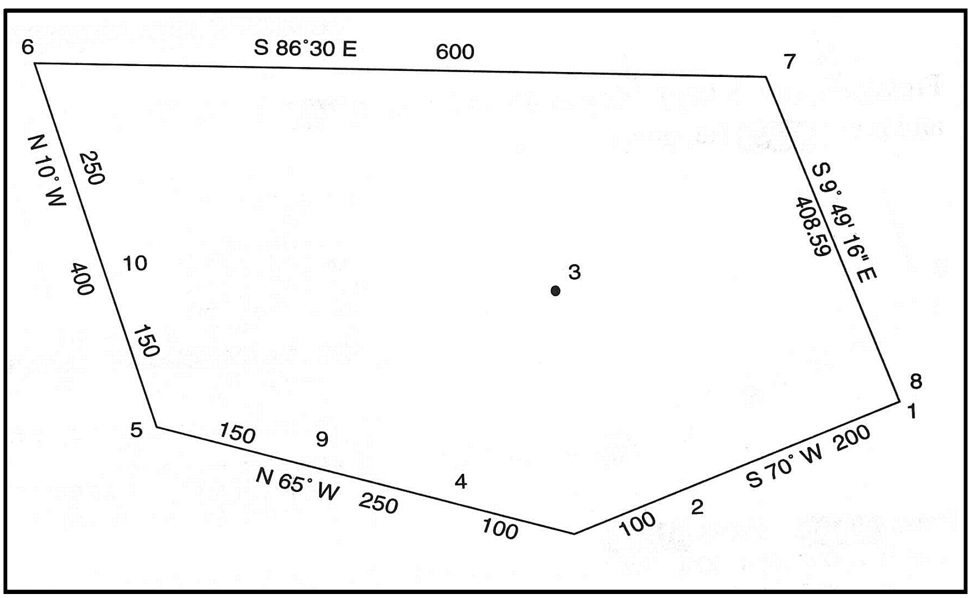


Figure 8-8 Traverse the Boundary Example

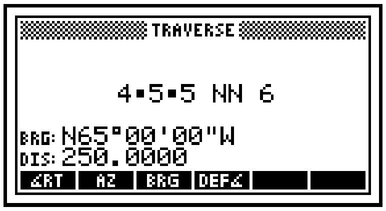


Figure 8-9 Storing Point 5

Point 5 is stored.

11. Key in `410` **(quadrant 4 and a 10-degree bearing) and press** **BRG** **.**

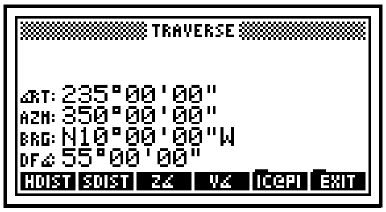


Figure 8-10 Entering the Bearing for Point 6

12. Key in `400` **and press** **HDIST** **.**

Figure 8-11 Storing Point 6

Point 6 is stored.

13. Key in `286.30` **and press** **BRG** **(quadrant 2 and the bearing).**

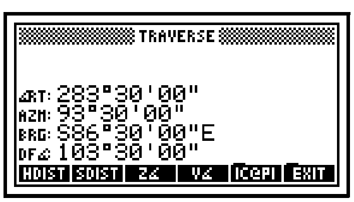


Figure 8-12 Entering the Bearing for Point 7

14. Key in `600` **and press** HDIST **.**

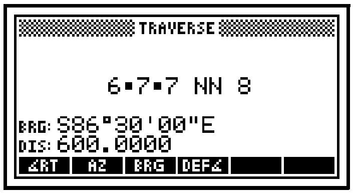


Figure 8-13 Storing Point 7

Point 7 is stored.

Find the Bearing and Distance from 7 Back to Point 1

Key in `1` and press ↱ PINV (for Point Inverse) (the P key).

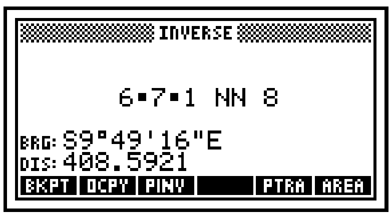


Figure 8-14 Finding the Bearing and Distance from Point 7 to Point 1

The bearing is S 9° 49’ 16” E. The distance is 408.59.

Traverse to Point 1 Using the Inversed Distance

1. Press TRAV **.**

2. Key in `209.4916` **and press** BRG **.**

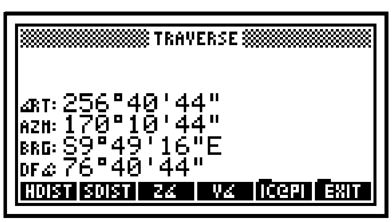


Figure 8-15 Entering the Bearing

3. Key in `408.59` **and press** HDIST **.**

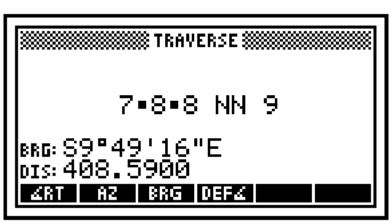


Figure 8-16 Traversing to Point 1

Check the Distance Error from 8 to 1

Key in 8 [SPC] 1 and press the **P-P** key.

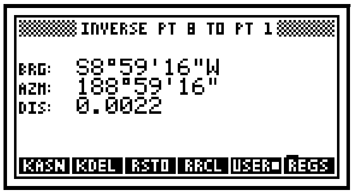


Figure 8-17 Checking the Distance Error Between Points 8 and 1

Find the Area, Perimeter, Square Feet, and Precision

1. **Press [RPTS].**

   Key in 1 [SPC] [↱] [—] (this displays the double quotes) 2 [SPC] 3 [SPC] 4 [▶] (cursor right to move past the quotes) [SPC] 5.8 (this means to use all points from 5 through 8) [SPC] 1. The entry should look like this:

   `1 “2 3 4” 5.8 1`

2. **Press [ENTER].**

3. **Press [PREC].**

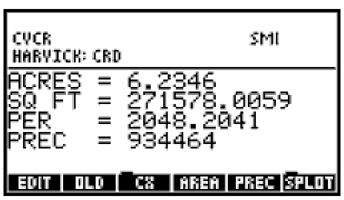


Figure 8-18 Displaying the Precision

   This shows a super high precision. It is much higher than you can hope for in the field.

4. **If you press [AREA] now, the display will show the following figure.**

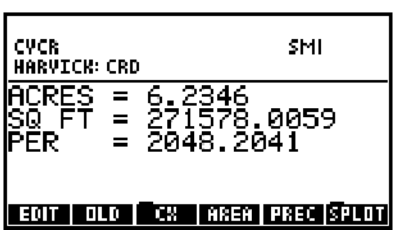


Figure 8-19 Area Precision

   Point 8 is very close to point 1. Above you see that the difference was .0022 feet. Therefore, the square feet and precision are going to be more accurate if you take out point 8 and just leave 1. As stated earlier, you will not be able to get a precision that high in the field.

   Here is a more accurate way of getting area: Edit the above Random Points File by pressing [RPTS]. You will see `1 “2 3 4” 5.000008 1` (The program puts the zeroes in the file automatically to separate the two numbers. This allows point numbers of up to 999,999.)

Change the 8 to a 7 and delete the last 1 by using the backspace (◀) key. By removing point 8, you will get more accurate numbers for the lot.

Another way to edit this file is to press ON and re-enter. Either way is OK:

`1 “2 3 4” 5.000007` or `1 “2 3 4” 5.7`.

Press ENTER and press AREA.

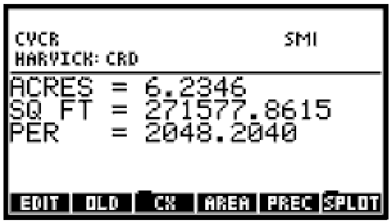


Figure 8-20 Displaying the Area

It is amazing how .0022 feet will make that much of a difference in the square footage.

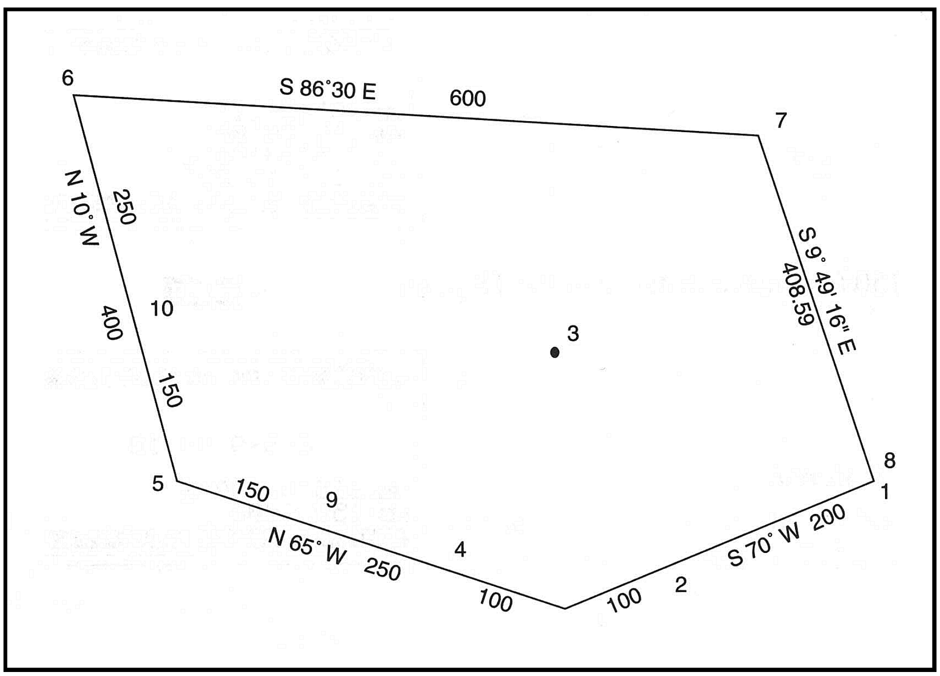


Figure 8-21 Area, Perimeter, Square Feet, and Precision Example

Design a Spiral with 5 as the Main PI

Design the spiral such that Spiral Length Back will be 100, the Spiral Length Ahead will be 100, and the radius of the simple curve will be 150.

First store two points at estimated TS (Tangent to Spiral) and ST (Spiral to Tangent) points.

1. Press SETUP.

2. **Key in** 5**, press** **OCPY** 8 **and** **BKPT**.

Figure 8-22 Storing Points 5 and 8

3. **Press** **SIDS**.

4. **Key in** 5 **SPC** 4 **and press** **A Z**.

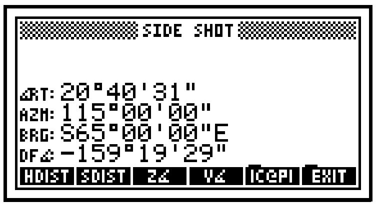


Figure 8-23 Azimuth from Point 5 to Point 4

5. **Key in** 150 **(estimated distance to the TS point) and press** **HDIST** .

Figure 8-24 Storing Point 9

Point 9 is stored.

6. **Key in** 5 **SPC** 6 **and press** **A Z**.

Figure 8-25 Azimuth from Point 5 to Point 6

7. **Key in** `150` **and press** **HDIST** **.**

Figure 8-26 Storing Point 10

Point 10 is stored.

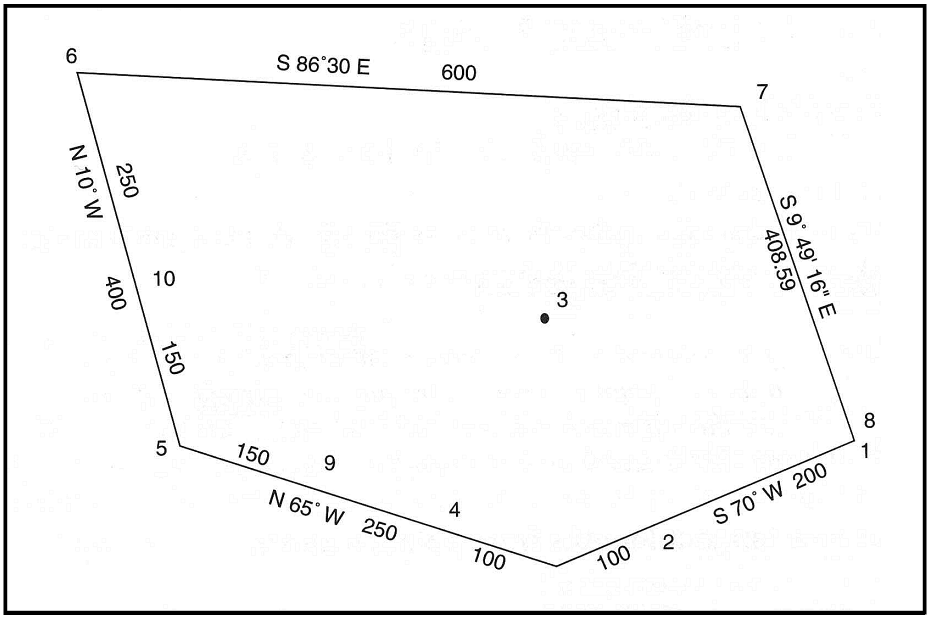


Figure 8-27 Spiral Example

Let ***SMI*** create a spiral according to the design and compute the mathematically correct positions of points 9 and 10. See *Spirals in CVC* on page 191 for additional information. First, enter the desired spiral data into the horizontal control.

Entering Horizontal Control

See *Horizontal Control with Construction Five* on page 277 for additional information regarding horizontal control.

1. **Press the** CONST **or M key,** NXT **HCCL** **and key in the horizontal control data.**

   Enter the entire boundary from point 1 to point 8 and insert the spiral into the horizontal control.

   1 SPC `0` SPC (0+00 is the station at point 1:)

   ↱ – (the minus sign to get the double quotes for entering a simple curve)

   2 SPC 3 SPC 4 ▶ (cursor right to move the cursor to the right of the quotes) SPC

   ↰ + This will add {} to the display.

   9 (the estimated tangent to spiral point)

SPC 5 (the main PI) SPC 10 (the spiral to tangent point)

SPC `150` (the radius of the simple curve between the spirals)

SPC `100` (spiral length back and ahead is the same so we only enter once) ▶ (cursor right) SPC 6 SPC 7 SPC 8

The entry should look like this:

`1 0 “2 3 4”   {9 5 10 150 100} 6 7 8`

2. **If the entry resembled the entry above, press ENTER.**

   Points 9 and 10 will give a prompt asking whether to override.

3. **Press ENTER in each case.**

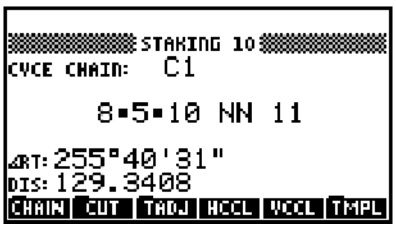


Figure 8-28 Override Points

✎ *If you do not wish to override the original points, key in a desired point number before pressing ENTER. If you use this approach, you must edit the HCCL file to replace 9 and 10 with the new point numbers.*

Check the New Tangent Lengths from Points 9 and 10

1. **Key in** 5 SPC 9 **and press the** `P-P` **key.**

   The distance is 129.3408.

2. **Key in** 5 SPC `10` **and press the** `P-P` **key.**

   The distance is 129.3408.

Find the Station of Points 2, 4, 5, 6, 7, and 8

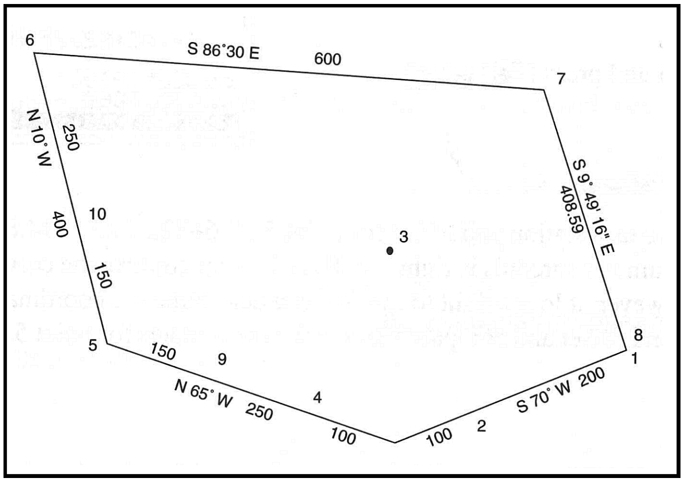


Figure 8-29 Find Station of Points Example

✎ *A station is a location along a defined centerline.*

Stations measure distance along a horizontal centerline. Each station is usually 100 feet long if measuring in feet or 1000 meters long when measuring in meters. When indicating a particular distance along the centerline, the station is followed by a plus and the remaining distance to get to the correct position. For example, station 2+55.5 is 255.5 feet down the centerline from station 0+00. Station 10+000.00 would be 10 km from station 0+000.

When entering a station into the data collector, just omit the plus symbol and enter the distance. So, to enter station 2+55.5, simply type 255.5. Offsets from the centerline are entered as positive (right) or negative (left) values.

1. **Press CONST, the M key.**
2. **Key in** 2 **and press ↰ FS (the C soft key).**

   The functions in the ***Construction Five*** menu assume stations instead of point numbers. If you want to work with point numbers, you must key in ↰ before pressing FS (foresight point).

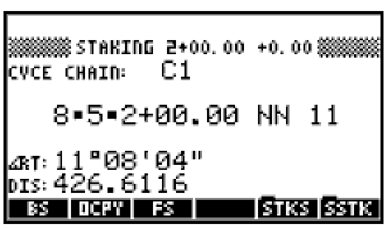


Figure 8-30 Station and Offset at Point 2

Based on what the display is telling you, the station is 2+00 and the offset is 0. The instrument is occupying point 5 and backsighting point 8. Based on this occupied point and backsight point, the given angle to turn and the distance to go are listed in the lower left-hand corner of the display.

3. **Key in** 4 **and press** ↰ **FS**.

Figure 8-31 Station and Offset at Point 4

Before continuing, suppose you have to change your occupy and backsight points. Press **SETUP** 7 **OCPY** 6 **BKPT**.

Now press **CONST** or the M key again to return to the Construction menu.

4. **Now key in** 5 **and press** ↰ **FS**.

Figure 8-32 Station and Offset at Point 5

SMI gives a station and offset for point 5 of 6+32.27 and left offset of 22.23. You can determine the coordinates for that station and offset and compare them to the coordinates for point 5.

5. **Press** **NXT** **NXT**, **key in** `632.27` **SPC** `22.23` **+/−** **(the Y key) and press** **STSTO** **for station store.**

   The software flashes ‘`Point 11 Stored`’.

6. **Key in** 5 **SPC** `11` **and press the** **P-P** **key.**

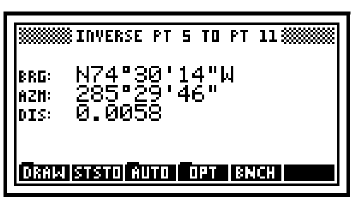


Figure 8-33 Inverse Point 5 to Point 11

This does not positively prove the correctness of the work; however, it is good circumstantial evidence.

Perform one more test:

7. **Press the** **CONST** **key, key in** `632.27` **SPC** `22.23` **+/−** **(it should look like this:** `632.27 -22.23`**) and press** **FS**.

✎ *Note that when a station and offset are used, press* F S*, but when a point number is used, press* ↰ F S.

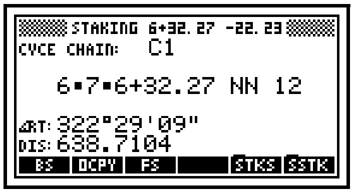


Figure 8-34 Staking Points

Now compare the angle and distance when you use a point and when you use a station and offset that were computed. It is not perfect, but it is close. This is additional circumstantial evidence to prove the accuracy.

You can still do one more thing.

8. Press STAKE.

9. Key in point 5 and press FSPT.

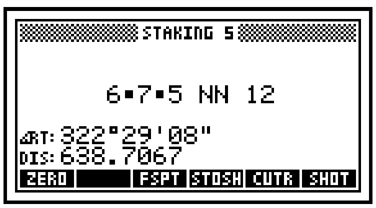


Figure 8-35 Key in 5

10. Press the CONST **or M key, key in** 6 **and press** ↰ F S.

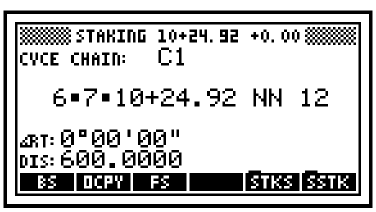


Figure 8-36 Key in 6

All these examples show that we can accept the station number as being OK. You know the offset should be 0+00. Look at the angle and distance. This makes sense, since the instrument is backsighting on the same point, and the distance is 600.

11. Key in 7 **and press** ↰ F S.

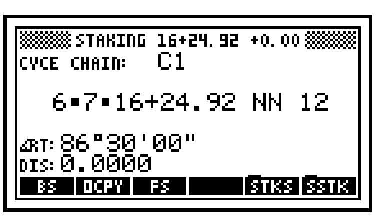


Figure 8-37 Key in 7

The distance should be zero; the offset should be 0+00. The station number is exactly 600 feet more.

Check the last point.

12. Key in 8 **and press** ↰ FS.

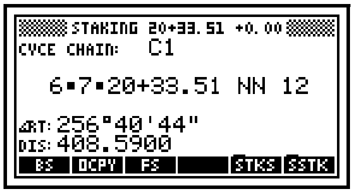


Figure 8-38 Key in 8

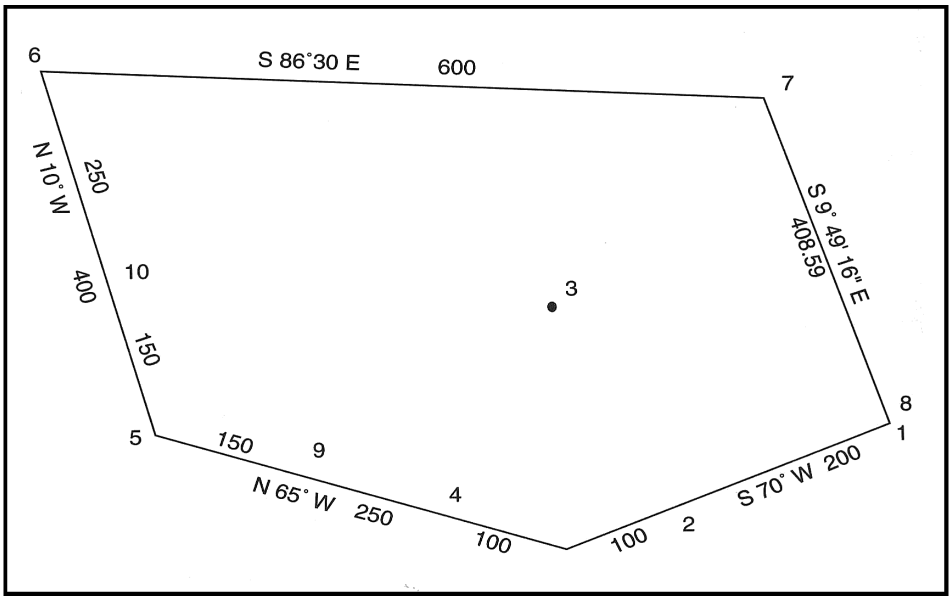


Figure 8-39 Find the Station of Points 2, 4, 5, 6, 7, and 8 Example

The distance and offset are correct. The Angle Right looks OK, but perform the next step to check it.

13. Press MORE **(the Z key),** CAR **(Compute Angle Right), key in** 7 SPC 6 **and press** BKAZ**. Press** 7 SPC 8 **and press** FSAZ**.**

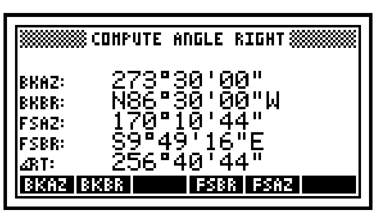


Figure 8-40 Checking the Angle Right

The Angle Right checks: 256° 40’ 44”.

Regarding the station number, recall that previously, the perimeter of this project was discussed. That perimeter should be a little more than this perimeter because of the spiral insert at 5.

Below is a copy of what was done.

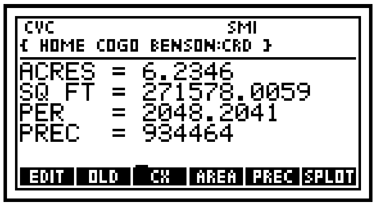


Figure 8-41 Copy of Example

Everything checks out OK for the free station resection point. You are now ready to take shots anywhere and get station and offset positions on the boundary. You can also give any station and any offset and get an angle to turn and a distance to go. Take a sample shot to get a clock direction to head or get the Go or Come and Right or Left distances to the point.

As you have perhaps observed, this example is a control file with a closed loop.

Go to the field using the information from the example just shown.

The area is open, except for one large oak tree, and you will level your instrument over a place that is convenient to work from and in view of at least two control points.

Free station to the shaded area:

1. **Press [SETUP] [NXT] [2PFS] [NXT] and enter the two control points used for the free station position.**
2. **Key in** `5` **and press [PT A].**
3. **Key in** `7` **and press [PT B].**

   From now on, ***SMI*** will remember these points as A (the northwesterly point) and B (the southerly point).
4. **Level the instrument. Position the prism at point 5 or A (zeroing on A is optional – it seems impossible, but *SMI's* Free Station Resection program works if you do not zero on anything).**
5. **Choose your instrument: Press [SETUP] [NXT] [NXT] [INST] or use the shortcut [↱] X (Your brand), (Your type).**
6. **Since you might be in the office right now, if flag i is displayed at the top of the display, press [↰]** `5` **to exit the Instrument mode.**

   [↰] 5 is a toggle that turns Instrument mode on or off.

✎ *If flag i is off, the instrument will be off and when you press a key that normally causes the instrument to measure, you will be prompted to enter the Slope Distance, Zenith Angle, and Angle Right.*

7. **Press [↱], then the [DEL] key (a shortcut key to access).**

   The instrument takes a reading and displays the information.
8. **After pressing [A DIR], key in** `175.39` **(the Slope Distance), [SPC]** `87.56` **(Zenith Angle), [SPC]** `0` **(the circle reading,) and press [ENTER].**
9. **Position the prism over point 7, then turn the instrument to point 7 or B and press [B DIR].**
10. **Here is what you should use in an indoor setting (By now you know to put a space between each entry):**

    `463.46` [SPC] `89.30` [SPC] `181.2130` [ENTER].

11. **Press RSLTS.**

Figure 8-42 Displaying the Results

The precision shows 1 foot in 26446. If you get this in the field, that will be great. Pressing STORE is optional. However, for our example, for the rest of the chapter, press STORE so our point number will agree. If you do not press STORE here, the occupied point will read FREE, meaning the instrument is on a free station point.

Check your work.

12. **Press STAKE.**
13. **Key in** `2` **and press FSPT.**
14. **Position the prism over point number 2, point the instrument at point 2, and press SHOT.**

    The reading from the instrument is:

    Circle Reading 253° 41,

    Zenith Angle 86.50, and

    Slope Distance 343.30.

15. **Key in** `343.30` SPC `86.50` SPC `253.41` **and press** ENTER**.**

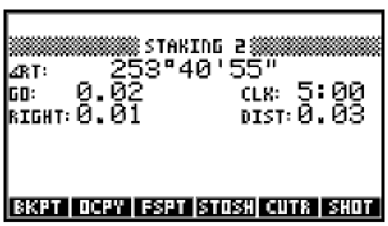


Figure 8-43 Staking 2

That is a fairly good check.

Take Some Readings in Construction Five

These readings will require manual input for simplicity.

Stake a Point at Station 6+00

This point happens to be in the spiral, but it does not matter. ***SMI*** finds the station wherever it is.

1. **Press the CONST key.**

2. **Key in** `600` **and press** FS.

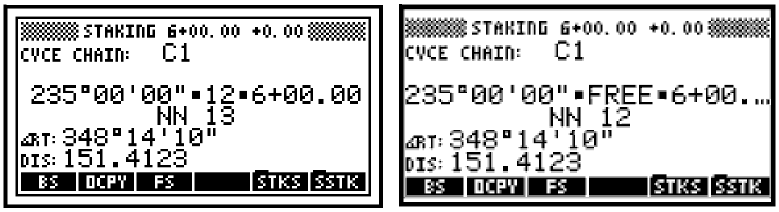


Figure 8-44 Key in 600

If you pressed STORE, your screen will read the occupied point as “`12`” (the figure above on the left); if you did not store the free station point, the occupied point is “FREE” (the figure above on the right). For the rest of the example, the occupied point will be 12.

3. **Press** STKS **(Stake Shot).**

4. **Key in** `150` SPC `80` SPC `348` **and press** ENTER.

Figure 8-45 Shot Values

5. **Have the rodman move accordingly.**

6. **Press** SHOT.

7. **Key in** `153.75` SPC `80` SPC `348.14` **and press** ENTER.

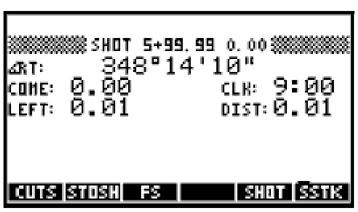


Figure 8-46 Drive the Stake

Drive the stake.

This point happens to be in the spiral. It does not matter. ***SMI*** finds the station wherever it is.

Staking Right of Way

The right of way marker is to be at station 8+50 at an offset of 50 feet.

Stake this point from the current free station position.

1. **Press the** CONST **key.**

2. **Key in** 850 SPC 50 **and press** F S.

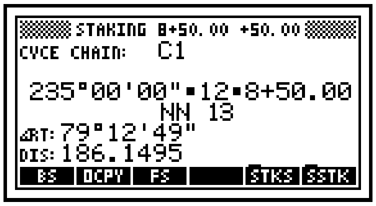


Figure 8-47 Enter Station and Offset

3. **Press** STKS **and key in** 186.20 SPC 89.40 SPC 79.12 **and press** ENTER.

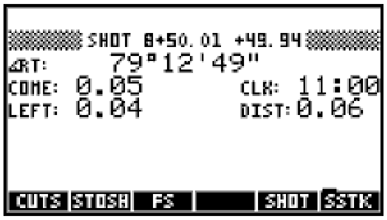


Figure 8-48 Come, Left, and Dist Values

4. **Have the rodman move a half inch toward the instrument and a half inch to the rodman's left, or have him move .06 feet toward 11 o'clock.**

5. **Drive the stake and press** SHOT **to check.**

Staking the Centerline

Stake the centerline on 50-foot intervals beginning with station 0+00.

1. ***SMI*** **defaults on 100-foot increments. To change the increment, press** CONST NXT NXT OPT.

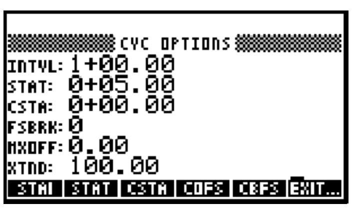


Figure 8-49 SMI Default

2. **Key in** 50 **and press** STAI **(Station Interval).**

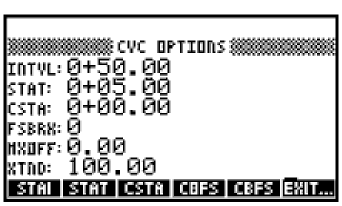


Figure 8-50 Station Interval

3. **Press the** CONST **key.**

4. Key in `0` and press **F S**.

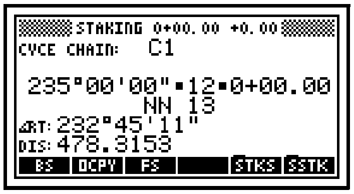


Figure 8-51 CVCE Chain C1

5. You are now ready to point at the prism. Press **STKS** and stake the point.
6. Key in `478.3753` **SPC** `90.2430` **SPC** `231.4511` and press **ENTER**.

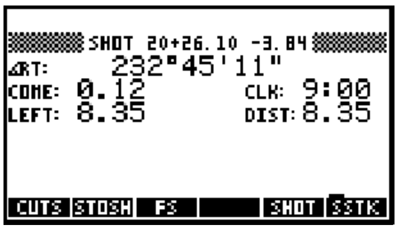


Figure 8-52 Come, Left, and Dist Values

7. To increment to the next station to stake, press **F S** without keying in any value.

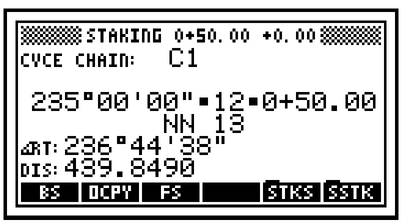


Figure 8-53 Stake the Next Station

8. Stake this, and press **F S** to increment to the next point, etc.

Staking a Point on an Offset and Incrementing

1. Press the **CONST** key.
2. Key in `100` (station number) **SPC** `50` (offset distance) and press **F S**.

Figure 8-54 Station and Offset

3. Stake the point and press FS again.

Figure 8-55 Staking the Point

Note that the offset remains constant as you press FS to increment to the next station.

You are now ready to learn how to work with vertical control and templates.

Entering Vertical Control

There are several types of vertical control. Following are some examples.

The vertical control example below includes slopes, a vertical curve, and break point. You will learn how to enter this vertical control into SMI's ***Construction Five***.

1. **Press the CONST key, NXT and VCCL.**
2. **The following information should be keyed in for this vertical control example:**

   STA, elevation, percent, quotes, pvc station, pvt station, close quote, percent, station, and percent. See the figure below.

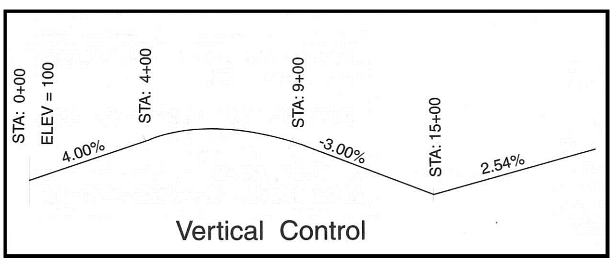


Figure 8-56 Vertical Control

The data, when entered in the data collector, should look like this: 0 100 4 "400 900" -3 1500 2.54

The keystrokes to enter the data are: (zero is already displayed and a space is already there)

`100` SPC `4` SPC ↱ — (the minus key) `400` SPC `900` ▶ (cursor right)

SPC `3` +/− (the Y key) SPC `1500` SPC `2.54`

0 100 4 "400 900" -3 1500 2.54

3. **Press ENTER.**

Figure 8-57 Enter the Vertical Control

This enters the vertical control for the HARVICK job with which you have been working.

Continuing to use the example from above, the occupied point is still a free station point. You do not have to use a free station point when using a vertical control – any known point will do.

How to Find the Designed Elevation for Station 0+00, 1+00, 9+00, and 15+00:

4. **Press** [shift key] `3`**, the shortcut to turning on Elevations.**

5. **Press the CONST key, key in** `0`**, and press FS.**

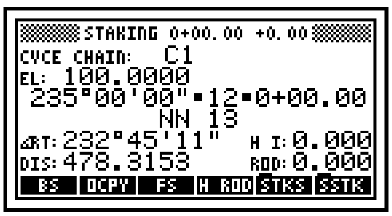


Figure 8-58 Find the Designated Elevation

The elevation is 100, as it should be, because you are at the beginning station and your vertical control start elevation is 100.

6. **Key in** `100` **and press FS.**

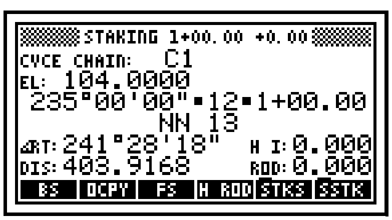


Figure 8-59 Elevation at Station 1+00

The elevation at station 1+00 is 104. At a 4% slope, that could have been predicted.

7. **Key in** `400` **and press FS.**

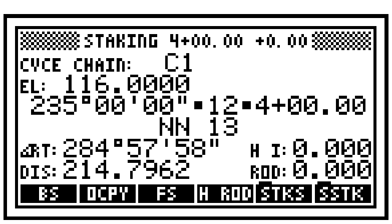


Figure 8-60 Elevation at Station 4+00

8. **Key in** `900` **and press** **FS**.

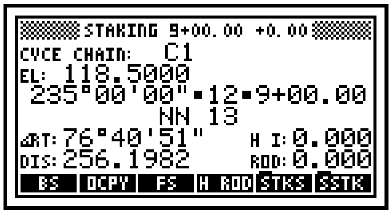


Figure 8-61 Elevation at Station 9+00

9. **Key in** `1500` **and press** **FS**.

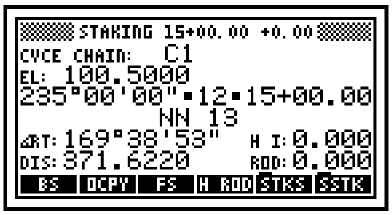


Figure 8-62 Elevation at Station 15+00

10. **Press** **FS**.

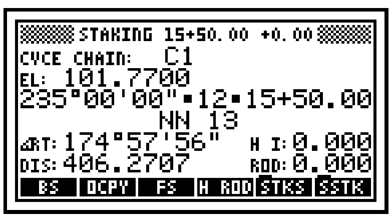


Figure 8-63 Elevation at Station 15+50

See that the software automatically incremented 50 feet. Recall that previously, the increment was set from 100 to 50 feet.

Try giving ***SMI*** a station and an offset.

11. **Key in** `400` **SPC** `50` **and press** **FS**.

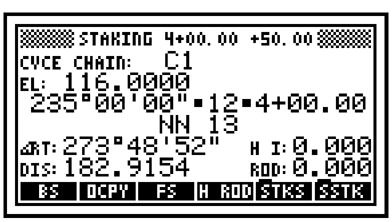


Figure 8-64 Elevation at Station 4+00.00 +50.00

Note that the elevation is the same as station 4+00 at the centerline. This indicates there is a default flat cross-section template in this job. Go to the Template menu and see what it looks like.

Draw Vertical Control

SMI can show you a drawing of the vertical control in your job.

1. **Press CONST NXT NXT.**
2. **Press DRAW then VCCL for vertical control.**

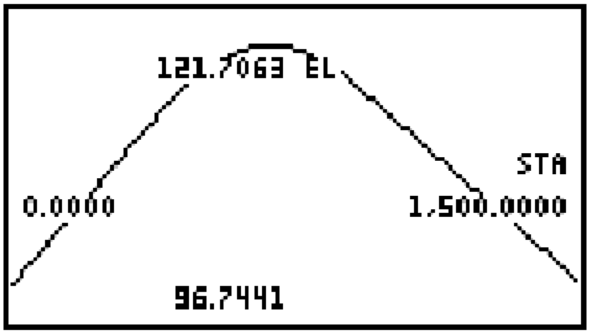


Figure 8-65 Draw Vertical Control

The number on the bottom of the screen is the low point of the control. The number on the top is the high point of the control. The numbers on the left and right sides are the beginning and ending stations.

✎ *Please note that the vertical control is exaggerated. If it was not, the drawing would look like a flat line in most cases.*

Entering Templates

See *Horizontal Control with Construction Five* on page 277 for additional information.

1. **Press NXT and TMPL.**

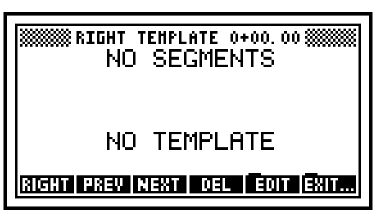


Figure 8-66 Default Template

Do not let this fool you. There is a default template hidden in there, but it is flat. Once you go to TMPL and press EDIT, the default template disappears and you need to enter your own template.

2. Press **EDIT**.

Figure 8-67 Right Template

Note that the station defaulted on 0+00. You are now ready to enter segment 1.

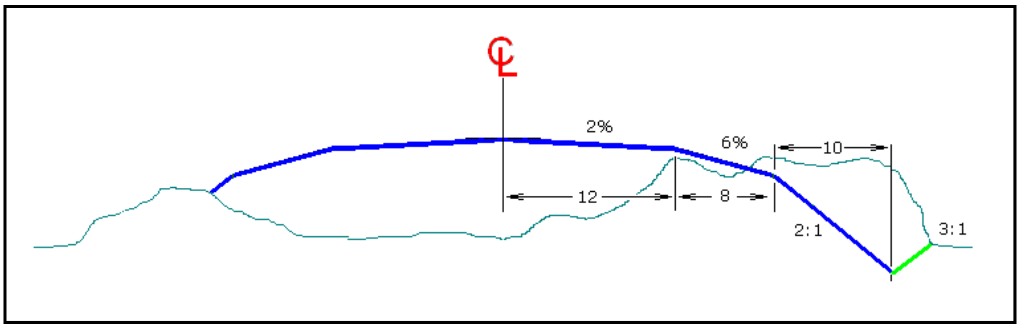


Figure 8-68 Station Template

If this is what the road work is calling for, the next figure is what the template looks like.

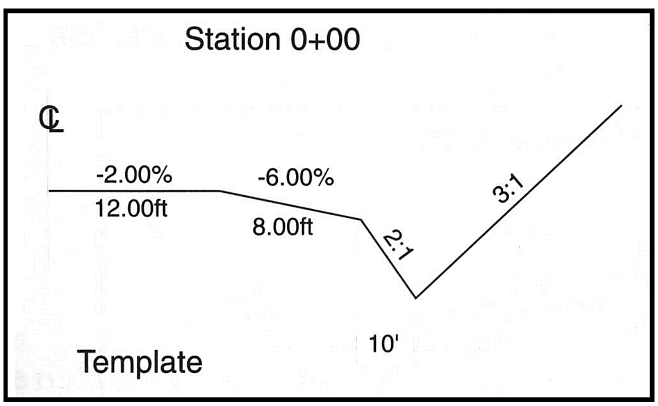


Figure 8-69 Station 0+00 Template

3. Press **SEG1**.

This is what the data should look like: -2 12

Following are the keystrokes:

4. **Key in** `2` **(for the -2% downward slope) and press** **+/−** **(the Y key)** **SPC** `12` **(for the number of feet that the -2% grade travels) and press** **ENTER**.

Figure 8-70 Segment 1

5. **Press** **SEG2**, **key in** `6` **(for the -6% downward slope)** **+/−** **SPC** `8` **ENTER** **(for the number of feet that the -6% grade travels).**

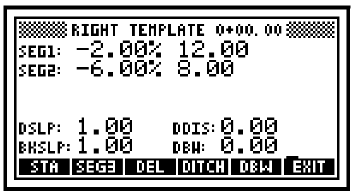


Figure 8-71 Segment 2

6. **Press** **DITCH** **and** **ON** **to remove the default ditch.**

7. **Key in** `2` **SPC** **(for the 2:1 ditch slope)** `10` **SPC** **(for the number of feet the 2:1 ditch travels)** `3` **(for the 3:1 backslope) and press** **ENTER**.

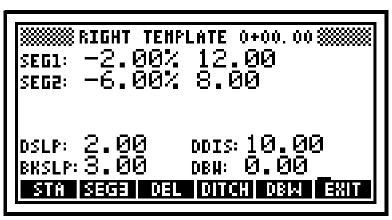


Figure 8-72 Ditchslope and Backslope

That finishes the template at station 0+00. Now enter the next template on the right side of the centerline 200 feet down the road.

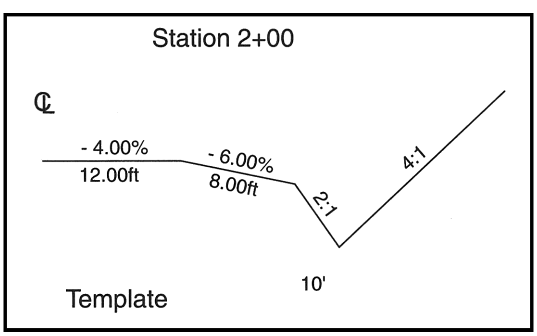


Figure 8-73 Station 2+00 Template

First go to station 2+00.

8. **Key in** `200` **and press** **STA**.

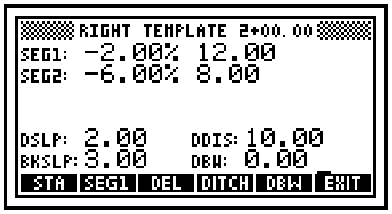


Figure 8-74 Station 2+00

9. **To go to a segment not displayed, first key in the segment number that you wish to edit and press** **SEG1** **or it may be** **SEG2** **or** **SEG3**. **Since the** **SEG1** **is displayed here, it is not necessary to press the segment number first.**
10. **Key in** `1` **and press** **SEG1**.
11. **Use the arrow and backspace keys to change the -2 to a -4. The entry should be -4 12. When it is, press** **ENTER**.

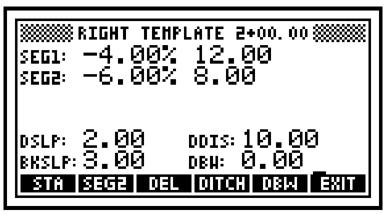


Figure 8-75 Segment 1

12. **Press** **DITCH**.

    You see `2 10 3`.

13. **Use the** **▶** **(cursor right) key to move the cursor to the 3 and change it to a** `4`. **Press** **ENTER**.

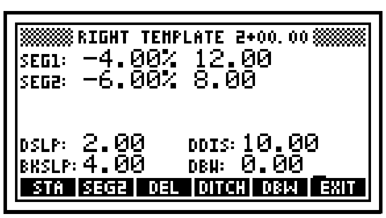


Figure 8-76 BKSLP 4

Draw the Template

1. **Press** **CONST** **NXT** **NXT**.
2. **Press** **DRAW** **then** **TMPL** **for vertical control.**
3. **The program will then prompt you for the station you would like drawn; 0 is the default. For this example, just press** **ENTER** **to accept 0 as the station.**

4. **You will now be prompted for the left or right side of the center line. Press RIGHT for now.**

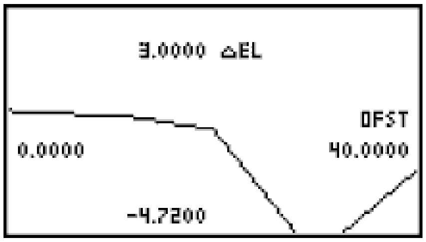


Figure 8-77 Template Drawing

The number on the left is the offset from the centerline (it will always be zero). The top number is the change in the elevation from the centerline to the top of the scene. The bottom number is the change in elevation from the centerline to the bottom of the scene.The right side number is the offset to the right of the scene.

Templates – Uncommon

Templates with Curbs

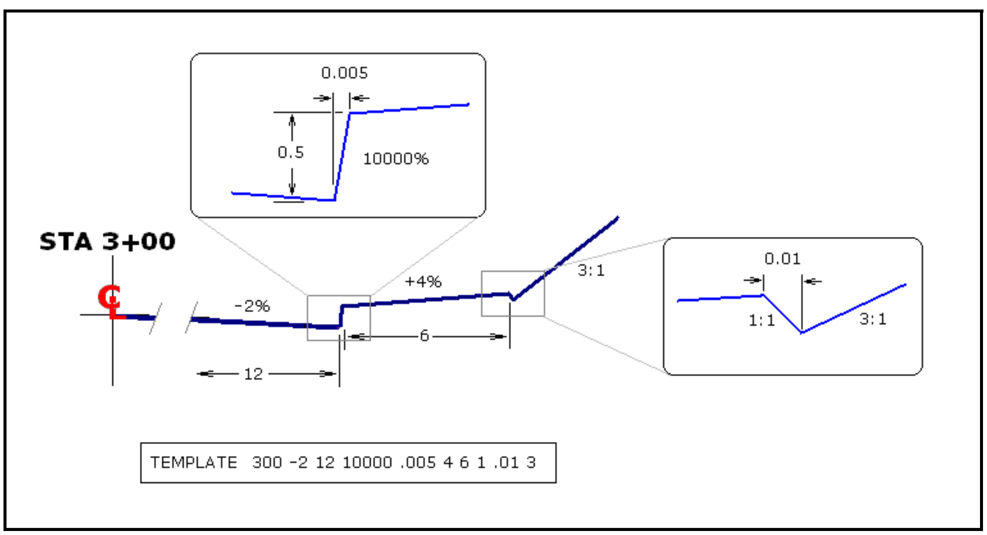


Figure 8-78 Cut Template with a Curb

This example demonstrates how to handle a vertical distance such as a curb. This situation is handled by entering a very steep slope for a very short distance. Figure 8-78 above shows a 0.5’ curb.

Straight up is an infinite slope. To solve this mathematical problem, the curb can be entered as being 0.005’ long with a slope of 10000% (10000%/100 * 0.005’ = 0.5’ of vertical change). Therefore, whatever the vertical change is, you can enter a slope of 10000 and move the vertical distance decimal two places to the left.

1. **Press CONST NXT TMPL to get in the Template Viewer. Press NEXT until the current template is at station 2+00. Press EDIT to get in the Template Editor.**

2. **Type** `300` **and press STA to start editing the template at station 3+00. This new template is a copy of the previous template. You will change it to match the template shown in Figure 8-78 above.**

3. **Type** `1` **and press** SEG1 **to edit the first segment. Press** ON **to clear the previous slope and distance and type** `2` +/− SPC `12` **and press** ENTER**.**
4. **Press** SEG2**, press** ON **to clear the previous entry, type** `10000` SPC `.005` **and press** ENTER**.**
5. **Press** SEG3 **type** `4` SPC `6` **and press** ENTER**.**
6. **Continue entering this template in the next section.**

Cut Templates without a Fill Slope

Figure 8-79 Cut Templates without a Fill Slope Template

The template in Figure 8-78 on page 178 also demonstrates how to enter the ditch information when there is no ditch slope (fill slope). The software requires that the ditch slope (fill slope), ditch distance, and back slope (cut slope) always have a nonzero value. If you make the ditch distance value close to zero, both the cut and fill slopes will start from the shoulder. Since you can assume that all shots will be taken above the shoulder, only the cut slope will be used. This step is continued from the previous section.

7. **Press** DITCH**, press** ON **to clear the previous entry, type** `1` SPC `.01` SPC `3` **and press** ENTER**.**

✎ *Note that if a shot is taken below the "ditch" on this template, the data collector will catch on the 1:1 ditch slope.*

Fill Templates without a Backslope

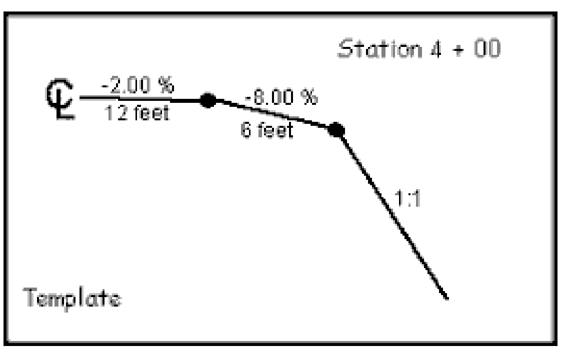


Figure 8-80 Fill Templates without a Backslope Example

This example demonstrates how to enter a template that does not have a back slope. The software requires that the ditch slope (fill slope), ditch distance, and back slope (cut slope) always have a nonzero value. If you make the ditch distance value close to zero, both the cut and fill slopes will start from the shoulder. Since you can assume that all shots will be taken below the shoulder, only the fill slope will be used.

1. **Press CONST NXT TMPL to get in the Template viewer. Press NEXT until the current template is at station 3+00. Press EDIT to start the Template Editor.**

2. **Type** `400` **and press STA to start editing the template at station 4+00. This new template is a copy of the template at station 3+00. You will change it to match the template shown in Figure 8-80 on page 179.**

3. **Type** `1` **and press SEG1 to edit the first segment. Press ON to clear the previous slope and distance and type** `2` **+/− SPC** `12` **and press ENTER.**

4. **Press SEG2, press ON to clear the previous entry, type** `8` **+/− SPC** `6` **and press ENTER.**

5. **Press DEL, type** `3`**, and press ENTER to delete segment 3.**

6. **Press DITCH, press ON to clear the previous entry, type** `1` **SPC** `.01` **SPC** `1` **and press ENTER.**

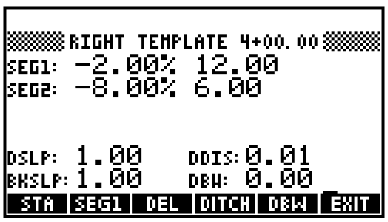


Figure 8-81 Fill Templates without a Backslope

✎ *The backslope must be entered as a placeholder, even though it does not exist.*

Template with Ditch Bottom Example

If the template needs to represent a cut ditch with a flat bottom, use the following example:

Template with Ditch Bottom

100 -2 20 -5 10 1 4 2 1.5

Whereby the “2” in the sequence represents the horizontal distance or width of the ditch bottom measured from the base of the cut ditch slope or foreslope.

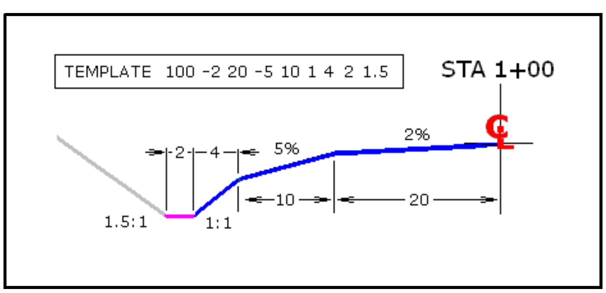


Figure 8-82 Template with Ditch Bottom Example

✎ *The presence of a ditch bottom is assumed when there is an odd number of elements in the template.*

Widening Example

Widening may be performed along the first segment or element of your template. Typically, this section is widened, as it represents the travelway pavement or subgrade section of a standard two-lane road. To perform a widening, you need to enter four stations with templates. Place a template at the beginning of the widening (B), start of full widening (C), end of full widening (D), and end of widening (E). Refer to the diagram below for referenced stations.

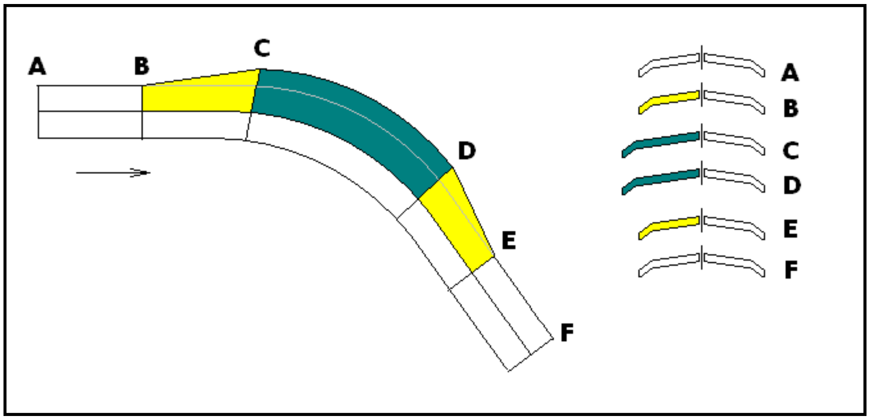


Figure 8-83 Standard Widening Transition Example

Above is an example of a standard widening transition. You will use two different templates for the left side only.

The diagram is illustrated as follows:

Standard Widening Transition Example Explanation

Left Template	*Right Template*	*Station*
Normal width left	Normal width right	Beg
<none required>	<none required>	A
Normal width left	<none required>	B
Full widening left	<none required>	C
Full widening left	<none required>	D
Normal width left	<none required>	E
<none required>	<none required>	F

The templates illustrated may have been entered as follows:

Standard Widening Transition Templates

Left Template	***Right Template***	***Station***
0 -2 12 -8 4 3 4 3	0 -2 12 -8 4 3 4 3	Beg.
<none required>	<none required>	A
1300 -2 12 -8 4 3 4 3	<none required>	B
1600 -2 20 -8 4 3 4 3	<none required>	C
2000 -2 20 -8 4 3 4 3	<none required>	D
2300 -2 12 -8 4 3 4 3	<none required>	E
<none required>	<none required>	F

Superelevation Example

To perform superelevation, you also need to transition between a series of templates. These templates need to be placed at the beginning and ending of the transitions. If you have a horizontal curve turning to the right (clockwise), a standard method is to begin rotating the left side upwards until the cross-slope of the pavement or subgrade matches that of the right side.

Then, both sides rotate uniformly until the station where the maximum superelevation (MSE) is reached. Place another set of templates at the station the MSE is ending to start the transition back down. Place yet another one at the point at the end of the superelevation to mark the end of the superelevation transition.

The slope transition works on the first segment from the start of the template only.

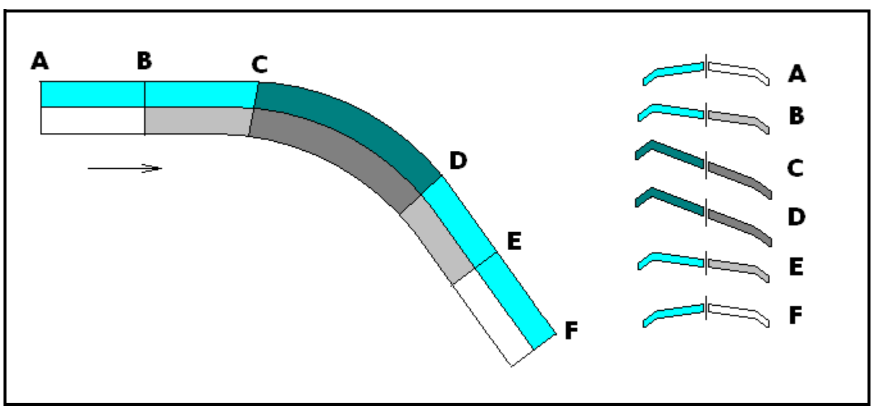


Figure 8-84 Standard Superelevation Transition Example

Figure 8-84 above is an example of a standard superelevation transition. You use two different templates for the left side and two different templates for the right side.

The diagram is illustrated as follows:

Standard Superelevation Transition Example Explanation

Left Template	***Right Template***	***Station***
Normal crown left	<none required>	A
<none required>	Normal crown right	B
Maximum super left	Maximum super right	C

Standard Superelevation Transition Example Explanation

Left Template	***Right Template***	***Station***
Maximum super left	Maximum super right	D
<none required>	Normal crown right	E
Normal crown left	<none required>	F

The templates illustrated may have been entered as follows:

Standard Superelevation Transition Templates

Left Template	***Right Template***	***Station***
0 -2 12 -8 4 3 4 3	0 -2 12 -8 4 3 4 3	Beg.
1000 -2 12 -8 4 3 4 3	<none required>	A
<none required>	1300 -2 12 -8 4 3 4 3	B
1600 6 12 -8 4 3 4 3	1600 -6 12 -8 4 3 4 3	C
2000 6 12 -8 4 3 4 3	2000 -6 12 -8 4 3 4 3	D
<none required>	2300 -2 12 -8 4 3 4 3	E
2600 -2 12 -8 4 3 4 3	<none required>	F

Interpolation Between Templates

When a shot is taken, or a foresight is entered for a station that is between two templates, the slopes and distances from each segment are interpolated to create a new template exactly at that station. When the two templates being interpolated between have different numbers of segments, the data collector displays the error message "`Templates Not Similar`." To prevent this from happening, a template with the same number of segments should be placed right next to the template that has a different number of templates.

The template at station 3+00 in the HARVICK example used in this chapter has three segments while the other templates at 0+00, 2+00, and 4+00 have two segments.

You can correct this problem by creating a copy of the template at station 2+00 at station 2+99.99 and putting a copy of the template at station 3+00 at station 3+99.99.

1. **Press CONST NXT TMPL to get in the Template viewer. Press EDIT to start the Template editor.**
2. **Type `200` and press STA to recall the template at station 2+00. When there is a station number of an existing template entered before pressing STA, the template at that station is recalled.**
3. **Type `299.99` and press STA to store the current template at station 2+99.99.**

   This new template is a copy of the template at station 2+00. When STA is pressed after entering a station number for a template that does not yet exist, the information from the template at the station previous to the station entered is used to create the new station.
4. **Press STA to recall the template at station 3+00.**

   When there is nothing on the stack, STA recalls the next template.
5. **Type `399.99` and press STA to store the current template at station 3+99.99.**

This new template is a copy of the template at station 2+00. When there is a station number of a template that has not been stored entered before pressing **STA**, the current station is stored.

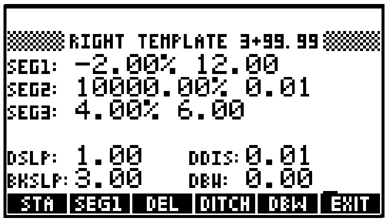


Figure 8-85 Interpolation Between Templates Example

Copy Templates to Other Side

Duplicate the right template on the left side of the centerline.

1. **Press EXIT NXT R→L YES.**

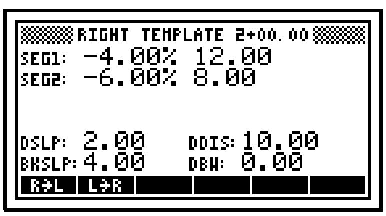


Figure 8-86 Right Template

2. **Press NXT and RIGHT (this shows the left template).**

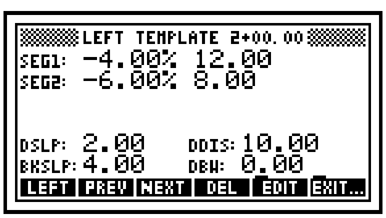


Figure 8-87 Left Template

3. **Press PREV or NEXT on the soft keys to move up or down through the stations.**

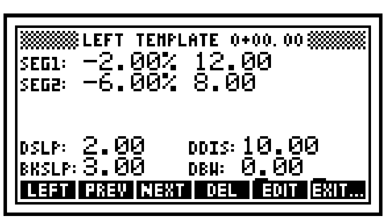


Figure 8-88 Navigate through the Stations

This example has demonstrated how to edit any template or add any template to the control file. Once this is done, you are ready to go to the field and set slope stakes, reference point stakes, grade stakes, property line stakes and collect cross-section data.

Slope Staking

The goal of slope staking is to place stakes in the correct locations and put information on the stakes that will help those operating earth moving equipment to know where the earth needs to be moved. The stake is either placed at the catch point (intersection of the template and the existing ground) or at a reference location offset from the catch point. The information put on the stake varies among survey crews, so the ***SMI*** software provides several different types of information.

This example will demonstrate some of the features of ***SMI's*** slope staking functions. It assumes that you have entered the horizontal and vertical control using the HARVICK example in this chapter. Entering the templates in the previous examples is not required because this example will enter the template you will be using.

1. **Press CONST NXT and TMPL to get in the Template Viewer. Press EDIT to start the Template Editor.**
2. **Type** `450` **and press STA to start editing the template at station 4+50. This new template is a copy of the template at the previous station. You will change it to match the template in Figure 8-89 below.**

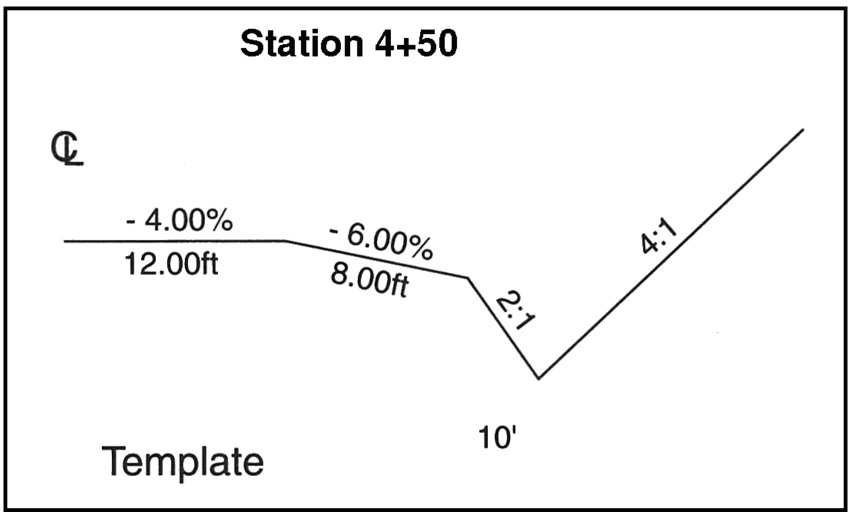


Figure 8-89 Station 4+50

3. **Type** `1` **and press SEG1 to edit the first segment. Press ON to clear the previous slope and distance and type** `4` **+/− SPC** `12` **and press ENTER.**
4. **Press SEG2, press ON to clear the previous entry, type** `6` **+/− SPC** `8` **and press ENTER.**
5. **Press DITCH, press ON to clear the previous entry, type** `2` **SPC** `10` **SPC** `4` **and press ENTER.**

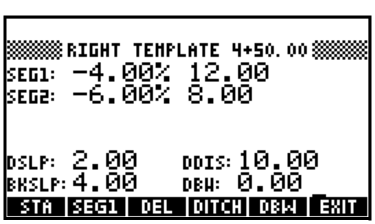


Figure 8-90 Template at Station 4+50

6. **Press** SETUP.

7. **Key in** 12 **and press** OCPY.

8. **Key in** 5 **and press** BKPT.

To shoot a benchmark:

9. **Press** SETUP NXT B M **key in** 100 SPC 89 SPC 0 **and press** ENTER.

Figure 8-91 Benchmark

10. **Key in** 100 **and press** E L?.

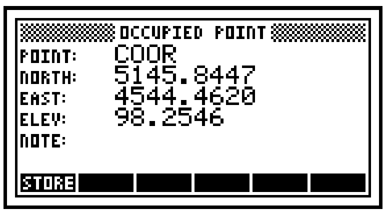


Figure 8-92 Occupied Point

Try staking station 5+00 at station 50 right.

11. **Press the** CONST **key.**

12. **Key in** 500 SPC 50 **and press** F S.

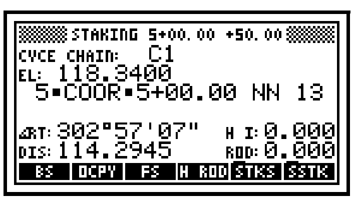


Figure 8-93 Stake Station 5+00

13. **Point the instrument at the prism and press** STKS.

14. **For Manual mode, key in** 114 SPC 89 SPC 303 **and press** ENTER.

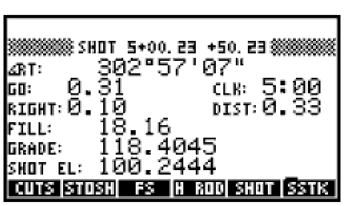


Figure 8-94 Station Stakeout Menu

To find slope stake information:

15. **Press SSTK.**

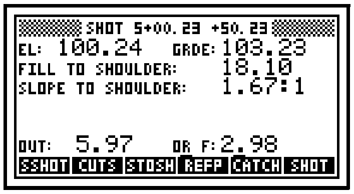


Figure 8-95 Slope Stake Information

16. **Have the rodman move out about 6 feet and take another shot by pressing SHOT.**

17. **For Manual mode, key in** `109` **SPC** `89` **SPC** `301.30` **and press ENTER.**

Figure 8-96 Slope Stake Menu

BRKC, BRKR, and BRKI represent three ways that data can be displayed by ***SMI***. Each refers to cuts and fills and distances from the catch point or from the centerline.

With any of these options you have enough information to write on the slope stake so that the grader operator can grade from the catch point to the centerline of the road.

The best way to learn is to practice:

18. **Press CATCH.**

    The catch point is at the intersection of the template and the existing ground. In other words, it is where the grader can stop cutting or filling.

    Notice that when you pressed CATCH, the station was rounded to the nearest station, which is 5+00. The Angle Right, Go/Come, and Left/Right values will put you on the even station. If you do not want the stations rounded, set the Station Tolerance to 0 in the ***Construction Five*** Options menu (CONST NXT NXT OPT STAT). Change the Station Interval STAI in the same menu to control which stations will be rounded. The default is to round to every station evenly divisible by 1+00 if within 5 feet of that station (round to every station ending with +00).

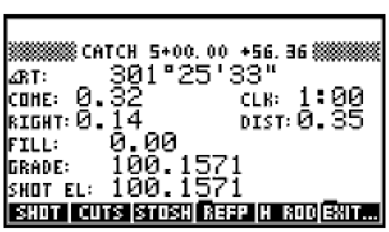


Figure 8-97 Catch Point Menu

19. **Press STOSH to store the last shot taken to a point. It will be stored to point 13, the current next number.**

To shoot a reference point:

20. Press CUTS to store the last shot in the cutsheet file. The following record will be stored:

STATION	***OFFSET***	***GRADE***	***SHOT***	***CUT/FILL***	***SHOULDER***	***NOTE***
5+00.00	56.02	100.16	100.16	F 0.00		

Press REFPT to stake a reference point offset 10 feet from the catch point. If you enter an offset value before pressing REFPT, that value will be used instead.

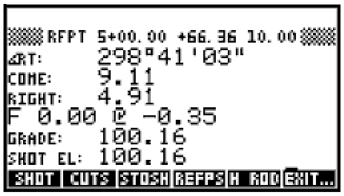


Figure 8-98 Reference Point Menu

21. Press SHOT then key in 103 SPC 89.25 SPC 303 **and press ENTER.**

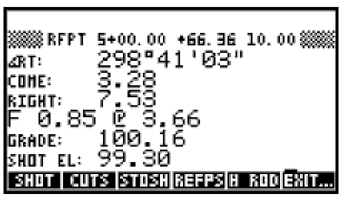


Figure 8-99 Shot Data

Display the Reference point stake information.

22. Press NXT, BRKC.

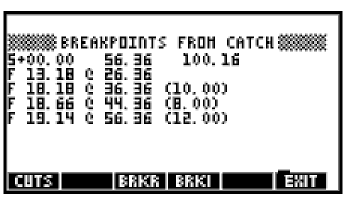


Figure 8-100 Breakpoints from Catch

23. Press BRKR.

Figure 8-101 Breakpoints from Shot

24. **Press BRKI.**

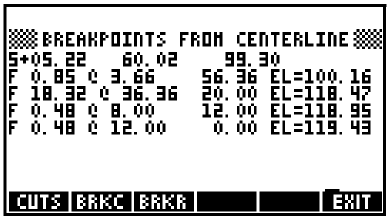


Figure 8-102 Station 2+00 Template

Cutsheet Files

The cutsheet file stores information about stations and offsets, their grade elevations, and depending on the application, it may also store the shot elevation, cut/fill values, and shoulder information. The cutsheet can be viewed in the data collector by pressing CONST NXT CUT and VIEW. Individual entries in the cutsheet file cannot be edited or deleted. There are CUTS soft keys in various menus that will store the current information to the current cutsheet. The current cutsheet has the same name as the current chain file. The cutsheet is deleted when the chain it is associated with is deleted. The cutsheet file can be sent to a PC using ***SMI Transfer***.

Automatically Generating Cutsheet Files

The Auto Cutsheet menu can generate offsets and elevations for a range of stations. The offset can be either a constant offset or an offset can be generated for the centerline and all breaks in the template on both the right and left sides.

The following example assumes that you have entered the HARVICK example in this chapter up to this point.

1. **Press CONST NXT NXT AUTO to start the Auto Cutsheet menu.**
2. **Press** `0` **BEG** `400` **END** `100` **INTVL** `0` **OFFST to indicate storing offsets and elevations for each breakpoint in the templates at stations 0+00 through 4+00. If an offset other than 0 had been entered, only that offset and elevation would be generated at each station.**
3. **Press CUTS to store the indicated entries to the cutsheet.**

   If COOR had been pressed instead of, or in addition to, pressing CUTS, points with coordinates at each of the stations and offsets and grade elevations would have been stored.

When sent to a PC using ***SMI Transfer***, the cutsheet file looks like this:

Cutsheet File

STATION	*OFFSET*	*GRADE*	*SHOT*	*CUT/FILL*	*SHOULDER*	*NOTE*
0+00.00	0.00	100.00				
0+00.00	-12.00	99.76				
0+00.00	-20.00	99.28				
0+00.00	-30.00	94.28				
0+00.00	12.00	99.76				
0+00.00	20.00	99.28				

Cutsheet File

STATION	*OFFSET*	*GRADE*	*SHOT*	*CUT/FILL*	*SHOULDER*	*NOTE*
0+00.00	30.00	94.28				
1+00.00	0.00	104.00				
1+00.00	-12.00	103.64				
1+00.00	-20.00	103.16				
1+00.00	-30.00	98.16				
1+00.00	12.00	103.64				
1+00.00	20.00	103.16				
1+00.00	30.00	98.16				
2+00.00	0.00	108.00				
2+00.00	-12.00	107.52				
2+00.00	-20.00	107.04				
2+00.00	-30.00	102.04				
2+00.00	12.00	107.52				
2+00.00	20.00	107.04				
2+00.00	30.00	102.04				
3+00.00	0.00	112.00				
3+00.00	-12.00	111.76				
3+00.00	-12.01	112.26				
3+00.00	-18.01	112.50				
3+00.00	-18.02	112.49				
3+00.00	12.00	111.76				
3+00.00	12.01	112.26				
3+00.00	18.01	112.50				
3+00.00	18.02	112.49				
4+00.00	0.00	116.00				
4+00.00	-12.00	115.76				
4+00.00	-18.00	115.28				
4+00.00	-18.01	115.27				
4+00.00	12.00	115.76				
4+00.00	18.00	115.28				
4+00.00	18.01	115.27				

Spirals in CVC

Definitions

Simple Spiral

Connects and is tangent to a straight line and a circular arc. The radius of the spiral at the TS is infinite and at the arc is equal to the radius of the arc. The method used in SMI software to compute the spiral can be referred to as a clothoid, Euler spiral, American spiral, or transition spiral. Other easement curves not supported by ***SMI*** are cubic parabola, lemniscate, Searles, and A.R.E.A. 10 chord spirals.

Combining Spiral

Connects and is tangent to two arcs. The radius of the spiral at the two arcs is equal to the radius of each arc. Not supported in ***CVC***.

Compound Spiral

Connects and is tangent to a straight line and a circular arc. The radius of the spiral at the TS is not infinite and at the arc is equal to the radius of the arc. Not supported in ***CVC***.

CVC requires entry of the TS, PI, ST, Radius, SLB, and SLA. The TS, PI, and ST are actually only used to define the tangents of the two spirals. It then calculates the position of the spirals and compares the computed ST and TS to the entered points. If they are different by more than the horizontal tolerance, the user is prompted to overwrite the points or store them to a new point number.

If the user expects the TS and ST points entered to be exactly correct and is prompted to overwrite them, he should store them to a different point number and then inverse between the entered and newly-stored points to see how far they are apart. If they are far apart, the spiral may have been entered incorrectly.

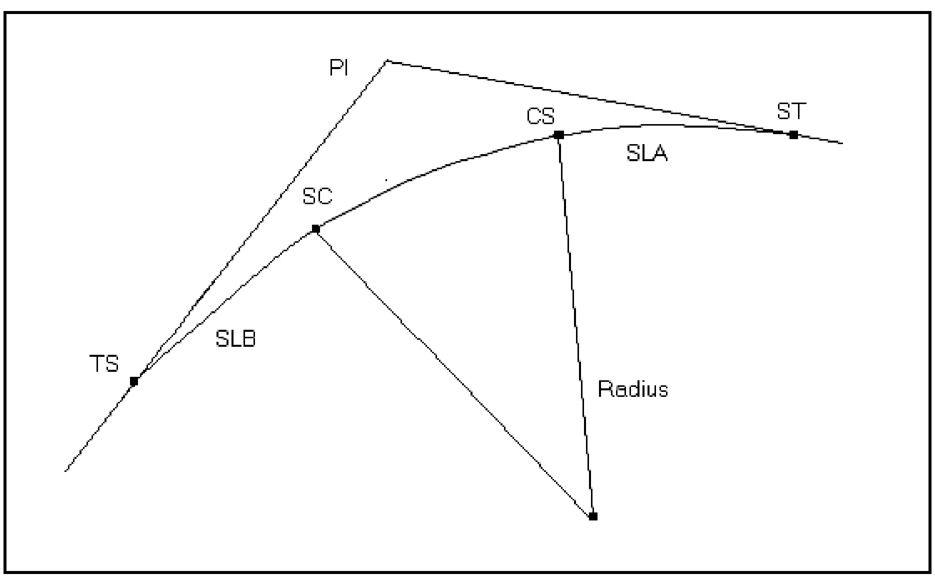


Figure 8-103 Spirals

Entering a Single Spiral

Sometimes it is useful to enter just one spiral instead of an arc inside two spirals, as is usually the case. To enter the spiral in the following picture enter: {`TS PIs SC Radius SLB 0`}.

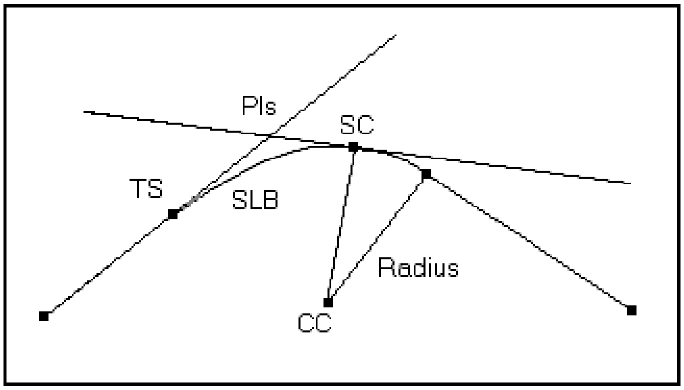


Figure 8-104 Single Spiral

One way the PIs (PI of the spiral) can be calculated is from the TS using the tangent direction and the line perpendicular to the CC at the SC. The Radius is the radius of the arc.

Entering a Spiral and an Arc

To enter a spiral and an arc: {`TS PI PT Radius SLB 0`}

If coming from the other direction: {`PT PI TS Radius 0 SLB`}

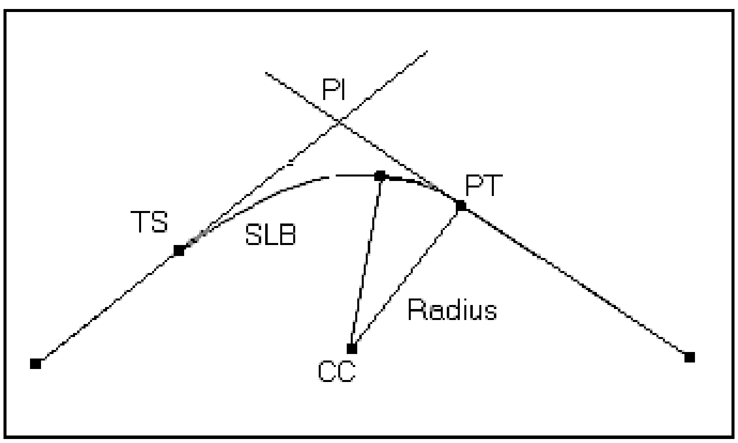


Figure 8-105 Spiral and Arc

Spiral Program

A simple spiral solver can be used by turning on ALPHA, typing `SPIRAL`, and pressing **ENTER**. Enter the Radius, SLB, SLA, and I (angle between tangents) to get some basic information about the two spirals on the stack:

```
X1 Y1 Xo1 o1 Tangent1 X2 Y2 Xo2 o2 Tangent2
```

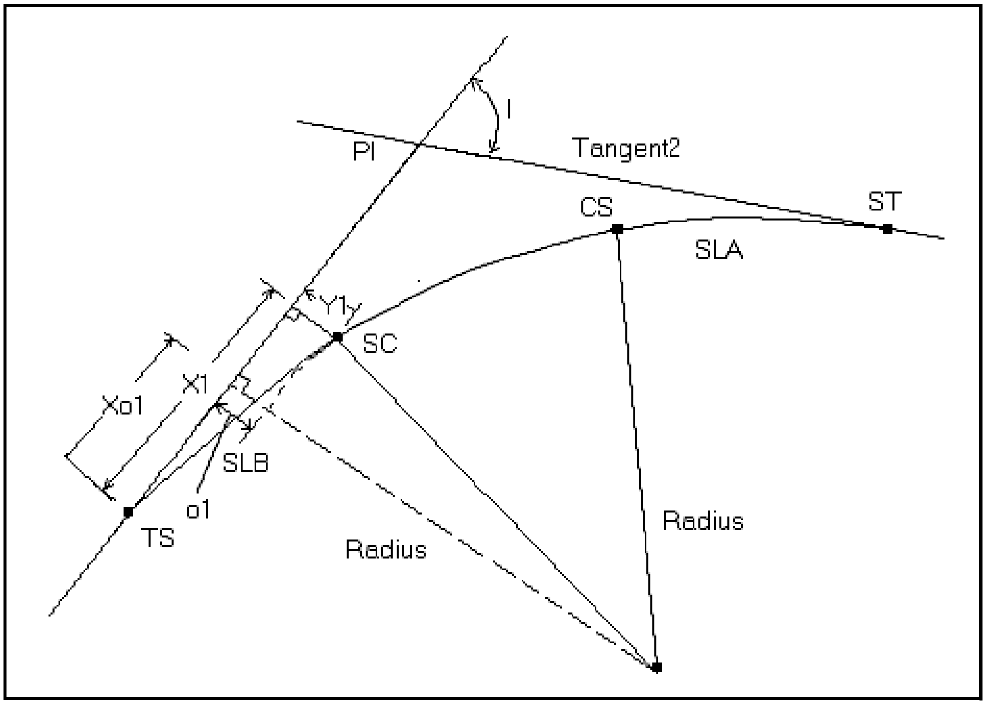


Figure 8-106 SPIRAL Program

o1 and o2 are sometimes called the “throw.” Xo1 and o1 define a point called the “offset T.C.”

Chapter 8: Construction Five

Robotic Functions

CHAPTER

9

In this chapter:

Key Definitions

Key	Function
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
Hard Keys	Hard key functions are imprinted on each key itself. The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card. **Hard keys are represented in this manual as black lettering on a gray, rectangular background.**
Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

Robotic Functions

The robotic functions are designed to work with robotic instruments as a tool to enable a one-man or two-man crew, rather than a two- or three-man crew. Another feature is the ability of the software to continuously update the screen while staking or slope staking without pressing any additional keys.

✎ *You will need to own the **Construction Five GPS/Robotics (CVCER)** or **Data Collection GPS/ Robotics (DCER)** program to access the following functions.*

Supported Equipment

Supports all standard instruments plus the following instruments optimized for one-man operation:

- ➥ Leica TCA Series
- ➥ Topcon AP-L1A and 800 series instruments
- ➥ Geodimeter 600 series instruments
- ➥ Trimble 5600 Series instruments
- ➥ Zeiss Elta S20

Auto Shots

KEYSTROKES: ➦ SHOTS NXT AUTO

The AUTO soft key on the second page of the SHOTS menu uses the robotics of the instrument to automatically do as many more sets as specified.

Procedure

1. **Set up a prism at the backsight and each point to be shot.**
2. **Sight on the backsight in the front face (zenith~90), press the ZERO key and then the BS key.**
3. **Sight on the foresight and press SHOT. Repeat step 3 for every foresight.**
4. **Type the number of total sets to turn and press AUTO. The current set is finished and then additional sets are performed. Enter** `1` **to finish the current set.**

Real-time Side Shot

KEYSTROKES: [→] RSIDS

[→] RSIDS (the Q key) records a side shot whenever the rod moves farther than the minimum distance from the last shot taken. The current distance from the last stored point is displayed until a new point is stored. The default minimum distance is 10. To change the minimum distance, type it in before pressing [→] RSIDS (the Q key).

If the prism pole is not completely level before the measurement is recorded, it might create a problem. Therefore, you may enter a negative sign before the distance so the data collector prompts you to store the side shot when the distance from the last point is reached. This should also give you time to level the prism before storing the shot.

(+) Distance = automatic storage

(-) Distance = user confirmed storage

Real-time Stakeout

KEYSTROKES: [←] SHOT

The SHOT key in any of the stakeout menus takes a single measurement. Pressing [←] SHOT starts the Real-time Stakeout mode. Every time a new measurement is completed, the Go/Come Left/ Right values are updated. To stop measuring, press ON or CANCEL twice.

Rezero

KEYSTROKES: [←] ZERO

SHORTCUT: [←] RE-0 (the 0 key)

The [←] ZERO keys in any of the menus sight on the backsight and set the Horizontal Angle to zero. After setting the backsight to zero, it displays the Horizontal Angle error and stores it in the raw data file if raw data is on. This routine assumes that the unshifted ZERO key was used previously to set the Horizontal Angle to zero and record the location of the backsight.

Instrument Servo Positioning Screen

KEYSTROKES: [→] POS (the O key)

A servo positioning screen is assigned to the [→] POS keys. The positioning screen is helpful anytime that tracking of the prism needs to be established. The screen shows live updates for angles, distance if available, battery strength if available, and tracking information. If there are problems in communicating with the instrument, the message “POSITION DATA NOT AVAILABLE” is displayed.

Robot Servo Menu

KEYSTROKES: ROBOT (the R key)

This menu can be used to change instrument options and control servo operations for any instrument that has servo abilities.

Robot Servo Menu Soft Keys

Option	Function
FINE CRS	These are the same Coarse and Fine measure mode keys used in the INST menu and on the FINE .
PRISM REFL	If the instrument driver supports it, you can switch between Prism mode and Reflectorless mode.
LTON LTOFF	This button toggles between the track light being on and off if the instrument driver supports it.
A Z	Enter an azimuth to turn the instrument to. Alternatively, enter two numbers that define a direction. The Zenith Angle is assumed to be 90.
FLOP	This function changes the face of the instrument.
F S FS ■	Use this toggle key to control whether the instrument turns to the foresight point when the FSPT or F S keys are used. This flag is turned on every time an instrument driver that has servo ability, but not robotic ability, is selected. Other instrument drivers turn this flag off when selected. Note that if Elevations are off, the instrument turns to a Zenith Angle of 90. If the difference in elevation between the occupied point and foresight point requires a Zenith Angle greater than 45° up or down, the Zenith Angle is set to 90 because this usually is caused by a point that does not have an elevation stored.
INSTR POLE	This toggle key determines whether left/right is from the instrument perspective or the rodman's perspective (only available on GPS/Robotic cards).
SRCH	Press this button to start a search for the prism (only available on GPS/Robotic cards).
SRCH■	This key toggles between turning on and off Search mode. This is useful when using robotic instruments at the instrument.
BRG	Enter a bearing to turn the instrument to. The Zenith Angle is assumed to be 90.
HAZA	This key turns the instrument to the Angle Right and Zenith Angle entered. If only one number is entered, it is assumed to be the Angle Right, and the Zenith Angle is assumed to be 90°.
TOPT	Enter the point number to turn the instrument. The current backsight, HI, HROD, and occupied point are used in the calculation. If Elevations are off, or if the point has a zero elevation, the Zenith Angle is set to 90.

Robot Servo Menu Soft Keys

Option	Function
CDIR	Enter the compass azimuth from the rod to the instrument. The instrument turns to point to the rod.
CDECL	This function is used to enter the magnetic declination for use with the CDIR command.

Angle Turning

KEYSTROKES: ↰ RIGHT to turn right

↰ LEFT to turn left

↰ TRAV to turn up

↰ DOWN to turn down

For Geodometer, Trimble, and Zeiss instruments, enter an angle before pressing ↰ and the arrow key. The instrument will turn by that number of degrees. If no angle is given, the previous angle is used again. The default angle is 3°.

For Leica and Topcon instruments, enter a number between 1 and 5 to indicate the speed of the turn. Press any key to stop turning. If no number is given, the previous number is used. The default number is 3.

Other Features

Two Point Free Station (2PFS), Mean Backsight (MBS), Trig Leveling (TRIG), and Benchmark (B M) all turn the instrument to the correct face when taking direct and reverse shots.

Notes About Using SMI with Robotic Total Stations

1. **How to avoid an error at 30 feet:**

   It is possible for a 10-foot error to occur when you take a shot at about 30 feet if the instrument sees two of the prisms on the 360° prism set instead of one.

2. **Increase speed and accuracy using 2PFS.**

   It is more desirable to use the Two Point Free Station function when using a robotic total station than to set on a known point and backsight a known point.

3. **Using 0.00 for H ROD sometimes works best.**

   If you have a rod reading other than 0.00 while working with elevations and free station resection, set this value at ROD A and ROD B in the 2PFS program also (SETUP NXT 2PFS NXT).

4. **Using AUTO for multiple shots to one or more points:**

   If you want to take multiple shots to multiple points, set a prism at the backsight point and each foresight point. Use OCPY and BKPT to occupy the robot at the backsight prism and press SETUP NXT SHOTS ZERO and BS .

   Turn to each foresight point and press SHOT . After the last foresight point, press NXT and AUTO . If you wish to have the robot automatically finish the set and do one more set, type 1 and press AUTO .

Now you may relax while the robot is directed by ***SMI*** to automatically finish all sets to all points and display the results. Press **STPTS** to store the meaned coordinate position of each point. If Raw Data is on, ***SMI***'s modified raw data of each shot is also stored.

Robotic Instrument Drivers

Geodimeter G600/Trimble 5600

To control the Geodimeter 600/Trimble 5600 series instruments via radios, you must have the Command and Control (C&C) option or have an instrument firmware version later than 696-03.00. If the C&C module is not installed on your instrument, it can be purchased from and installed by your dealer.

Setting up the Geodimeter 600/Trimble 5600 Instrument

To prepare the instrument to communicate with the ***SMI*** data collector, set the following parameters on the instrument:

Option	*Setting*
Station address	1
Remote address/control unit address	2
Radio channel	1

Perform the following steps on the instrument to set these values:

1. **Press** **MNU** `1` **(Set)** `5` **(Radio) “**`Channel=1?`**”** **YES** **“**`Station address`**”** `1` **ENT** **“**`Remote address`**”** `2` **ENT**.
2. **The communications of the instrument and both radios should be set to 9600 baud and no parity.**
3. **Press** **MNU** `4` **(Data com)** `1` **(Select Device)** `2` **(Serial) “**`Serial ON?`**”** **YES** `1.8.0.9600` **ENT**.
4. **Set the table number to 0 and press** **ENT**. **If asked “**`REG KEY?`**” answer** **NO**. **If asked “**`Slave?`**” answer** **NO**.

To put the instrument in RPU mode:

Press the **RPU** key and choose Remote mode. If asked “`Set sector?`” press **NO**. If asked “`Measure Ref obj?`” press **NO**. When told to press any key, do so.

✎ *It is not necessary to remove the keyboard. After pressing the key, the instrument turns off and is ready to accept commands through the radio.*

You may also set these values on the ***SMI*** data collector to match the settings on the instrument. Select the Custom Instrument Functions menu by pressing **INFN**. Use **CHAN** to change the radio channel, **IADD** to change the Instrument Address, and **CUADD** to change the Control Unit Address.

Setting up the SMI Data Collector

Press [→] [×] (multiplication key) or press SETUP NXT NXT INST to get to the instruments menu.To install the Geodimeter 600 driver, press NXT NXT GEO and G600. If you are using the Trimble 5600, press NXT NXT TRIM and 5600. You will be asked for a baud rate. Set the baud rate to match the instrument (usually 9600) and press ENTER.

Plug the data collector into the radio's A port (the lower one) and make sure the radio is turned on. Press [←] INFN to start the Instrument Functions menu. Make sure CHAN IADD CUADD match the settings in the instrument. To start communication through the radios, press the soft key labeled ON. This will initialize the radio communications and turn the instrument level compensators on.

Geodimeter/Trimble Custom Instrument Functions Menu

KEYSTROKES: [←] INFN

The Custom Instrument menu for the Geodimeter 600 and Trimble is explained below.

Geodimeter/Trimble Custom Instrument Functions Menu Soft Keys

Option	Function
ON	This function prepares the Geodimeter to receive commands from the data collector. The Geodimeter must be in RPU mode for this to work.
OFF	This function turns the Geodimeter off, but leaves the radio for the Geodimeter on. The radio the data collector is connected to can be turned off manually. To turn the Geodimeter back on, turn the radio for the data collector back on and press the ON button in the Custom Instrument Functions menu. To turn off the Geodimeter and its radio, press the ROFF key on the last page of the Custom Instrument Functions menu.
FOLL	This function immediately puts the Geodimeter in Follow mode. If needed, a search is performed before starting Follow mode. This is useful when AIM and FLW flags are turned off and you want the instrument to follow the prism.
DIST	This function immediately sets the Distance mode. If the CRS / FINE toggle is set to CRS (Coarse) the future shots use this Distance mode. You can enter 0-3 to select one of the following: 0: Standard >4s· 1: Track 0.4s· 2: Repeated Standard 4s· 3: Fast Standard 2s
AIM	Use this toggle key to select whether the Aim command is used before performing a Coarse mode shot. The Aim command adds about 4 seconds to the shot.
FLW	Use this toggle key to select whether the Follow command is used after performing a Coarse mode shot. If the Aim command is used, Follow must be executed before the instrument will follow the prism again.
SRHA	This function changes the horizontal search range.
SRZA	This function changes the Zenith Angle search range.
SOUN	This function sets the sound level of the instrument. Enter a value between 0 and 99.
LEVEL	This function enables the level compensator.

Geodimeter/Trimble Custom Instrument Functions Menu Soft Keys

Option	Function
ROFF	This function turns both the instrument and its radio off. To turn the Geodimeter on again, the Geodimeter must be manually turned on and put in the RPU mode again. To turn the Geodimeter off but leave the radio on, use the OFF key in the Custom Instrument Functions menu instead of the ROFF key. This is so it can be turned on again from the data collector.
CHAN	This function changes the default radio channel. The default is 1. The value should match the radio channel setting on the instrument.
IADD	This function changes the default instrument address. The default is 1. The value should match the "Station Address" setting on the instrument.
CUADD	This function changes the default control unit (data collector) address. The default is 2. The value should match the "Remote Address" setting on the instrument.

List of Error Messages

Custom Instrument Functions Menu Error Messages

Error Message	Procedure
"NO RESONSE FROM RADIO"	Check connection to radio. Try turning the radio off and back on.
"GEO: NOT RESPONDING"	Turn radio off and back on. Press the ON soft key in the ↰ INFN menu. It may be necessary to press the ON soft key a second time. If this does not work, restart Geodimeter 600 RPU mode.
"NOT LEVEL"	Instrument is not level.
"SCOPE FLOPPED"	Geodimeter cannot measure a distance or track the prism while flopped.
"NO DISTANCE"	Make sure of tracking prism and try again.
"BATT LOW"	Battery on Geodimeter is low.
"SERIAL ERROR"	Check cable connections.
"TIME OUT"	Try again.
"WRONG MODE"	Try again.
"TARGET NOT FOUND"	Point instrument toward prism and search again.
"TARGET LOST"	Search for prism.
"ZA TOO STEEP"	Data collector attempted to move to an invalid Zenith Angle.
"TRY AGAIN"	Previous operation interrupted, try again.

Notes on Using the G600 Driver or 5600 Driver

1. **While in reverse face, the instrument only measures if it is already on the prism. It cannot search while in reverse face. It first gets a distance from the prism, then moves down to the LED to get the angles and calculate the Zenith Angle to the prism. As implemented, it is assumed that all reverse face distances will be measured to prisms that are farther away than 20 feet. It will not zero or set angle in reverse face.**
2. **To connect the data collector directly to the instrument, select the GEO4 driver instead of the G600 driver (SETUP NXT NXT INST NXT GEO GEO4). A baud rate of 4800 works better when using a cable instead of the radios.**

3. **A shot in Coarse mode takes about 3 seconds if in Track mode and AIM and FLW flags are turned off. A shot in Fine mode takes about 10-15 seconds. The default setting is Fine. The mode is changed by using the CRS / FINE toggle key in the Instrument menu.**

Leica TCM/TCA

Setting up the Data Collector

To install the driver on the data collector, press SETUP NXT NXT INST NXT LEICA and TCA. You are asked for a delay time. The delay time is how long the data collector waits for the instrument to initialize itself after turning it on. You are also asked if you want to leave the instrument on. If you want to save battery power by having the data collector turn on and off the instrument before and after each shot, press NO. Setup is the same whether connecting to the instrument via cable or radio modems.

Setting up the Leica Instrument

To prepare the Leica to communicate with the data collector, set the GSI baud rate to 9600, the protocol to GSI, parity to NONE, Terminator to CRLF, and 8 data bits.

TCA1100

On the TCA1100, the following keys are used to set the communications:

Get in the Main menu and press SETUP to set the following:

Option	*Settings*
Rec. Device	RS232
Baud rate	9600
Protocol	GSI
Parity	NONE
Terminator	CR LF
Data bits	8
Stop bit	1

✎ *Make sure that Remote Control (RCS) is turned off in the Extra menu.*

✎ *The instrument must be in the Measure mode screen to work with the data collector. From the Main menu, press the MEAS key.*

If the data collector is used to turn on the Leica, the instrument should start up ready to use GSI. To do this on the TCA1100, from the main menu, press CONF and set the “autoexec-application” to “Meas & Rec (GSI).”

TCA1103

On the TCA1103, the following keys are used to set the communications:

1. **Get in the Main menu, then press SETUP and set “Meas Job:” to “RS232.”**
2. **Press ESC to get back to the Main menu.**

3. **Press** 5 **for Configuration and select** 2 Communication mode**.**
4. **Press** 1 **GSI Parameters and set the following:**

Option	*Setting*
Baud rate	9600
Protocol	GSI
Parity	NONE
Terminator	CR LF
Data bits	8
Stop bit	1

✎ *RCS mode must be turned off. On the Leica, press PROG (Program) RCS to turn it off.*

✎ *The instrument must be in the Measure mode screen to work with the data collector. From the Main menu, press the MEAS key.*

Leica Custom Instrument Functions Menu

KEYSTROKES: ↰ INFN

Leica Custom Instrument Functions Menu Soft Keys

Option	Function
SHOW	This function shows the current ATR, LOCK, and LOCKED status.
ATR	This toggles the ATR mode. Turning on ATR turns off the LOCK mode.
LOCK	This toggles the LOCK mode. Turning on LOCK mode turns on ATR mode. Turning off LOCK mode turns off ATR mode.
CLR	This function sends a STOP/CLEAR command to the instrument. This is useful when problems occur – especially the error @W100 (Instrument busy). This function also stops tracking the prism and stops the motors from moving.
PRISM	This function sends the prism constant to the instrument.
SRHA	This function changes the horizontal search range.
SRZA	This function changes the Zenith Angle search range.
OFF	This function turns the instrument on and off.
SET	This function requires an ID number and value and sets the ID in the instrument to the given value.
CONF	This function requires an ID number and returns the current value in the instrument.
GET	This function requires a WI number and returns the current value in the instrument as a string on the stack.

Leica Custom Instrument Functions Menu Soft Keys

Option	Function
DIST	This key toggles between “WILL USE DIST MODE ON LEICA” and “WON'T USE DIST MODE ON LEICA”. The “WILL” option allows the Distance mode to be set on the Leica and not have the data collector change the mode based on the Fine/Coarse toggle key.

Notes on Using the GSI Driver

1. **If you are seeing W100 (instrument busy), try turning off the ATR. Also try pressing CLR.**
2. **Toggling the instrument off and back on can help you get out of error situations.**
3. **See the *Wild Instruments On-line* manual for valid values to use in the SET, GET, and CONF commands and learn what the various GSI error numbers mean.**

Notes on Using the TCA Drivers

1. **The message** `E182` **can mean that an invalid target has been found. Try pointing closer to the prism and try again.**
2. **To use the arrow keys to move the instrument while in the Instrument Positioning (SETUP) menu, the instrument should not be locked on the prism (LCKD = 1). First, press the STOP key to exit Lock mode and then press the arrow keys.**
3. **When tracking the prism, the TCA scope may not be pointing exactly to the prism, but the exact angle to the prism is shown and sent to the data collector. Coarse mode does not apply the correction to the center of the prism.**
4. **When using the AUTO SHOTS routine in traffic, setting a narrow search range helps to overcome problems when the prism is temporarily obstructed. It is recommended that you use 5° for both SRHA and SRZA in the Instrument Functions menu (INFN).**

Topcon AP-L1A

Setting up the AP-L1A Instrument

1. **Turn on the AP-L1A and press the MENU key.**
2. **Press F1: PARAMETERS.**
3. **Press F3: COM.**
4. **Press F1: COM1.**
5. **Press F1: BIT FORMAT.**
6. **Select D8 S1 NONE and press F4.**
7. **Press F2: TRANS SPEED.**
8. **Select 9600 and press F4.**
9. **Press F3: TERMINATE.**
10. **Select ETX and press F4.**
11. **Press the ESC key to get back to the COM menu.**
12. **Press F2: COM2.**

13. Select Radio channel (B is default) and press F4.
14. Press MENU to exit the menu.

Putting the AP-L1A in Remote Mode

1. **Attach antennas to the radios.**
2. **Connect the data collector to the radio.**
3. **Attach the radio battery to the radio.**

   The CTS light should be on and steady.
4. **Turn on the AP-L1A and press the MENU key.**
5. **Press F3: REMOTE.**
6. **Press F1: REMOTE.**

Setting up a Direct Cable Connection to the Instrument

1. **Connect the data collector's cable to the instrument's SIG connector.**
2. **Turn on the AP-L1A and leave it in the standard screen that shows the angles on the screen.**

Setting up the Data Collector

To install the driver in the data collector, press SETUP NXT NXT INST NXT TOPCO NXT NXT and APL1A. The data collector attempts to set up some default values on the instrument. If the instrument is not connected to the data collector when APL1A is pressed, the Busy light stays on until the CANCEL key is pressed. If the CANCEL key is pressed, the driver is still installed.

AP-L1A Custom Instrument Functions Menu

KEYSTROKES: ↰ SETUP

AP-L1A Custom Instrument Functions Menu Soft Keys

Option	Function
OPT	This function gets the current options from the instrument and shows them on the screen of the data collector: ➥ SRCH HA: Horizontal Angle range for searches. ➥ SRCH ZA: Zenith Angle range for searches. ➥ SCAN: “NARROW” “MIDDLE” “WIDE” ➥ SPEED: “LOW” “MIDDLE” “HIGH” ➥ WAIT: Time in seconds.
SRHZA	Enter the Horizontal and Zenith Angle search ranges.
SCAN	Enter the scan range (1-3).
SPEED	Enter the tracking speed (0-2).
WAIT	Enter a wait time. This represents the time lag the instrument waits before searching again when the lock on the prism is lost.

AP-L1A Custom Instrument Functions Menu Soft Keys

Option	Function
SENS	Enter the tracking sensitivity (0-2).
PTRN	Enter a normal or high search pattern (0-1).
CH2AS	Enter the radio channel for the Satel 2ASx radio (0-9 or A-F).
CH3AS	Enter the radio channel for the Satel 3ASd radio (0-9 or A-F).

Notes on Using the APL Driver

1. **See the AP-L1A manual for optimum settings for SCAN SPEED WAIT and SENS.**
2. **If the CD light on the radio indicates a poor signal, check the antennae and batteries.**
3. **The radio may not work well when within 5 feet of the instrument radio.**
4. **Several lights flashing on the radio when the data collector is not in use indicate radio interference. Change the radio channel at the instrument and at the data collector.**
5. **Older models of the Satel Radio Modem may only support channel B.**

Chapter 9: Robotic Functions

Topcon GTS-800A Driver

Setting up the GTS-800A/GTS-802A Instrument

The GTS-800A can be set up to communicate with the data collector in three different ways. The methods are through a cable, through the 2Asx or 3ASd radios, or through the RC-2R using optical communications.

Cable Connection

1. **Turn on the GTS-800A and let the self-check finish.**
2. **Press F6: Para.**
3. **Press F2: Communication.**
4. **Press F1: Serial Port RS232C / RC-1.**
5. **Press F3 to select RS232C.**
6. **Press F1: SET and answer YES.**
7. **Press F2: Set RS232C.**
8. **Set "B. Rate" to 1200, "Data.L" to 7, and "Parity" to "even" and press F1:SET and answer YES.**
9. **Press ESC to go back to the main menu.**
10. **Select STD to see horizontal and vertical angles.**
11. **Connect the data collector to the instrument with the cable.**

12. **On the data collector, press → INST NXT TOPCO NXT 800. When asked "Using Cable to 800?" press YES. When asked "Use Search?" answer YES if you want the instrument to automatically search for and track the prism.**

The next time the instrument is turned on, the only steps needed are 1 and 10-12.

Radio Connection

1. **If you are using a Y cable, make sure the dip switch 3 on the RC-2R is set to the ON position. Dip switches are located behind the batteries of the RC-2R. More detailed information is available in the RC-2R manual.**
2. **Attach the antennas and batteries to radios. The CTS light should be on and steady.**
3. **Connect the data collector (and RC-2R if using a Y cable) to one radio and the GTS-800A to the other radio.**
4. **Turn on the GTS-800A and let the self-check finish.**
5. **Press F1: Prog.**
6. **Press F6: MORE.**
7. **Press F3: EXT. LINK.**
8. **Press F2: Setting.**
9. **Press F1: CABLE/RADIO MODEM/RC-1, RC-2.**
10. **Select the type of radio modem you have, either 2ASx or 3ASd and press F1: SET.**
11. **Press F4: PARAMETER(RADIO MODEM).**
12. **Press F1: SELECT PARAMETERS.**
13. **If you are using 2Asx, select the desired radio channel and press F1: SET.**
14. **Select REC-B and press F1:SET.**
15. **If you are using 3ASd, press F4: PARAMETER(RADIO MODEM).**
16. **If you are using 3ASd, press F3: SET CHANNEL(3ASd).**
17. **If you are using 3ASd, select the desired radio channel and press F1:SET and F6:OK.**
18. **Press the ESC key to get back to the EXTERNAL LINK menu.**
19. **Press F1: Execute.**

    You will see the message "Remote control is being done from the controller."
20. **If the message is "Failed Initialize", check the connection to the radio and the radio battery.**
21. **On the data collector, press → INST NXT TOPCO 800. When asked "Using Cable to 800?" press NO. When asked "Using RC-2R Optical Communication?" answer NO. When asked "Using RC2 Y cable?" answer YES if using the RC2 Y cable to connect the radio, data collector, and RC-2R. The RC-2R can also be used without the Y cable, but the trigger button on the RC-2R must be pressed manually.**

The next time, the only steps needed are 1-7 and 19-21.

RC-2R Optical Connection

1. **Make sure the dip switch 3 on the RC-2R is set to the OFF position. Dip switches are located behind the batteries of the RC-2R. More detailed information is available in the RC-2R manual.**
2. **Turn on the GTS-800A and let the self-check finish.**

3. **Press F1: Prog.**
4. **Press F6: MORE.**
5. **Press F3: EXT. LINK.**
6. **Press F2: Setting.**
7. **Press F1: CABLE/RADIO MODEM/RC-1, RC-2.**
8. **Select the RC-2 option and press F1: SET.**
9. **Press the ESC key to get back to the EXTERNAL LINK menu.**
10. **Press F1: Execute.**

    You will see the message "Remote control is being done from the controller."

11. **On the data collector, press [↱] [INST] [NXT] [TOPCO] [800]. When asked** "Using Cable to 800?" **press [NO]. When asked** "Using RC-2R Optical Communication?" **answer [YES].**

The next time, the only steps needed are 1-5 and 9-10.

GTS-800A Custom Instrument Functions Menu

KEYSTROKES: [↰] [INFN]

✎ *Not available if using cable connection.*

GTS-800A Custom Instrument Functions Menu Soft Keys

Option	*Function*
OPT	This key gets the current options from the instrument and shows them on the screen of the HP 48. ➥ SRCH HA: Horizontal Angle range for searches ➥ SRCH ZA: Zenith Angle range for searches ➥ SCAN: "NARROW" "MIDDLE" "WIDE" ➥ SPEED: “LOW” “MIDDLE” “HIGH” ➥ WAIT: Time in seconds
SRHZA	Enter the Horizontal and Zenith Angle search ranges.
SCAN	Enter the scan range (1-3).
SPEED	Enter the tracking speed (0-2).
PTRN	Enter the normal or high search pattern (0-1)
WAIT	Enter a wait time. This is how long the 800 waits before searching when the lock on the prism is lost.
SENS	Enter the tracking sensitivity (0-2).
RC2Y	This key toggles between using the RC-2 to find the prism and using a search pattern.
RC2O	This key toggles between using the RC-2 optical communications and not using them.

GTS-800A Custom Instrument Functions Menu Soft Keys

Option	Function
MACH	This key sets the instrument to Machine Control mode.
SURV	This key sets the instrument to Survey Control mode.
CH2AS	This key changes the radio channel of the 2ASx radio.
CH3AS	This key changes the radio channel of the 3ASd radio.

Notes on Using the GTS-800A Driver

1. **See the GTS-800A manual for optimum settings for SCAN, SPEED, PTRN, WAIT, SENS, MACH and SURV.**
2. **The CD light on the radio indicates a poor signal. Check the antennae and batteries on both radios.**
3. **The data collector radio may not work well when within 5 feet of the instrument radio.**
4. **Several lights flashing on the radio when the data collector is not in use indicates radio interference. Change the radio channel at the instrument and at the data collector.**
5. **Older models of the Satel Radio Modem may only support channel B.**
6. **The "LIVE" update in the Instrument Positioning (SETUP) menu is not available when connecting directly to the instrument and using the Topcon STD screen.**
7. **If the cable connection option of "External Link" is used, the data collector will behave just like it does when connected through the radios.**
8. **If you are using a RC2-R and it will not cause the instrument to turn, follow the RC2-R setup instructions to match the RC2-R's channel to the instrument.**

Notes on Using the Topcon RC-2R

1. **Tracking mode is necessary for the RC-2A to optically communicate with the 802-A. Because of this, the angle turning functions such as TOPT, ◀, ▶, ▲, and ▼ keys are deactivated.**
2. **When using the RC-2A closer than 10m to the instrument, the RC-2A should be in low power mode. Activate low power mode by holding the ESC key down on the RC-2A while pressing the RC-2A power key. You will hear two beeps as the RC2-A turns on to indicate low power mode instead of one beep for full power mode.**
3. **RC2 will beep once when starting a search and twice when a link is established.**
4. **The "NO RESPONSE" message when using optical communications is referring to no response from the instrument. When there is no response from the RC-2R, the message "RC2 NOT RESPONDING" will be displayed instead.**

Zeiss ELTA S20 (DLS 70 Radio)

Setting up the Data Collector

Most HP 48 calculators are not set up to run at the 19200 baud rate required to control the Zeiss Elta S20 through the radio. The HP 48 controls the Zeiss Elta S20 by connecting directly to the serial port on the instrument. To install the driver in the HP 48, press SETUP NXT NXT INST ZEISS and S20. A shortcut is to press ↰ Z.

✎ *If you have a Turbo 48, **Pocket SMI**, or a **Titan** data collector, you will be able to communicate with the instrument using the radio's native baud rate of 19200.*

Setting up the TURBO 48

The TURBO 48 can run at up to double the speed of the HP 48. It can be connected directly to the Zeiss radio because it runs at the required 19200 baud rate. To install the driver in the TURBO 48, press SETUP NXT NXT INST ZEISS and S20R. A shortcut is to press ↱ Z.

To set the baud rate on ***Pocket SMI*** or ***Titan*** to 19200, select "Settings…" in the File menu. Turn on "Force baud rate" and select 19200. Press OK to exit. Select the instrument by pressing SETUP NXT NXT INST NXT ZEISS and S20R.

Setting up the Zeiss Elta S20R (DLS 70 Radio)

1. **Put the *SMI* interface for the S10/S20 PCMCIA card into the PCMCIA slot in the Zeiss instrument.**
2. **Turn on the instrument by pressing the PWR button.**
3. **Use the left and right arrow keys to select S_*SMI*xxx (xxx is the version number) and press ENTER (the blue arrow key at the lower right side of the keyboard).**
4. **Press F9 (SETUP). Steps 5 through 10 are only necessary if the current setting is wrong.**
5. **Press F1 (RADIO) to enter the radio serial number.**
6. **Press F2 (RDIO/RDIO*) to toggle "Using Radio" to YES.**
7. **Press F3 (BAUD) to toggle the baud rate at the serial port.**

   This is not necessary if using the data collector at the radio.
8. **Press F4 (PRISM) to change the prism constant.**
9. **Press F5 (CRS1/CRS2) to toggle Coarse mode to "Fast" (No Finelock) or "Accurate" (2 second Finelock).**
10. **Press F6 (ROBOT/MAN) to toggle between Robotic and Manual modes. Manual mode turns off Quicklock, Finelock, and Tracklock. Pressing the Search key on the data collector or the Zeiss turns the Robotic mode back on.**
11. **When finished setting the options, press F10 (EXIT). To exit the Setup menu without saving changes, press the ESC key.**

Zeiss Elta S20R (DLS 70 Radio) Functions Menu

KEYSTROKES: [↰] [INFN]

Zeiss Elta S20R (DLS 70 Radio) Functions Menu Soft Keys

Option	Function
LEVEL	This function displays the current level status at the instrument.
PRISM	This function changes the prism setting on the instrument.

Notes on Using S20 and S20R Drivers

1. **When in Coarse mode (CRS in INST menu), FineLock mode is not used unless the Coarse mode in the Zeiss SETUP menu is set to "Accurate." When using the Accurate Coarse mode, Finelock takes two seconds. When in Fine mode, FineLock adds about five seconds to the shot.**
2. **When the reflector is hidden while the S20 is searching horizontally, the instrument makes two complete revolutions and then stops. If it is hidden while the S20 is searching vertically, the instrument scope will point straight up or down. Put the reflector in view and try again.**
3. **The Zeiss 360 prism has an offset of 3 mm.**

Zeiss ELTA S20 (Georadio QL)

Setting up the Data Collector for Connection to a Serial Port on S20

Connect the data collector to the serial port on the Zeiss S20 using the standard or Y cable. Press SETUP NXT NXT INST ZEISS and S20 .

Setting up the Data Collector for Connection to Georadio QL

1. **Connect the data collector to the serial port labeled "A" on the Georadio QL.**
2. **Connect the Quicklock sensor cable to the port labeled "B" on the Georadio QL.**
3. **On the data collector, press SETUP NXT NXT INST ZEISS and S20Q .**
4. **Turn on the Georadio QL.**
5. **Press [↰] INFN to start the Instrument Functions menu.**
6. **Press the SHOW soft key; the data collector gets the current settings from the Georadio QL. "NO RESPONSE" means the data collector was unable to communicate with the Georadio QL. Check the cables and batteries.**
7. **The default settings on the Show screen are CHAN: 1, CUADD: 2, IADD:1. Use the CHAN , CUADD , and IADD soft keys to change the settings on the radio.**

✔ ***Note that these settings must match what is set in the S20.***

Setting up the Zeiss Elta S20 (Georadio QL)

1. **Put the *SMI* Interface for S10/S20 PCMCIA card into the PCMCIA slot in the Zeiss instrument.**
2. **Turn on the instrument by pressing the PWR button.**
3. **If the *SMI* Interface program starts automatically, press the ESC button.**
4. **Use the up and down arrow keys to select S_*SMI*xxx.EXE (xxx represents the version number) and press the Space key to the left of the blue arrow keys. This makes the *SMI* Interface the default application.**
5. **Use the blue up and down arrow keys to select "System Software."**
6. **Press ENTER to get past the leveling screen and press 9 (Configuration).**
7. **Press `1` (Instrument), `3` (Switches), and `9` (Data Radio).**

   If there is no data radio option, then this version of the S20 firmware uses the DLS 70 radio. Please see the instructions in *Zeiss ELTA S20 (DLS 70 Radio)* on page 211.
8. **Press `1` (Configuration) - make sure the Module selected is "Georadio QL." Press the SPACE key to toggle.**
9. **Make sure the Installation selected is "Internal."**
10. **Press ESC to exit back to the "Data Radio Switch" screen.**
11. **Press `2` (Parameter). There will be a long pause while the internal radio parameters are checked. The Address field defaults to 1 and should match IADD on the data collector. The Channel field defaults to 1 and should match CHAN on the data collector. Protocol is fixed at 23.**
12. **Press the ESC key several times until prompted to exit. Select "Yes" and press ENTER.**

    The instrument turns off.
13. **Turn the data collector's radio on.**

    The instrument tries to connect when the program is started.
14. **Turn the instrument back on. The *SMI* program should start automatically. If it does not, use the up and down arrow keys to select S_*SMI*xxx.EXE and press ENTER.**
15. **Press F9 (SETUP).**

    Steps 15 through 20 are only necessary if the current setting is wrong.
16. **Press F1 (RADIO) to enter the data collector's radio number.**

    This should match CUADD on the data collector. The default is 2.
17. **Press F2 (RDIO/RDIO*) to toggle "Using Radio" to YES.**
18. **Press F3 (BAUD) to toggle the baud rate at the serial port. This is not necessary if you are using data collector at the radio.**
19. **Press F4 (PRISM) to change the prism constant.**
20. **Press F5 (CRS1/CRS2) to toggle Coarse mode to "Fast" (No Finelock) or "Accurate" (2 second Finelock).**
21. **Press F6 (ROBOT/MAN) to toggle between Robotic and Manual modes. Manual mode turns off Quicklock, Finelock, and Tracklock. Pressing the Search key on the data collector or the Zeiss turns the Robotic mode back on.**
22. **When finished setting the options, press F10 (EXIT). To exit the Setup menu without saving changes, press the ESC key.**

✎ *The instrument tries to connect with the radio using the new settings when exiting Setup.*

Zeiss Elta S20Q (Georadio QL) Functions Menu

KEYSTROKES: ↰ INFN

Zeiss Elta S20Q (Georadio QL) Functions Menu Soft Keys

Option	Function
SHOW	This function shows the current radio channel, Control unit ID, and instrument address.
CHAN	This function changes the radio channel at the data collector's radio. Change the channel at the instrument to match by following steps 1 through 11 in *Setting up the Zeiss Elta S20 (Georadio QL)* on page 213. The default is 1.
CUADD	This function changes the control unit (data collector) address. Change the radio number at the instrument to match by following steps 14 through 16 in *Setting up the Zeiss Elta S20 (Georadio QL)* on page 213. The default is 2.
IADD	This function changes the instrument address. Change the instrument address at the instrument to match by following steps 1 through 11 in *Setting up the Zeiss Elta S20 (Georadio QL)* on page 213. The default is 1.
LEVEL	This function displays the current level status at the instrument.
PRISM	This function changes the prism offset setting on the instrument.

Notes on Using S20 & S20Q Drivers

1. **When in Coarse mode (CRS in INST menu), FineLock mode is not used unless the Coarse mode in the Zeiss Setup menu is set to "Accurate." When using the Accurate Coarse mode, Finelock takes two seconds. When in Fine mode, FineLock adds about five seconds to the shot.**
2. **When the Quicklock sensor is hidden while the S20 is searching horizontally, the instrument makes two complete revolutions and then stops. If it is hidden while the S20 is searching vertically, the instrument points straight up or down. Put the Quicklock sensor in view and try again.**
3. **The Zeiss 360 prism has an offset of 3 mm.**
4. **To use more than one radio with the same instrument at the same time, set a unique Control Unit Address (CUADD) on each radio. Set them all on the same channel as the instrument. When a search is started from a particular radio, the Quicklock only finds the sensor attached to the radio that started the search.**

Guide to GPS

CHAPTER

10

This chapter will guide you through the process of setting up your equipment, establishing the GPS orientation, verifying the orientation, using GPS to perform survey operations, and using GPS with total stations. If you are working on a job with State Plane Coordinates, follow the steps in *GPS Setup Using State Plane Coordinates* on page 216. If you are using local coordinates for your job, skip to the section *GPS Setup Using a Local Coordinate System* on page 217.

In this chapter:

Key Definitions

Key	Function
Soft Keys	These keys are called soft because their functions (and labels) change, depending on the menu selected. **Soft keys are represented in this manual as white lettering on a black, rectangular background.**
Toggle Keys	A toggle is a key whose function changes each time you press it. **Any soft key in the display that has a square after it is a toggle.**
Hard Keys	Hard key functions are imprinted on each key itself. The functions of these assigned keys are identified by the ***SMI*** surveying overlay that came with your ***SMI*** program card. **Hard keys are represented in this manual as black lettering on a gray, rectangular background.**
Primary Keys	Primary functions (or keys) are noted directly above each key on the ***SMI*** overlay. **Primary keys are represented in this manual as black lettering on a white, rectangular background.**

GPS Setup Using State Plane Coordinates

Complete the following steps to use State Plane Coordinates for GPS setup.

1. **Make sure that you have a point stored in the current job that contains the State Plane Coordinates for the location that you will put the base receiver on.**
2. **Press SETUP to see the current flag settings for raw data, elevations, and Meters mode. If they are on, you will see R, Z, and M. Raw data and elevation settings can be changed in the first page of the Change menu CHG. Press CHG NEXT MODE and the FEET/ METER toggle key to change the Meters mode.**
3. **Press GPS OPT to get in the GPS Options menu.**
4. **Press the first soft key labeled SPCS and enter the state plane zone you are in. The format to use is the state abbreviation followed by the zone abbreviation if there is more than one zone. Examples of valid entries are: ALE (Alabama East), CA3 (California 3), UTS (Utah South), TXNC (Texas North Central), SC (South Carolina). A space can be put between the state and zone if desired: AL E, CA 3, UT S, TX NC, SC. See *State Plane Zones* on page 226 for a complete list.**
5. **Press the SPC/LOCAL toggle key to select "STATE PLANE COORD."**
6. **Press REPS and enter how many measurements you want to average for each shot. Enter** `0` **to average measurements until you press the USE key. See *GPS Average Shots* on page 219 for a description of the Shot Averaging screen.**
7. ***Pocket SMI* and *Titan* only: If you want to use a Geoid file, you can download it to the data collector using *Transfer 7* using the "Download Geoid File" command in the Geoid menu. Turn on the use of the Geoid file after downloading it by selecting "Use Geoid99" in the Geoid menu. See *Geoid99 Files* on page 226 for additional information.**
8. **If you are not using a Geoid file, enter the Geoid separation in meters using the GEOID soft key. You can find your local Geoid separation at the Web site: http://www.ngs.noaa.gov/GEOID/GEOID99/datageo99upc1.html**

   If you are going to use Benchmark (B M) to establish your elevations, this step is optional.
9. **Measurements that exceed the tolerances will be rejected with an error message. To change the default values for quality and position tolerances, press GPS TOL. See *GPS Tolerance Menu* on page 224 for additional information.**

10. **Follow the steps for setting up the data collector, base receiver, and rover receiver in the section named *Drivers for GPS Receivers*, which starts on page 227.**
11. **If the elevation of your base station is not accurate, or you do not want to measure the height of the base and rover antennae, you can use Benchmark (B M) to establish the vertical position. Position the rover antenna on a point with a known elevation. Press SETUP NXT B M.**

Verify the accuracy of the setup by staking some points.

GPS Setup Using a Local Coordinate System

Complete the following steps to use a local coordinate system for GPS setup.

1. **Get in the job you will be working with by pressing JOB OLD and selecting the job. If this will be a new job, press JOB NEW NEW.**
2. **Press SETUP to see the current flag settings for raw data, elevations, and Meters mode. If they are on, you will see R, Z, and M. Raw data and elevation settings can be changed in the first page of the Change menu CHG. Press CHG NEXT MODE and the FEET/METER toggle key to change the Meters mode.**
3. **Press ➦ GPS OPT to get in the GPS Options menu.**
4. **Press the SPC/LOCAL toggle key to select "LOCAL COORDINATES."**
5. **Press REPS and enter the number of measurements you want to average for each shot. Enter `0` to average measurements until you press the USE key. See *GPS Average Shots* on page 219 for a description of the Shot Averaging screen.**
6. ***Pocket SMI* and *Titan* only: If you want to use a Geoid file, you can download it to the data collector using *Transfer 7* using the "Download Geoid File" command in the Geoid menu. Turn on the use of the Geoid file after downloading it by selecting "Use Geoid99" in the Geoid menu. See *Geoid99 Files* on page 226 for additional information.**
7. **If you are not using a Geoid file, entering a constant Geoid offset is of little benefit unless you have a large job and want to enter a different Geoid offset as you move to different areas of the job. Enter the Geoid separation in meters using the GEOID soft key.**
8. **Measurements that exceed the tolerances will be rejected with an error message. To change the default values for quality and position tolerances, press ➦ GPS TOL. See *GPS Tolerance Menu* on page 224 for additional information.**
9. **Follow the steps for setting up the data collector, base receiver, and rover receiver in the section named *Drivers for GPS Receivers*, which starts on page 227.**
10. **If you put the base receiver on a known point that you entered as the base point, perform this step: Put the rover on a known point, entering it as the backsight point (SETUP BKPT) and then pressing ➦ and the ZERO key. The data collector will get a position from the receiver to orient the horizontal angles from the base. Skip the next step.**
11. **If you put the base receiver on an unknown point, press SETUP NXT 2PFS. Using 2PFS with GPS is identical to using it with a total station, except that you do not use the REV keys. See *Free Station (Two-Point Free Station/Resection)* on page 295 for more information about 2PFS. If the elevations of the points you used for 2PFS are accurate, you can skip the next step.**

12. **If the elevation of your base station is not accurate, or you do not want to measure the height of the base and rover antennae, you can use Benchmark (B M) to establish the vertical position. Position the rover antenna on a point with a known elevation. Press SETUP NXT B M. Enter a point number or elevation and press BMPT or E L respectively.**
13. **Verify the accuracy of the setup by staking a few points.**

GPS Functions

The following sections provide information to familiarize you with various GPS functions.

GPS Status Screen

KEYSTROKES: ➦ POS

The screen will show a live update of the current HMS latitude, HMS longitude, number of satellites, seconds since the last radio message (link), position quality (5 is RTK fixed), HDOP, VDOP, horizontal error estimate, and vertical error estimate. The GPS status screen does not change the current menu. When any key is pressed, the status screen will disappear and the key function is executed.

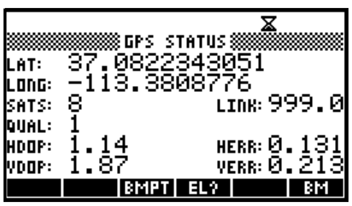


Figure 10-1 GPS Status Screen

The items in the display of the GPS status screen are:

GPS Status Screen Terms and Definitions

Term	Definition
LAT	Latitude in HMS.
LONG	Longitude in HMS.
SATS	Number of satellites being used.
LINK	Number of seconds since last receipt of a radio transmission from the base. The number 999 indicates that no transmissions are being received. This number should be 1 when connected to the rover receiver. The base does not receive radio messages, so the link will be 999 when connected to the base receiver.
QUALITY	Shows the quality of the current GPS position. See the glossary for a complete description. At the base the quality is 1 (stand-alone); at the rover it should be 5 (fixed RTK).
HDOP	Horizontal Dilution of Precision: This value should be less than 2 for accurate positions.
VDOP	Vertical Dilution of Precision: This value should be less than 3 for accurate elevations.
HERR	Horizontal Error: Shows the receiver's estimate of the horizontal error in the current distance units.
VERR	Vertical Error: Shows the receiver's estimate of the vertical error in the current distance units.

GPS Average Shots

The data collector can average several measurements from the receiver to get a more precise position. Anytime the data collector needs to get a position from the receiver, if REPS (press GPS OPT REPS) is set to a number other than 1, the GPS Average Shots screen appears to show the progress of the collection of the measurements. Individual measurements that do not meet the current tolerance settings are not used. A lot of useful information about how close together the positions being collected are is shown, along with some soft keys that give the user several options while the positions are coming in.

After the shots specified have been measured, the shots are averaged and used. If the horizontal and/or vertical standard deviation tolerances have been set in the GPS Tolerance menu (↱ GPS TOL HSDEV and/or VSDEV), the standard deviations are compared to the tolerance values. If the standard deviation tolerances are not met, the user is asked whether to use or discard the results.

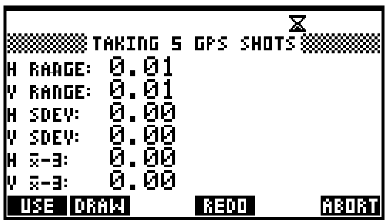


Figure 10-2 GPS Average Shots Screen

The items in the display of the GPS Average Shots screen are:

GPS Average Shots Screen Terms and Definitions

Term	Definition
H RANGE	The diagonal length of a box drawn around all the measurements.
V RANGE	The farthest vertical distance between all the measurements.
H SDEV	The Horizontal Standard Deviation: 68% of the measurements are within this distance of the average. The lower the number, the closer together the measurements are.
V SDEV	The Vertical Standard Deviation: 68% of the measurements are within this distance of the average. The lower the number, the closer together the measurements are.
H x̄-3	The distance from the average horizontal measurement to the last measurement collected. The number after "x̄-" is the number of the measurement.
V x̄-3	The distance from the average vertical measurement to the last measurement collected. The number after "x̄-" is the number of the measurement.

The soft keys in the menu of the GPS Average Shots screen are:

GPS Average Shots Screen Soft Keys

Option	Function
USE	Stop collecting measurements and use measurements already taken. When REPS is set to 0, the GPS Average Shots screen averages measurements until the USE button is used. This allows you to take as many shots as you want.
DRAW	When DRAW is pressed, a scatter plot of all the measurements is drawn on the screen. No measurements are collected while in the Draw screen. Press any key to return to the GPS Average Shots screen.
REDO	Discard all measurements taken so far and start over.
ABRT	Discard all measurements and cancel current operation.

Side Shot

Occupy a point with the rover antenna and take a side shot by pressing the SIDS key. If the position from the receiver is within the tolerances, the point will be stored. If one of the tolerances is exceeded, the data collector will beep and show the value that is bad. It will continue to try to collect the position and show the bad value until a good position is collected. If the number of shots to be averaged is more than one, the GPS Average Shots screen will show the progress of the shots. The number of measurements to be averaged can be changed by pressing GPS OPT REPS.

Staking

Pressing SHOT will cause the data collector to get a position from the receiver. If the position from the receiver is within the tolerances, the stakeout information is shown. If one of the tolerances is exceeded, the data collector will beep and show the value that is bad. It will continue to try to collect the position and show the bad value until a good position is collected.

If the number of shots to be averaged is more than one, the GPS Average Shots screen will show the progress of the shots. The number of shots to be taken can be changed by pressing GPS OPT REPS.

To see a live update of the staking information, press SHOT. Again, the tolerances are checked to make sure the position is valid before displaying the results. The update of the screen will happen about every second or two. The GPS Average Shots screen is not used in this routine.

Graphical Stakeout (Not in HP 48)

Pocket SMI

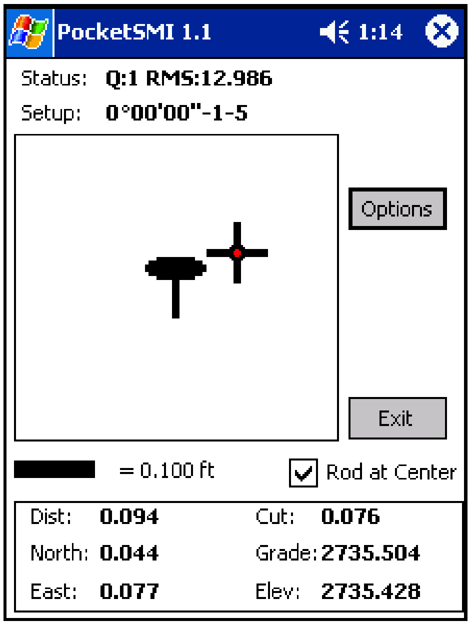


Figure 10-3 Pocket SMI Graphical Stakeout

Use **FSPT** in the Stake menu to enter the foresight point. Press the smiley-face icon at the bottom of the screen to start the graphical stakeout screen.

Titan

Use **FSPT** in the Stake menu to enter the foresight point. Press the large F in the lower right corner of the screen and select the Real-time Stake menu from the popup window. Press **GPSTK** and the stakeout data will be displayed.

Pocket SMI and Titan

Directions are given assuming that the top of the screen is pointed toward north. If your receiver supports it, the data will be updated five times per second. When you are within the tolerance distance of the point being staked, you will see a large smiley face. Press Options to change the stakeout tolerance and scale settings. Press **EXIT** to exit the Graphical Stakeout menu.

Storing a Known GPS Position to a Point

To convert known latitude, longitude, and ellipsoid height to a coordinate and store to a point, press **GPS** and the soft keys **UTIL** and then **LL2PT**. Enter latitude, longitude, and height and press **ENTER**. The point is stored using the current localization.

Real-time Side Shot

KEYSTROKES: ↱ RSIDS

Real-time Side Shot stores a point whenever the rod moves farther than the minimum distance from the last shot taken. The current distance from the last stored point is displayed until a new point is stored. The default minimum distance is 10. To change the minimum distance, type it in before pressing ↱ and the RSIDS key.

Real-time Stakeout

KEYSTROKES: ↰ SHOT

The SHOT key in any of the stakeout menus takes a single measurement. Pressing ↰ SHOT starts the Real-time Stakeout mode. Every time a new measurement is completed, the Go/Come, Left/Right, North/South, East/West values are updated. To stop measuring, press ON or CANCEL twice.

Summary of GPS Menus

The following sections provide summaries of various GPS menus.

GPS Menu

KEY: GPS

GPS Menu Soft Keys

Option	Function
BASE	This key prompts for base radio information and initializes the base receiver.
ROVER	This key prompts for rover radio information, initializes the rover receiver, and prompts for setup information.
INST	Select the type of GPS receiver.
OPT	GPS Options Menu.
TOL	GPS Tolerance Menu.
UTIL	GPS Utility Menu.

GPS Instruments Menu

GPS Instruments Menu Soft Keys

Option	Function
GGA	Driver for NMEA GGA data stream.
NCT	Driver for NavCom Technologies receivers.
JAVAD	Driver for Topcon/Javad receivers.
LEICA	Driver for Leica 500 series receivers.
ASH Z	Driver for Ashtech Z family receivers
LLQ	Driver for NMEA LLQ data stream.
PJK	Driver for NMEA PJK data stream.
MAN5	Driver for manual entry of Latitude, Latitude, and height.

GPS Options Menu

KEY: OPT

GPS Options Menu Soft Keys

Option	Function
SPCS	Enter the State Plane Coordinate system. The format to use is the state abbreviation followed by the zone abbreviation if there is more than one zone. Examples of valid entries are: ALE, CA3, UTS, TXNC, SC. A space can be put between the state and zone if desired: AL E, CA 3, UT S, TX NC, SC. See *State Plane Zones* on page 226 for a complete list.
SPC LOCAL	This key toggles between using a state plane system and local system.
REPS	Enter the number of measurements to average for each shot; the default is 1. If REPS is set to a number other than 1, the GPS Average Shots screen is displayed when a shot is taken. Enter `0` to indicate that you want to continue to collect measurements until you press the USE key in the GPS Average Shots menu.
GEOID	Enter the geoid separation. Use 0 if it is not known.
CUTOF	Press this key to have the data collector get the current cutoff elevation from the receiver. To change the cutoff elevation, enter it and press ENTER. Some receiver documentation calls this the elevation mask.
EXIT	Return to the Main GPS menu.

GPS Tolerance Menu

KEY: **TOL**

GPS Tolerance Menu Soft Keys

Option	Function
HSDEV	Horizontal Standard Deviation: When the GPS Average Shots screen is finished collecting measurements, the horizontal standard deviation of the shots is compared to this tolerance value. If the tolerance is exceeded, the data collector will ask whether you want to use the collected measurements.
VSDEV	Vertical Standard Deviation: When the GPS Average Shots screen is finished collecting measurements, the vertical standard deviation of the shots is compared to this tolerance value. If the tolerance is exceeded, the data collector will ask whether you want to use the collected measurements.
QUAL	Quality: To have survey-grade accuracy, the quality must be 5. Setting the quality tolerance to any value except 5 is not recommended unless you plan to use the receiver in Stand-alone mode instead of RTK. See *GPS Terms* on page 225 for more information.
HDOP	Horizontal Dilution of Precision: This value is compared to the HDOP sent from the receiver on each measurement and should be less than 2 for accurate positions. This value has no units.
VDOP	Vertical Dilution of Precision: This value is compared to the VDOP sent from the receiver on each measurement and should be less than 3 for accurate elevations. This value has no units.
EXIT	Return to the main GPS menu.
HERR	Horizontal Error: This value is compared to the receiver's estimate of the horizontal error on each measurement. This value is in the current distance units.
VERR	Vertical Error: This value is compared to the receiver's estimate of the vertical error on each measurement. This value is in the current distance units.

GPS Utility Menu

KEY: **UTIL**

GPS Utility Menu Soft Keys

Option	Function
LL2N	Enter the latitude and longitude to convert to Northing and Easting.
NE2L	Enter the Northing and Easting to convert to latitude and longitude.
PSES	Enter the State Plane Northing and Easting to get Plane scale and Ellipsoid scale on the stack. Multiply these numbers to get the combined scale factor.
POS	This option gets latitude/longitude and height values from the receiver and puts them on the stack.
LL2PT	This option gets latitude/longitude and height values from the stack and converts them to coordinates and stores them to a point.
EXIT	This option returns you to the GPS menu.

Raw Data Generated by GPS Routines

When Raw Data is turn on, measurements from the receiver are stored in the raw data file. The raw data records related to GPS are shown below.

Position

CM GPS Latitude Longitude Altitude HeightRod SPCSadj Geoid VertError HorzError Satellites VDOP HDOP Quality

Average Position

CM GPS lat long alt Hrod SPCSadj Geoid

VertError HorzError Satellites VDOP HDOP Quality

VertError HorzError Satellites VDOP HDOP Quality

...

Set Base Position

CM BASE Latitude Longitude Altitude HeightBase SPCSadj Geoid VertError HorzError Satellites VDOP HDOP Quality

Position Using NMEA LLQ and NMEA PJK

CM GPS North East Elevation HeightRod SPCSadj Geoid Satellites CoordinateQuality

✎ *SPCSadj is how much the state plane elevations are adjusted based on a benchmark done in State Plane mode. When using a local coordinate system, this value is zero.*

GPS Terms

Quality

In the ***SMI GPS*** software, quality refers to the type of location solution the receiver has calculated. There are five possible values:

Autonomous position: The base always has a quality of 1. If the rover has a quality of 1, then the rover is probably not receiving data from the base.

Code Differential mode: Does not apply to RTK mode.

RTK positioning with codes: This is not a good RTK position.

RTK positioning with float integers: This is not a survey grade position.

RTK positioning with fixed integers: A good position has been calculated.

RTK (Real Time Kinematic)

Corrections from the base receiver are used to get an accurate position at the rover.

Standard Deviation

Sixty-eight percent of the measurements are within this distance of the average.

The lower the number, the closer together the measurements are.

Geoid99 Files

PRODUCT: DCER+ (***Titan*** and ***Pocket SMI*** only)

Geoid: Geoid99

Select this option to correct elevations recorded by GPS instruments. The respective Geoid files must be installed in the data collector for the corrections to be applied.

Procedure

Before you start collecting GPS information with the ***Titan*** or ***Pocket SMI***, toggle on this option. Now each recorded point has a Geoid correction applied to it before it is saved to the job file.

✎ *Make sure you have transferred the Geoid files to the data collector. To do so, use the **SMI Transfer V7** product. The Geoid files may be accessed from the V7 CD in the /GEOID directory, or you may download them from our FTP site (ftp://ftp.smi.com/).*

State Plane Zones

* Alabama “ALE” “ALW”
* Alaska “AK1” “AK2” “AK3” “AK4” “AK5” “AK6” “AK7” “AK8” “AK9” “AK10”
* Arizona “AZE” “AZC” “AZW”
* Arkansas “ARN” “ARS”
* California “CA1” “CA2” “CA3” “CA4” “CA5” “CA6”
* Colorado “CON” “COC” “COS”
* Connecticut “CT”
* Delaware “DE”
* Florida “FLE” “FLW” “FLN”
* Georgia “GAE” “GAW”
* Hawaii “HI1” “HI2” “HI3” “HI4” “HI5”
* Idaho “IDE” “IDC” “IDW”
* Illinois “ILE” “ILW”
* Indiana “INE” “INW”
* Iowa “IAN” “IAS”
* Kansas “KSN” “KSS”
* Kentucky “KYN” “KYS”
* Louisiana “LAN” “LAS” “LASH”

* Maine “MEE” “MEW”
* Maryland “MD”
* Massachusetts “MAM” “MAI”
* Michigan “MIN” “MIC” “MIS”
* Minnesota “MNN” “MNC” “MNS”
* Mississippi “MSE” “MSW”
* Missouri “MOE” “MOC” “MOW”
* Montana “MT”
* Nebraska “NE”
* Nevada “NVE” “NVC” “NVW”
* New Hampshire “NH”
* New Jersey “NJ”
* New Mexico “NME” “NMC” “NMW”
* New York “NYE” “NYC” “NYW” “NYL”
* North Carolina “NC”
* North Dakota “NDN” “NDS”
* Ohio “OHN” “OHS”
* Oklahoma “OKN” “OKS”
* Oregon “ORN” “ORS”
* Pennsylvania “PAN” “PAS”
* Rhode Island “RI”
* South Carolina “SC”
* South Dakota “SDN” “SDS”
* Tennessee “TN”
* Texas “TXN” “TXNC” “TXC” “TXSC” “TXS”
* Utah “UTN” “UTC” “UTS”
* Vermont “VT”
* Virginia “VAN” “VAS”
* Washington “WAN” “WAS”
* West Virginia “WVN” “WVS”
* Wisconsin “WIN” “WIC” “WIS”
* Wyoming “WYE” “WYEC” “WYWC” “WYW”
* Puerto Rico and Virgin Islands “PR”

Drivers for GPS Receivers

This section contains instructions specific to particular models of GPS receivers. It is assumed that you are following the steps in this document when told to in either of the following sections: *GPS Setup Using State Plane Coordinates* on page 216 or *GPS Setup Using a Local Coordinate System* on page 217.

Javad/Topcon TPS GPS Driver

Instructions are specific to the Javad Legacy receivers, but will also work for other Javad/Topcon receivers.

Setting up the SMI Data Collector

Follow the steps in *GPS Setup Using State Plane Coordinates* on page 216 or in *GPS Setup Using a Local Coordinate System* on page 217.

Setting up the Javad Base Station Receiver

1. **Select the Javad driver by pressing [→] [GPS] [INST] [JAVAD].**
2. **Put the GPS antenna on a tripod in a spot where there is a wide view of the sky. If using State Plane Coordinates, it must be on a point for which you have the State Plane Coordinates. If using local coordinates, it can be on a known point or an unknown point.**
3. **Connect the GPS antenna to the receiver.**
4. **Connect the battery to the receiver's "Power" port.**
5. **Connect the cable from the data collector to the receiver's "Serial A" port.**
6. **Connect the base radio cable to the receiver's "Serial C" port.**
7. **Connect the power to the base radio.**
8. **Connect the radio antenna to the base radio. Put the radio antenna as high as possible.**
9. **Press the large "I" button to turn on the receiver.**
10. **Hold down the "FN" button until the "REC" light turns from red to green and back to red. This sets port "Serial A" to 9600 baud.**
11. **The "STAT" light flashes green once for each GPS satellite and orange once for each GLONASS satellite. If the green and orange flashes are followed by a red flash, the receiver has not been able to get a position yet. Wait until the red flashing has stopped before going to the next step.**
12. **Press [→] [POS] to see the GPS status screen. If you see the message "**POSITION DATA NOT AVAILABLE,**" there could be a problem with the baud rate, cable connection, or the receiver may not have a position yet. Check the cables, make sure the receiver's "STAT" light does not have a red flash, and repeat step 9.**
13. **The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the base, the quality will be 1, the link will be 999, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3. The RMS values shown are error estimates in feet or meters, depending on the current mode. The RMS values will be high at the base receiver. If the HDOP and VDOP values are high, they may get lower after a few minutes. If they do not get low enough, you can still proceed, but accuracy may not be very good unless more satellites come into view.**
14. **Press [SETUP] [H I] to enter the distance from the ground to the base of the antenna. Note that if you are using [2PFS] or [B M] to establish your elevations, it does not matter if the height of the base and rover antennae are entered.**

15. Press BASE in the GPS menu. Enter the point number occupied by the base station or `0` if the base is on an unknown location. You will be prompted for the radio baud rate. The default radio baud rate is 38400. Type `38400` and press ENTER. You will be prompted for the radio port number. If you are connected to a Legacy receiver, you should enter `2` for port C. If you have a Hyper or Odyssey receiver that has a built-in radio, you should enter `0` for Auto. The data collector will then initialize the receiver as a base station. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.
16. Turn on the base radio. You should see the Transmit light (TX) blink once per second. If the Receive light (RX) is blinking, there is radio interference. If the TX light is not blinking, make sure the radio port and baud rate entered using the BASE key are correct.
17. Disconnect the data collector from the base receiver.

Setting up the Javad Rover Receiver

1. Follow directions for setting up the Javad base receiver first.
2. Put the antennae on the pole.
3. Connect the GPS antenna to the receiver.
4. Connect the battery to the receiver's "Power" port.
5. Connect the cable from the data collector to the receiver's "Serial A" port.
6. Connect the rover radio cable to the receiver's "Serial C" port. Hyper and Odyssey receivers may have the radio built-in.
7. Connect the power to the rover radio; this is not necessary if the radio is built-in.
8. Press the large "I" button to turn on the receiver.
9. Hold down the "FN" button until the "REC" light turns from red to green and back to red. This sets port "Serial A" to 9600 baud.
10. The "STAT" light flashes green once for each GPS satellite and orange once for each GLONASS satellite. If a red flash follows the green and orange flashes, the receiver has not been able to get a position yet. Wait until the red flash has stopped before going to the next step.
11. Press SETUP HROD to enter the distance from the ground to the base of the antenna. Note that if you are using 2PFS or B M to establish your elevations, it does not matter if the height of the base and rover antennae are entered.
12. Press ROVER in the GPS menu. You will be prompted for the radio baud rate. The default radio baud rate is 38400. Type `38400` and press ENTER. You will be prompted for the radio port number. If you are connected to a Legacy receiver, you should enter `2` for port C. If you have a Hyper or Odyssey receiver that has a built-in radio, you should enter `0` for Auto. The data collector will then initialize the receiver as a rover. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.
13. If you are using a local coordinate system, see *GPS Setup Using a Local Coordinate System* on page 217 to finish setting up. If you are using a state plane system, see *GPS Setup Using State Plane Coordinates* on page 216 to verify setup.

Checking the Status of the Rover

1. **Press [→] [POS] to see the GPS status screen. If you see the message "**POSITION DATA NOT AVAILABLE,**" there could be a problem with the baud rate, cable connection, or the receiver may not have a position yet. Check the cables, make sure the receiver's "STAT" light does not have a red flash, and repeat step 9.**
2. **The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the rover, the quality should be 5, the link should be 1 or less, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3.**
3. **If the link value in the GPS status screen is higher than 1, there is a problem with radio communication. The link value shows how long since the last data was received from the radio. Without good radio communication, the quality will not get up to 5 and errors will be large. If the rover radio "Receive" LED is flashing once per second, then check the port and baud rate entered using the ROVER key.**
4. **High HDOP and VDOP values are caused by a poor arrangement of satellites or not enough satellites. Try moving to a location where more of the sky is visible. Sometimes the arrangement of satellites in the sky will be poor even if the entire sky is visible.**

Custom Instrument Functions Menu

KEYSTROKES: [←] [INFN]

Custom Instrument Functions Menu Definitions

Option	*Function*
RESET	This option resets the receiver. After reset, the receiver will have to reacquire the satellites.
OFF	This option turns off the receiver.

List of Error Messages

Custom Instrument Functions Menu Error Messages

Error Message	*Procedure*
"BAD QUALITY = 1"	The rover is not getting data from the base. Check connections and Send and Receive lights on the radios. Check the radio serial port and baud rate settings on the data collector.
"BAD HDOP = 6"	The HDOP for the last shot exceeded the HDOP tolerance set in the [GPS], OPT, and TOL keys.
"BAD VDOP = 6"	The VDOP for the last shot exceeded the VDOP tolerance set in the [GPS], OPT, and TOL keys.

Leica GPS Driver

Instructions are specific to the Leica 530 GPS receivers, but will also work for other Leica GPS System 500 receivers.

Setting up the SMI Data Collector

Follow the steps in *GPS Setup Using State Plane Coordinates* on page 216 or in *GPS Setup Using a Local Coordinate System* on page 217. Select the Leica GPS driver by pressing [→] [GPS] INST and LEICA.

✔ ***The Leica GPS receiver should not be put in Survey Mode before using it with the SMI data collector. If Survey Mode is on, the SMI collector will report Error 4 when the BASE function is run.***

Setting up the Leica Base Station Receiver

1. Put the GPS antenna on a tripod in a spot where there is a wide view of the sky. If using State Plane Coordinates, it must be on a point for which you have the State Plane Coordinates. If using local coordinates, it can be on a known point or an unknown point.

2. Connect the GPS antenna to the receiver.

3. Connect the battery to the “PWR” port or put a battery pack in the receiver.

4. If a Leica controller is connected to the receiver, remove it from the receiver.

5. Connect the cable from the data collector to the receiver’s “TERMINAL” port.

6. Connect the base radio cable to the receiver’s “PORT 1" port.

7. Connect the power to the base radio.

8. Connect the radio antenna to the base radio. Put the radio antenna as high as possible.

9. Press the receiver’s “ON/OFF” button to turn on the receiver. An alternate way to turn on and off the receiver is in the Leica Instrument Functions menu ([↰] [INFN]) using the [ON] and [OFF] soft keys.

10. Wait until the “Tracking” LED light is green and steady, indicating that enough satellites are being tracked to calculate a position.

11. Press [↱] [POS] to see the GPS status screen. If you see the message “POSITION DATA NOT AVAILABLE,**” there could be a problem with the cable connection, or the receiver may not have a position yet. Check the cables and make sure the receiver’s “Tracking” LED light is steady and green.**

12. The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the base, the quality will be 1, the link will be 999, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3. The RMS values shown are error estimates in feet or meters, depending on the current mode. The RMS values will be high at the base receiver. If the HDOP and VDOP values are high, they may get lower after a few minutes. If they do not get low enough, you can still proceed, but accuracy may not be very good unless more satellites come into view.

13. Press [↰] [INFN] and [ANT]. Select the type of antenna you have at the base and press [ENTER]. The data collector will tell the receiver which antenna you selected and the offsets for that antenna will be part of the calculations of the elevation. Press [SETUP] [H I] to enter the distance from the ground to the base of the antenna. If you are using the Leica Tripod hook, you should select one of the tripod antenna options and measure to the height hook instead of the base of the antenna. Note that if you are using [2PFS] or [B M] to establish your elevations, it does not matter if the height of the base and rover antennae are entered.

14. Press [BASE] in the GPS menu. Enter the point number occupied by the base station or `0` **if the base is on an unknown location. You will be prompted for the radio port number. Press** `1` **and [ENTER]. You will be prompted for the radio baud rate. The default radio baud rate is 38400. Type** `38400` **and press [ENTER]. The data collector will then initialize the receiver as a base station. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.**

15. Turn on the base radio. You should see the Transmit light (TX) blink once per second. If the Receive light (RX) is blinking, there is radio interference. If the TX light is not blinking, make sure the radio port and baud rate entered using the BASE key are correct.
16. Disconnect the data collector from the base receiver.

Setting up the Leica Rover Receiver

1. Follow the directions for setting up the Leica base receiver.
2. Put the GPS antenna on the pole.
3. Put the battery pack in the receiver.
4. Put the receiver on the pole if mounting to a pole.
5. Connect the GPS antenna to the receiver.
6. If the Leica controller is connected to the receiver, remove it from the receiver.
7. Connect the cable from the data collector to the receiver's "TERMINAL" port.
8. Connect the rover radio to the receiver's "PORT 1" or "PORT 3" port.
9. Connect the radio antenna to the rover radio.
10. Press the receiver's ON/OFF button to turn on the receiver. An alternate way to turn on and off the receiver is in the Leica Instrument Functions menu (INFN) using the ON and OFF soft keys.
11. The radio "Power" LED should be on. If not, check the connection.
12. The radio "Receive" LED should be blinking once per second. It may be difficult to see in direct sunlight. If it is flickering, there may be radio interference.
13. If using a local coordinate system, see *GPS Setup Using a Local Coordinate System* on page 217 to finish setting up. If you are using a state plane system, see *GPS Setup Using State Plane Coordinates* on page 216 to verify setup.
14. Wait until the receiver's "Tracking" LED light is green and steady, indicating that enough satellites are being tracked to calculate a position.
15. Press INFN and ANT. Select the type of antenna you have at the rover and press ENTER. The data collector will tell the receiver which antenna you selected, and the offsets for that antenna will be part of the calculations of the elevation. Press SETUP HROD to enter the distance from the ground to the base of the antenna. If you are using the AT502 pole or AT501 pole, enter a height of `2m` using the HROD key. Note that if you are using 2PFS or B M to establish your elevations, it does not matter what the height of the base and rover antennae are.
16. Press ROVER in the GPS menu. You will be prompted for the radio port number. If the rover radio is on "PORT 1," press `1`; if it is on "PORT 3," press `3` and ENTER. You will be prompted for the radio baud rate. The default radio baud rate is 38400. Type `38400` and press ENTER. The data collector will then initialize the receiver as a rover. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.

Checking the Status of the Rover

1. Press POS to see the GPS status screen. If you see the message "POSITION DATA NOT AVAILABLE," there could be a problem with the cable connection or the receiver may not have a position yet. Check the cables and make sure the receiver's "Tracking" LED light is steady and green.

2. **The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the rover, the quality should be 5, the link should be less than 1, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3.**
3. **If the link value in the GPS status screen is higher than 1, there is a problem with radio communication. The link value shows how long it has been since the last data was received from the radio. Without good radio communication, the quality will not get up to 5 and RMS error estimates will be large. If the rover radio "Receive" LED is flashing once per second, then check the port and baud rate entered using the ROVER key.**
4. **High HDOP and VDOP values are caused by a poor arrangement of satellites or not enough satellites. Try moving to a location where more of the sky is visible. Sometimes the arrangement of satellites in the sky will be poor even if the entire sky is visible.**

Custom Instrument Functions Menu

KEYSTROKES: ↰, INFN

Custom Instrument Functions Menu Definitions

Option	Function
ON	This option turns on the receiver.
OFF	This option turns off the receiver.
RESET	This option resets the receiver. After reset, the receiver will have to reacquire the satellites.
ANT	Select the type of antenna you are using. After you select it, the data collector will tell the receiver, and the offsets of that antenna will be used in calculating the positions. This allows you to measure the height to the base of the antenna or to the height hook if selecting one of the "Tripod" antennae.

List of Error Messages

Custom Instrument Functions Menu Error Messages

Error Message	Procedure
"BAD QUALITY = 1"	The rover is not getting data from the base. Check connections and send and receive lights on the radios. Check radio serial port and baud rate settings on the data collector.
"BAD HDOP = 6"	The HDOP for the last shot exceeded the HDOP tolerance set in the GPS OPT, TOL, and HDOP keys.
"BAD VDOP = 6"	The VDOP for the last shot exceeded the VDOP tolerance set in the GPS OPT, TOL, and VDOP keys.

Note on Using the Leica GPS Driver

Programming the radios using Pacific Crest's radio program may be necessary.

Navcom NCT 2000 GPS Driver

Instructions are specific to the Navcom NCT 2000 GPS receivers.

Setting up the SMI Data Collector

1. **Turn on the data collector and press ↱ GPS INST NCT.**

2. **Press GPS OPT. Press the second soft key to toggle the LOCAL/SPC key and indicate whether this job will use local coordinates or State Plane Coordinates.**

3. **If you are using State Plane Coordinates, press the SPCS key to enter the state plane zone you are in.**

4. **Press the REPS key to indicate how many measurements you want to average per shot. Enter `0` to have the data collector average measurements until you press the USE soft key.**

Setting up the NCT Base Station Receiver

1. **Put the GPS antenna on the tripod in a spot where there is a wide view of the sky. If you are using State Plane Coordinates, it must be on a point for which you have the State Plane Coordinates. If using local coordinates, it can be on a known point or an unknown point.**
2. **Connect the GPS antenna to the receiver.**
3. **Connect the power to the receiver.**
4. **Connect the cable from the data collector to the receiver's control port. The port should be preset to 9600 baud.**
5. **Connect the base radio cable to the receiver's data port. The port should be set to match the baud rate of the radio.**
6. **Connect the power to the base radio.**
7. **Connect the radio antenna to the base radio. Put the radio antenna as high as possible.**
8. **Press the receiver's "ON/OFF" button to turn on the receiver.**
9. **Wait until the "Tracking" LED light is green and steady, indicating that enough satellites are being tracked to calculate a position.**
10. **Press POS to see the GPS status screen. If you see the message "**`POSITION DATA NOT AVAILABLE`**," there could be a problem with the cable connection, or the receiver may not have a position yet. Check the cables and make sure the receiver's "Tracking" LED light is steady and green.**
11. **The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the base, the quality will be 1, the link will be 999, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3. The RMS values shown are error estimates in feet or meters, depending on the current mode. The RMS values will be high at the base receiver. If the HDOP and VDOP values are high, they may get lower after a few minutes. If they do not get low enough, you can still proceed, but accuracy may not be very good unless more satellites come into view.**
12. **Press SETUP H I to enter the distance from the ground to the base of the antenna. Note that if you are using 2PFS or B M to establish your elevations, it does not matter if the height of the base and rover antennae are entered.**
13. **Press BASE in the GPS menu. Enter the point number occupied by the base station or `0` if the base is on an unknown location. You will be prompted for the radio baud rate. The default radio baud rate is 38400. Type `38400` and press ENTER. The data collector will then initialize the receiver as a base station. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.**

14. Turn on the base radio. You should see the Transmit light (TX) blink once per second. If the Receive light (RX) is blinking, there is radio interference. If the TX light is not blinking, make sure the radio port and baud rate entered using the BASE key are correct.
15. Disconnect the data collector from the base receiver.

Setting up the NCT Rover Receiver

1. Follow directions for setting up the NCT base receiver first.
2. Put the GPS antenna on the pole.
3. Put the battery pack in the receiver.
4. Put the receiver on the pole if mounting to a pole.
5. Connect the GPS antenna to the receiver.
6. Connect the cable from the data collector to the receiver's control port. The port should be preset to 9600 baud.
7. Connect the rover radio cable to the receiver's data port. The port should be set to match the baud rate of the radio.
8. Connect the radio antenna to the rover radio.
9. Press the receiver's "ON/OFF" button to turn on the receiver.
10. The radio "Receive" LED should be blinking once per second. If it is flickering, there may be radio interference.
11. Wait until the receiver's "Tracking" LED light is green and steady, indicating that enough satellites are being tracked to calculate a position.
12. Press SETUP HROD to enter the distance from the ground to the base of the antenna. Note that if you are using 2PFS or B M to establish your elevations, it does not matter if the height of the base and rover antennae are entered.
13. Press ROVER in the GPS menu. You will be prompted for the radio baud rate. The default radio baud rate is 38400. Type `38400` and press ENTER. The data collector will then initialize the receiver as a rover. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.
14. Press ➦ POS to see the GPS status screen. If you see the message "POSITION DATA NOT AVAILABLE", there could be a problem with the cable connection, or the receiver may not have a position yet. Check the cables and make sure the receiver's "Tracking" LED light is steady and green.
15. The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the rover, the quality should be 5, the link should be 1 or less, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3.
16. If the link value in the GPS status screen is higher than 1, there is a problem with radio communication. The link value shows how long it has been since the last data was received from the radio. Without good radio communication, the quality will not get up to 5 and RMS error estimates will be large. If the rover radio "Receive" LED is flashing once per second, then check the port and baud rate entered using the ROVER key.
17. High HDOP and VDOP values are caused by a poor arrangement of satellites or not enough satellites. Try moving to a location where more of the sky is visible. Sometimes the arrangement of satellites in the sky will be poor even if the entire sky is visible.

18. **If you are using a local coordinate system, see *GPS Setup Using a Local Coordinate System* on page 217 to finish setting up. If you are using a state plane system, see *GPS Setup Using State Plane Coordinates* on page 216 to verify setup.**

Custom Instrument Functions Menu

KEYSTROKES: ↰ SETUP (HP48) or RED SHIFT INFN (Titan or Pocket SMI)

Custom Instrument Functions Menu Definition

Option	Function
RESET	This option resets the receiver. After reset, the receiver will have to reacquire the satellites.

List of Error Messages

Custom Instrument Functions Menu Error Messages

Error Message	Procedure
"BAD QUALITY = 1"	The rover is not getting data from the base. Check connections and Send and Receive lights on the radios. Check the radio serial port and baud rate settings on the data collector.
"BAD HDOP = 6"	The HDOP for the last shot exceeded the HDOP tolerance set in the GPS OPT, TOL, and HDOP keys.
"BAD VDOP = 6"	The VDOP for the last shot exceeded the VDOP tolerance set in the GPS OPT, TOL, and VDOP keys.

Ashtech Z GPS Driver

Instructions are specific to the Ashtech Z receiver family.

Setting up the Ashtech Z Base Station Receiver

1. **On the data collector, select the Ashtech Z driver by pressing ↱ GPS INST and ASH Z.**
2. **Put the GPS antenna on a tripod in a spot where there is a wide view of the sky. If using State Plane Coordinates, it must be on a point for which you have the State Plane Coordinates. If using local coordinates, it can be on a known point or an unknown point.**
3. **Connect the GPS antenna to the receiver.**
4. **Make sure the battery is installed in the receiver.**
5. **Connect the cable from the data collector to the receiver's "Serial A" port.**
6. **Connect the base radio cable to the receiver's "Serial B" port.**
7. **Connect the radio antenna to the base radio. Put the radio antenna as high as possible.**
8. **Press the power button to turn on the receiver. Push one of the arrow keys on the receiver to get past any warning messages.**
9. **Press ↰ INFN to see the Ashtech Instrument Functions screen. Press the INIT soft key to set the receiver back to the default settings. Any warning messages that appear when turning on the power will appear again. Press one of the arrow keys to dismiss them.**

10. Press [↱] [POS] to see the GPS status screen. If you see the message "POSITION DATA NOT AVAILABLE," there could be a problem with the baud rate or cable connection. Check the cables and try again. If the receiver has not calculated a position yet, the latitude and longitude will be zero.
11. The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the base, the quality will be 1, the link will be 999, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3. The RMS values shown are error estimates in feet or meters, depending on the current mode. The RMS values will be high at the base receiver. If the HDOP and VDOP values are high, they may get lower after a few minutes. If they do not get low enough, you can still proceed, but accuracy may not be very good unless more satellites come into view.
12. Press SETUP HI to enter the distance from the ground to the base of the antenna. Note that if you plan to use 2PFS or B M to establish your elevations, it does not matter if the height of the base and rover antennae are entered.
13. Press BASE in the GPS menu. Enter the point number occupied by the base station or `0` if the base is on an unknown location. You will be prompted for the radio port number. Usually, you should enter `1` to use port B. You will be prompted for the radio baud rate. The default radio baud rate is 9600 if you are using the Pacific Crest RFM96W radios, or 38400 if you are using the Pacific Crest PDL radios. Type the baud rate and press [ENTER]. The data collector will then initialize the receiver as a base station. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.
14. Turn on the base radio. You should see the Transmit light (TX) blink once per second. If the Receive light (RX) is blinking, there is radio interference. If the TX light is not blinking, make sure the radio port and baud rate entered using the BASE key are correct.
15. Disconnect the data collector from the base receiver.

Setting up the Ashtech Z Rover Receiver

1. Follow the directions for setting up the Ashtech Z base receiver first.
2. Put the GPS antenna on the pole.
3. Connect the GPS antenna to the receiver.
4. Make sure the battery is installed in the receiver.
5. Connect the cable from the data collector to the receiver's "Serial A" port.
6. Connect the rover radio cable to the receiver's "Serial B" port.
7. Connect the radio antenna to the rover radio.
8. Press the power button to turn on the receiver. Press one of the arrow keys on the receiver to get past any warning messages.
9. Press [↰] [INFN] to see the Ashtech instrument functions screen. Press the INIT soft key to set the receiver back to the default settings. Any warning messages that appear when turning on the power will appear again. Press one of the arrow keys to dismiss them.
10. Press SETUP HROD to enter the distance from the ground to the base of the antenna. Note that if you are using 2PFS or B M to establish your elevations, it does not matter if the height of the base and rover antennae are entered.

11. **Press ROVER in the GPS menu. You will be prompted for the radio port number. Usually, you should enter** `1` **to use port B. You will be prompted for the radio baud rate. The default radio baud rate is 9600 if you are using the Pacific Crest RFM96W radios or 38400 if you are using the Pacific Crest PDL radios. Type the baud rate and press ENTER. The data collector will then initialize the receiver as a rover. If there is an error communicating with the receiver, it will beep and display an error message. If it is successful, it will return to the GPS menu.**
12. **If you are using a local coordinate system, see *GPS Setup Using a Local Coordinate System* on page 217 to finish setting up. If you are using a state plane system, see *GPS Setup Using State Plane Coordinates* on page 216 to verify setup.**

Checking the Status of the Rover

1. **Press ↱ POS to see the GPS status screen. If you see the message "**POSITION DATA NOT AVAILABLE,**" there could be a problem with the baud rate, cable connection, or the receiver may not have a position yet. Check the cables and try again.**
2. **The GPS status screen shows a live update of position and other useful information about the accuracy of the position. When connected to the rover, the quality should be 5, the link should be 1 or less, there should be at least 5 satellites, the HDOP should be lower than 2, and the VDOP should be lower than 3.**
3. **If the link value in the GPS status screen is higher than 1, there is a problem with radio communication. The link value shows how long it has been since the last data was received from the radio. Without good radio communication, the quality will not get up to 5 and errors will be large. If the rover radio's "Receive" LED is flashing once per second, then check the radio port and baud rate entered using the ROVER key.**
4. **High HDOP and VDOP values are caused by a poor arrangement of satellites or not enough satellites. Try moving to a location where more of the sky is visible. Sometimes the arrangement of satellites in the sky will be poor even if the entire sky is visible.**

Custom Instrument Functions Menu

KEYSTROKES: ↰ INFN

Custom Instrument Functions Menu Definitions

Option	Function
SLEEP	This option puts the receiver in power-saving Sleep mode.
INIT	This option initializes the receiver. After INIT, the receiver will have to reacquire the satellites.
RESET	This option resets the receiver. After reset, the receiver will have to reacquire the satellites. You will need to set the Base and Rover modes again.
RELIA	This option is used to set the RTK reliability of the receiver. The higher the reliability setting, the longer it takes to achieve a fixed RTK solution. Press the button to see the options. See the Ashtech manual for more details.
MULTI	This option is used to set the multipath setting of the receiver. Press the button to see the options. See the Ashtech manual for more details.

List of Error Messages

Custom Instrument Functions Menu Error Messages

Error Message	Procedure
"BAD QUALITY = 1"	The rover is not getting data from the base. Check connections and Send and Receive lights on the radios. Check the radio serial port and baud rate settings on the data collector.
"BAD HDOP = 6"	The HDOP for the last shot exceeded the HDOP tolerance set in the GPS OPT and TOL keys.
"BAD VDOP = 6"	The VDOP for the last shot exceeded the VDOP tolerance set in the GPS OPT and TOL keys.

NMEA LLQ GPS Driver

The NMEA LLQ message contains local coordinates instead of latitude and longitude. The LLQ driver can be used with GPS receivers that will output LLQ messages.

Setting up the SMI Data Collector

To install the LLQ driver on the SMI data collector, press ↱ GPS INST and LLQ. Another way is to press SETUP NXT NXT INST NXT NXT GPS and LLQ.

A tolerance value for the coordinate quality can be set by pressing ↱ GPS TOLM HDOP. If the coordinate quality exceeds the value set in HDOP, the coordinate will not be used.

Setting up the GPS Receiver

To prepare the GPS receiver to communicate with the data collector, set the baud rate to 9600, the parity to NONE and the protocol to NMEA LLQ. If there is an output frequency option, set it to 1 record per second.

Allen Osborne Associates Rascal Receiver

First ensure that your GPS setup is complete and that you have a real-time solution. Once you have obtained a solution on your Rascal rover receiver (viewed on the Survey Point Navigation screen), follow these steps to prepare the rover receiver to send LLQ messages to the data collector.

1. **From the rover Rascal's main menu, select TurboKinematic Setup (5).**
2. **Toggle option 5 so that the NMEA output is on.**
3. **Plug the SMI RS-232 cable into the AUX port of the Rascal.**

Notes on Using the LLQ Driver

1. **Setting the base station as the occupied point gives a good orientation for the Go/Come Left/Right values in the Stake menu.**
2. **If you want to manually type in the coordinates and elevation instead of getting them electronically, choose the MAN3 option in the Instruments menu (SETUP NXT NXT INST and MAN3).**
3. **When raw data is turned on, a comment record precedes shot information as follows: CM GPS north east elevation Hrod Geoid Satellites CoordinateQuality.**

Quick Reference of Menus and Functions

Appendix

A

In this appendix:

In this section are listed the command key functions and soft key functions of your surveying program in alphabetical order by function name. The program that the function requires is listed under each function also. For example, if you are trying to access a robotic function but only have an ***SCE*** program, you will be unsuccessful. The following are the programs SMI offers.

- SCE - Standard COGO
- ACE - Advanced COGO
- DCE - Data Collection
- CVCE - Construction Five
- DCER - Data Collection/Robotics
- CVCR - Construction Five GPS/Robotic
- DOT - Construction Five Department of Transportation

✎ *Remember to take advantage of SMI's upgrade program if you find a function in this manual that you would like to use but do not have the correct program to do so.*

Angle Adjustment

KEY: AA

PRODUCT: ACE+

KEYSTROKES: ➦ COMPAS AA or RPTS ENTER NXT AA

This function performs an angle adjustment using a current Random Points file and can be accessed from the Random Points menu or the Compass menu.

When running the AA command once while the raw data flag is set on (↰ 2), the angular error and the number of angles are stored to the raw file.

Procedure

✎ *Remember to copy or back up your job before performing an Angle Adjustment or Compass Rule function.*

Create a Random Points file for the current job. The last two traverse points in the file should define the direction assumed to be correct; the two traverse points immediately before the last two points should define the error direction.

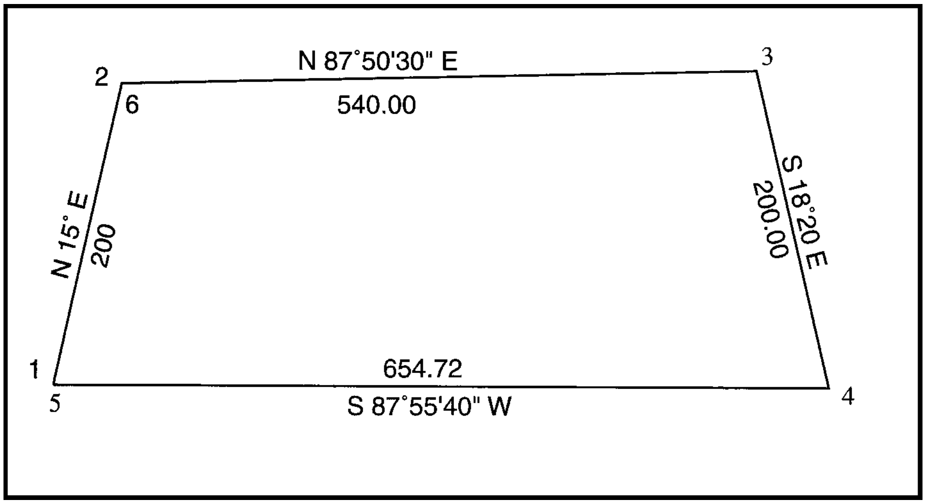


Figure A-1 Angle Adjustment

Example 1 – Closed Traverse Without Side Shots

Refer to the illustration above and assume that it represents a field traverse where you shot point 1 and called it point 5 and shot point 2 and called it 6. The direction from point 5 to 6 will be slightly different from the direction from 1 to 2.

To perform an angle adjustment, press RPTS, key in `1.6` SPC `1` SPC `2` and press ENTER. To find the angle error, press ➦ COMPAS and press ∆ ERR. Press AA to adjust the angle error out of the traverse. The program will go through its calculations and when it is through, the screen will display "DONE." Now to confirm the angle from 5 to 6 is the same as from 1 to 2; key in 5 SPC 6 and press the P-P key.

✎ *Side shots from the traverse points should be entered as negative numbers (see below).*

Example 2 – Closed Traverse to Known Points

Assume point 4 has side shots of points 101 through 108. The Random Points file should look like this: 1 2 3 4 -101.108 5 6 1 2. To cause 101.108 to be negative, key in `101.108` and press the +/− key (the Y key), not the minus key.

Appendix A: Quick Reference of Menus and Functions

Example 3 – Angle Adjustment with an Open Traverse

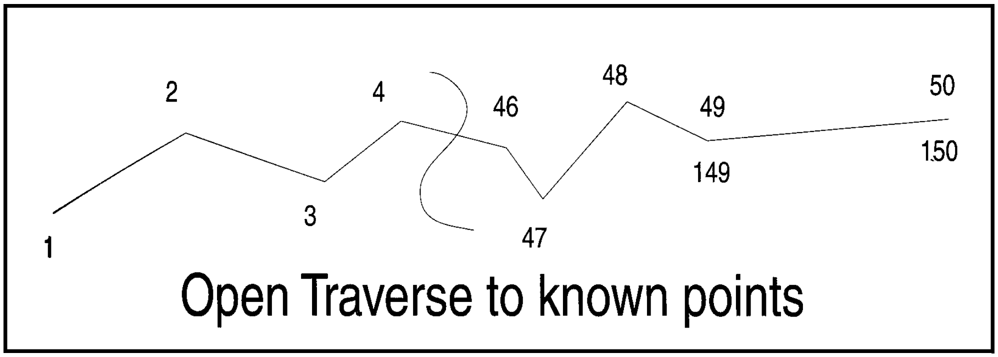


Figure A-2 Open Traverse to Known Points

In the above illustration, you traversed from point 1 to point 50, where points 1, 2, 149, and 150 are previously established points. The Random Points file would look like this: 1.50 149 150. To find the angle error, press [→] and press [∆ ERR]. When [AA] is pressed, the direction from 49 to 50 will become the same as the direction from 149 to 150 with all of the angles between appropriately adjusted.

✎ *To enter Angle Left while traversing, key in the Angle Left, press* [+/–] *to change the sign, then press* [∆ RT] *in the Traverse menu. The program understands that a negative Angle Right is an Angle Left.*

Angle Point and Intersection Point

KEY: [∆ PT] and [X PT]

PRODUCT: SCE+

KEYSTROKES: [SETUP] [NXT]

Use these two functions from two different instrument locations. Coordinates and elevations may be collected from the remote points without a prism.

In order for the elevations to be correct, the height of instrument should be stored in the ***SMI*** program before shooting the benchmark.

Procedure

From one instrument location, use [∆ PT] to store angles to a point (or points), such as towers, bridge abutments, road centerlines, fence lines, and so on.

From another instrument location, use [X PT] to create points at the intersection point of each of these points.

Angle Point and Intersection Point Definitions

Option	Function
∆ PT	Angle point is used to collect angles from an occupied point.
X PT	Intersection point is used to create intersection points from another occupied point to the objects pointed when angle points were stored.

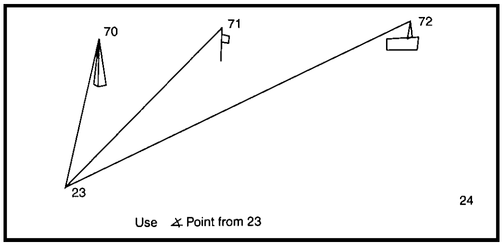


Figure A-3 Angle Point from 23

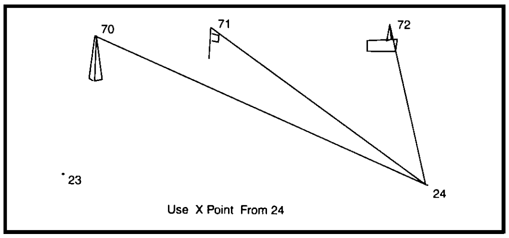


Figure A-4 Angle Point from 24

Once you have stored an angle point from one instrument position, you can move to another setup or traverse point and point to the same object; the program will create an intersection point – with elevation (if Elevations are on).

1. **While your instrument is sighted on the point, press [∡ PT] to store an angle to the next number, or enter the point number where you want the angle stored, then press [∡ PT]. Take as many angle point readings as desired.**
2. **Move to another point. (Traverse, free station, or occupy a different point in the normal manner.)**
3. **Point the same object with the instrument: press [SETUP] [NXT] then key the point number used in the angle point and press [X PT].**

When the program recognizes the number as an angle point, it will collect the angles to the point and calculate the coordinates (and elevation, if on) of the point. The current angle automatically is intersected with the previous angle to create an intersection with the coordinates (and elevation, if on) by point number.

Example

As the following will illustrate, this function can be used to get coordinates and elevations of inaccessible objects or when in dangerous places; special thanks to Shelly Van Winkle of the Missouri Department of Highways for suggesting this innovative program!

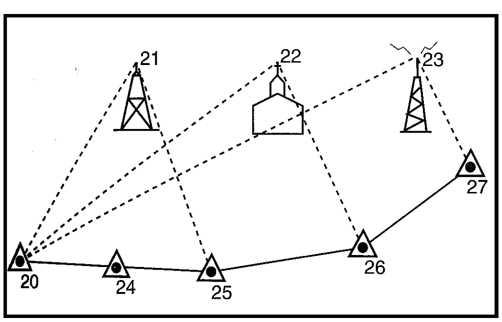


Figure A-5 Angle Points Stored from Point 20

In the illustration in Figure A-5 on page 247, angle points were stored from control point 20. The angle points are numbered 21, 22, and 23.

While the instrument occupied point 20, it sighted the tower and **∠ PT** was pressed. This was stored as angle point 21. Then the church steeple was sighted and **∠ PT** pressed; this was stored as angle point 22. Finally, the radio tower was sighted and **∠ PT** pressed; this was stored as angle point 23.

The instrument was then traversed to point 24 and then to point 25. While occupying 25, the tower was sighted (point 21) and an intersection point was shot. To do this, **SETUP**, **NXT** were pressed then 21 keyed in and **X PT** pressed.

✎ *Note that since the next number was set to 21, it was not necessary to key in 21 before pressing* **∠ PT**. *Since each* **X PT** *was stored in the same order as* **∠ PT**, *it was not necessary to key in a point number before pressing each* **X PT**. *If Elevations are on, elevations will be stored from the* **X PT** *positions. Remember, in order for the elevations to be correct, the height of instrument should be stored in **SMI** before shooting the benchmark.*

Area

KEY: **AREA**

PRODUCT: SCE+

KEYSTROKES: **RPTS** (key-in data) **ENTER** **AREA**

This function computes the acreage of an area within a predefined boundary.

Procedure

Work though the following examples to compute the area for various situations.

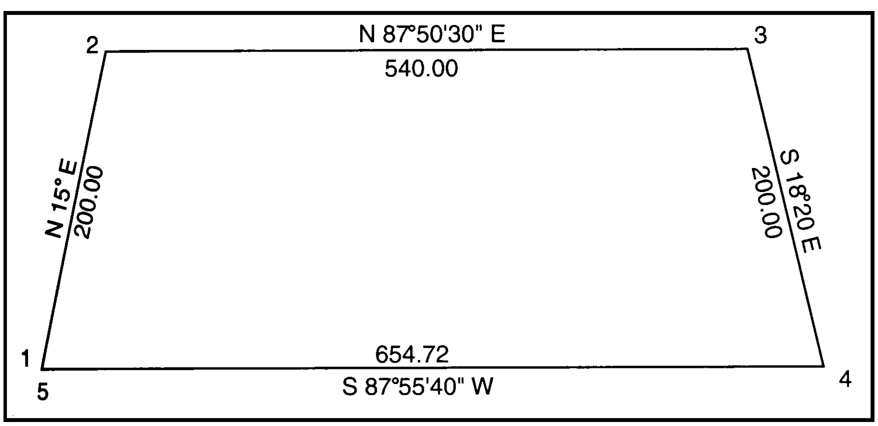


Figure A-6 Compute Area Illustration

How to Find the Acreage in the Compute Area Illustration

1. **Traverse from point 1 to point 4.**

   This stores points 1 through 4.

2. **Press RPTS, key in `1.4` and press ENTER.**

3. **Press AREA.**

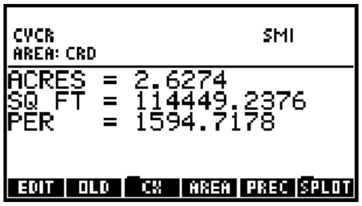


Figure A-7 Find Area

How to Find the Area, Precision, and Perimeter at the Same Time

1. **Traverse from point 1 to point 5.**

   This stores points 1 through 5.

2. **Press RPTS, key in** `1.5` **SPC** `1` **and press ENTER.**

3. **Press PREC.**

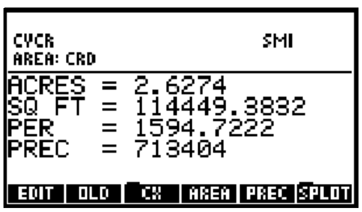


Figure A-8 Find Area, Precision, and Perimeter

For more information about using Random Points files, see *Random Points* on page 329.

How to Find Acreage Around a Boundary with a Curve

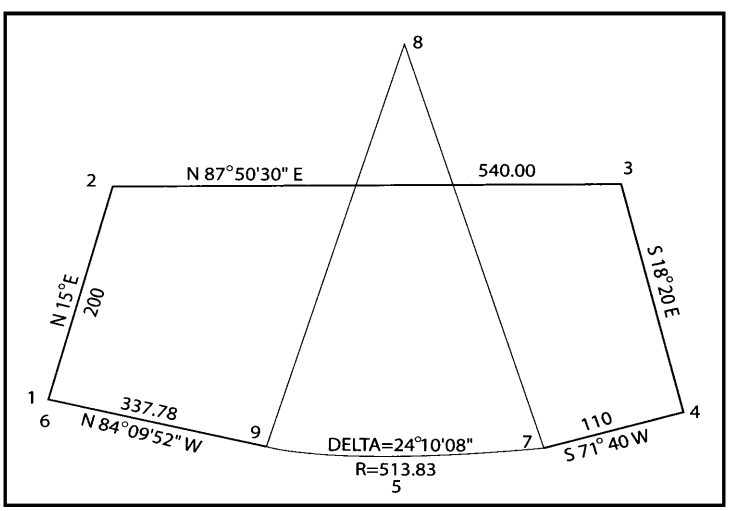


Figure A-9 Find Acreage Around Boundary with a Curve

Refer to the illustration above.

Points 1 through 9 must be stored in the data collector.

1. **Press** RPTS **, key in** `1.4` SPC ↱ — **(the minus key)** 7 SPC 8 SPC 9 ▶ **(the R key)** SPC 6 **and press** ENTER**.**

   The data should look like this: 1.4 “7 8 9” 6

2. **Press** AREA**.**

How to Find Acreage Around a Boundary with a Non-tangent Curve

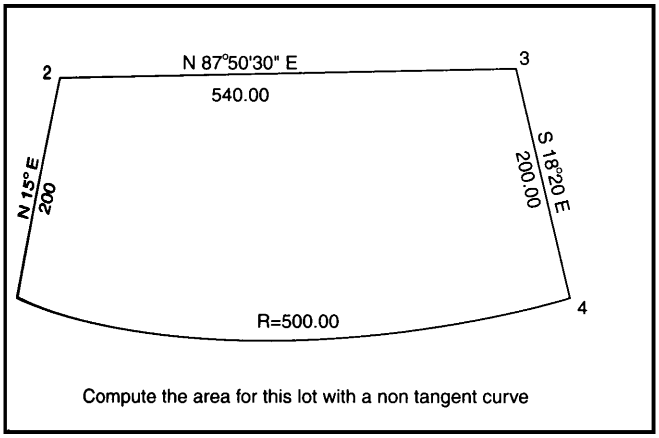


Figure A-10 Compute the Area for a Lot with a Non-tangent Curve

Refer to the illustration above.

1. **Traverse around the boundary and store points 1 through 4.**
2. **Perform a distance - distance intersection from points 1 and 4 using the radius as the distance from points 1 and 4.**
3. **Store the radius point at 5.**
4. **Press** RPTS **, key in** `1.3` SPC ↱ — **(to get quotes) key in** 4 SPC 5 SPC 1 **and press** ENTER**.**

   The data should like this: 1.3 “4 5 1”

5. **Press** AREA**.**

See *Example 2 – Inputting Points While Traversing* on page 47 for additional information.

Assign Default Keys

PRODUCT: SCE+

KEYSTROKES: α K ENTER

This function automatically assigns ***SMI*** surveying functions to keys on the data collector and starts the ***SMI*** program.

To exit ***SMI*** and go to the HP 48 functions, press ↰ QUIT (the α key). To re-enter ***SMI***, press α K ENTER.

Azimuth-to-Bearing Conversion

KEY: **ATB**

PRODUCT: SCE+

KEYSTROKES: **ATB** (the 5 key)

This function converts an azimuth to a bearing.

Procedure

With the azimuth value entered into the command line, execute the function. The display will show the value as Angle Right, bearing, and deflection angle.

For example, a back azimuth of 301°12' would be converted to a bearing of N58°48'W. Other angles will be displayed based on the current back azimuth.

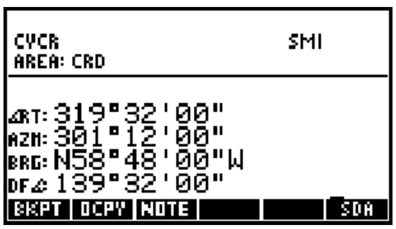


Figure A-11 Azimuth-to-Bearing Conversion

Backsight Point

KEY: **BKPT**

PRODUCT: SCE+

KEYSTROKES: **SETUP** **BKPT**

This function allows you to enter a backsight point from your occupied point, and computes and stores a back azimuth from the occupied point. This requires a zero set on the instrument when the backsight is pointed if doing an Angle Right survey.

Procedure

Press **SETUP**. Key in the desired backsight point and press **BKPT**. The backsight point will be stored, and the back azimuth will be computed and stored using the coordinates of the current occupied point.

✎ *DCE+ users: In the* **SETUP** *menu, you also can press* **BKPT** *to shoot the backsight point and compare it to the stored backsight point. After prompting for the backsight point number, a shot is taken that gives you a check on the backsight distance. Information about the backsight point check is stored in the raw data file if Raw Data is on.*

Bench

KEY: **BNCH**

PRODUCT: CVCE+

KEYSTROKES: **CONST** **NXT** **NXT** **BNCH**

This function, used for a back-of-terrace position for slope staking, has been improved thanks to a suggestion by Jess Stanley and Mike Jones, two of our great customers from California.

Ditch data may now be entered without defining the vertical control or template. A horizontal control must be entered and the BNCH data (offset, elevation and slope) must be entered. Backslope can be down (fill area) or up (cut area); the program knows, based on where you take the shot.

Bench will also override the current template information. This is useful when a special ditch needs to be used that is not defined in the current template.

Procedure

The illustration below shows ditch data without using a template.

✎ *Elevations should be turned on when slope staking benches.*

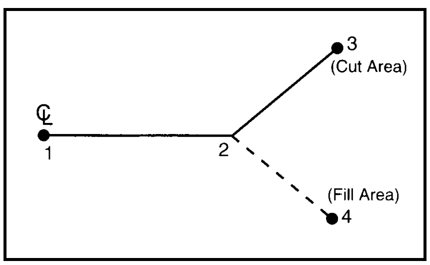


Figure A-12 Ditch Data Without Using a Template

If a template has not been defined, the program uses only the ditch defined by the **BNCH** key.

Another option is to use a template (as in the example shown in the illustration below).

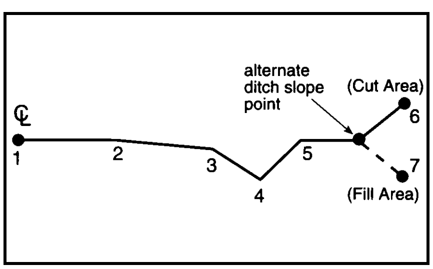


Figure A-13 Ditch Data Using a Template

If you take a shot between the centerline and the alternate ditch slope point, the program will use the template. If you take a shot outside that point, the program will use the alternate ditch slope information.

Here is another example:

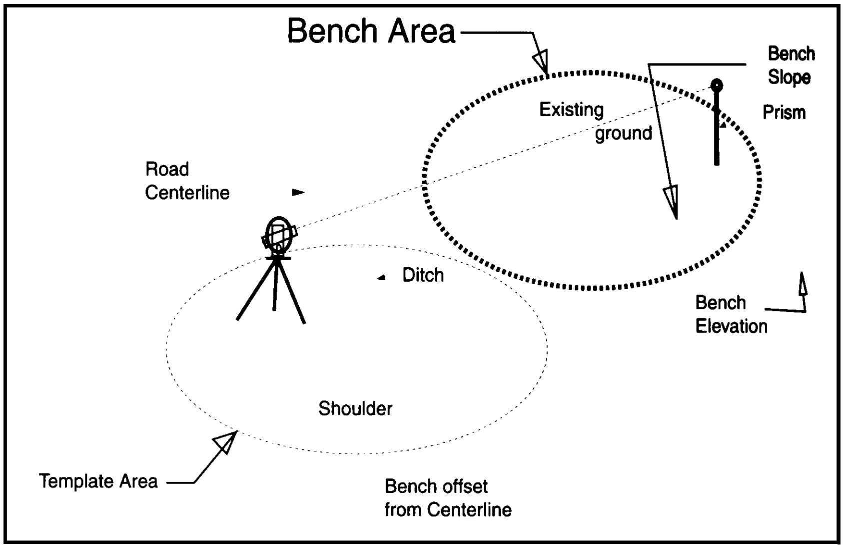


Figure A-14 Alternate Slope

In the illustration above, the alternate slope or bench is defined by the offset from centerline, bench elevation, and the bench slope.

When you press **BNCH**, these are the items requested by ***SMI***. When a shot is taken where the offset is greater than the bench offset used, the slope stake information given will be based on the bench data that has been entered.

If the offset to the shot is less than the bench offset used, the template will be used if a template has been entered.

The illustration indicates that the ground level is higher than the bench elevation. If the elevation at the rod is less than the elevation of the bench, ***SMI*** assumes the slope given was down instead of up.

For example, if the slope given was 2 and the elevation of the rod is above the bench elevation, the slope would be up at a 2:1 slope. If the elevation of the rod is less than the bench elevation entered, the data given would assume the slope to be down on a 2:1 slope.

When using bench information and the shots are beyond the bench offset, a template is not needed. If there is a template, it will be ignored for all points beyond the bench offset used.

Bench data entered for the right side of the road is mirror imaged for the left side of the road. Therefore, if you want to use the template on the left side of the road beyond the bench offset, the bench should be nullified.

To nullify a bench, press **CONST** **NXT** **NXT** **BNCH** key in `0` and press **ENTER**.

Horizontal control should be entered to use benches; otherwise, ***SMI*** has no idea where the offset is from.

Appendix A: Quick Reference of Menus and Functions

Benchmark Menu

KEY: **B M**

PRODUCT: DCE+

KEYSTROKES: **SETUP** **NXT** **B M**

Use this function for shooting a location with a known elevation to establish the elevation of the occupied point. This function allows you to transfer a benchmark elevation to the instrument.

The comment record (CM) within the raw data reports Benchmark Elevation, Height of Instrument, Height of Rod, Horizontal Angle (reporting an angle right), Zenith Angle, and Slope Distance.

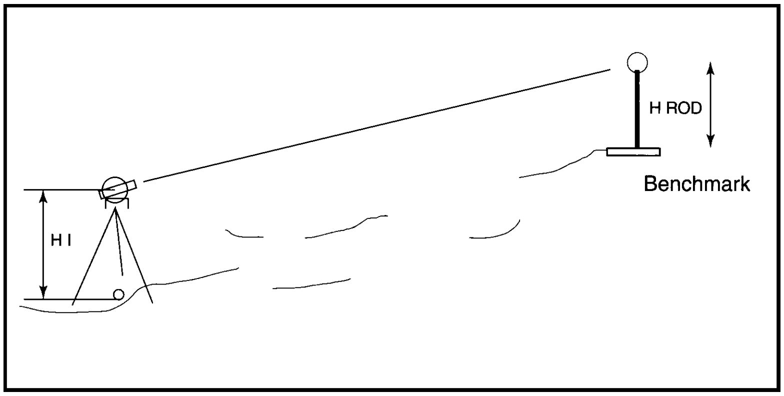


Figure A-15 Transferring a Benchmark Elevation to the Instrument

Procedure

Manual Entry

Press SETUP. Press NXT B M. Key in Slope Distance, Zenith Angle, and Angle Right (each value must be separated by a space).

When finished, press ENTER. You will see the following submenus:

Benchmark Menu 1 Soft Keys

Option	Function
REV	Press this key to collect a second Zenith Angle to be averaged with the first shot.
BMPT	Press this key to get the elevation from the given point number. This calculates a new elevation for the occupied point and occupies it.
E L?	Key in the elevation of the benchmark. Press E L?. The elevation of the occupied point is now displayed and occupied.
B M	Press this key to start over by taking another shot.

Benchmark Menu 2 Soft Key

Option	Function
STORE	Using this function is optional.

- You may press STORE to store the elevation with the occupied point.
- You may key in a point number and press STORE to store the coordinates and elevation in a different point.
- You may go to another function such as STAKE or Side Shot without using STORE. The elevation will stay intact. The new occupied point is displayed as COOR, since the point was not stored.

You may now key in an elevation of the benchmark and press **E L?** (or key in a point number that contains the benchmark elevation and press **BMPT**).

Or, you may flop the scope and press **REV**; key in Slope Distance, Zenith Angle, and Angle Right (each value must be separated by a space), and press **ENTER**.

Electronic Entry

The instrument should be pointing to the prism on the benchmark point and ready to take a reading. Press **SETUP** **NXT** **B M**. When the instrument reads the data, it will be displayed on the screen.

Key in the elevation of the benchmark point and press **E L?** (or key in a point number that contains the benchmark elevation and press **BMPT**).

The reference elevation is displayed and temporarily stored with the occupied point information (but it is not yet permanently stored in a point number). To store this elevation at a point, key in the point number and press **STORE**.

Advantages/Disadvantages of Setting HI and HROD

If **H I** and **HROD** are left at 0.00, the elevation this benchmark routine brings to the instrument will be a "reference elevation." This will not be the current elevation at the point under the instrument; however, when side shots are taken to the same rod (that has not been raised or lowered), ***SMI*** will store the correct elevations along with the north and east coordinates. If you are using tripods for prism points, **△ PT** and **X PT**, **SDA** for remote elevations, or **STOEL**, it will be necessary to enter the HI and HROD.

Change/Defaults

KEY: **CHG**

PRODUCT: SCE+

KEYSTROKES: **CHG** (the W key)

This menu key accesses the Change/Defaults menu, which includes functions that allow you to modify defaults used by the program for display and storage of data.

Procedure

The Change/Defaults menu includes a large number of soft keys; your card will determine which are available. Many of the soft key options are toggle switches; a box in the soft key indicates that the item has been selected. Press **NXT** to scroll through the soft key menu screens.

Once you have set the defaults the way you want them to be, press **JOB** **NXT** **SFLG** (Save Flags). You can then make other changes or even clear the memory of the data collector (assuming you have a RAM card installed). You can then get your saved defaults back by pressing **JOB** **NXT** **RFLG** (for Recall Flags).

The two categories of defaults that will not be restored are tolerances (**TOLM**) and beginning point defaults (**BGPT**).

Change/Defaults Menu 1

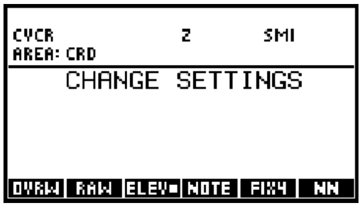


Figure A-16 Change Settings Menu 1

Change/Defaults Menu 1 Soft Keys

Option	Function
OVRW OVW ■	This toggle key lets you control the replacement (or overwriting) of point data. When selected (on), the card will automatically replace points; the number 1 will appear in the display to the left of SMI to indicate that this option has been activated. When deselected, the card will check before replacing point data. The default is off, requiring you to confirm before a point is overwritten.
RAW RAW ■	This toggle key lets you select whether raw data will be stored with each point. When selected (on), the number 2 will appear in the display to the left of USER to indicate that this option is active. The default is off.
ELEV ELEV ■	This toggle key lets you select whether elevations will be stored with point data. When selected (on), the number 3 will appear in the display to the left of USER to indicate that this option is active. The default is off.
NOTE AUTO LNTE NTBL	This four- way toggle key toggles between: ➥ PROMPTING OFF, WON'T STORE LAST NOTE ➥ PROMPTING OFF, WILL STORE LAST NOTE ➥ PROMPTING WITH LAST NOTE ➥ PROMPTING WITH NOTE TABLE When Notes are on, you will be prompted to enter a note or description for each new point when it is stored. If Notes are off, you can still put a note on the last point or any other point if the coordinates have been stored. SETUP NOTE prompts for a note on the last point. If a point number is entered before pressing SETUP NOTE, it prompts for a note on the specified point number. When this option is used, the number 4 will appear in the display to the left of SMI to indicate that this option is active.
FIX4	This function lets you modify the number of decimal places displayed on the screen when using the data collector for adding, subtracting, multiplying, and dividing and when using ***SMI*** to display distance and elevation. The display will prompt you to enter the fixed number of digits you want shown after the decimal point. That number will then appear in this soft key. The default is four decimal places. Other values such as Go/Come, Left/Right, cut/fill, triangle solutions, and intersections are not affected by this fix point. To have this fix point also control these other values, press CHG NXT DSPLY FIX4. (See *Display Options Menu* on page 257.) H I and HROD are not affected by either of the fix points. These are always defaulted to three places after the decimal.
N N NN ■	This toggle key lets you select whether the card will prompt for the next number to be stored. If this option is not selected, the card will automatically use the next available number, unless you manually key in a point number to be used.

Cursor Position in Notes

By default, the cursor is at the beginning of the note for editing. However, if you want the cursor to be at the end of the note, press CHG NXT INPUT END. You will be prompted with END COMMAND LINE CURSOR POSITION.

Change/Defaults Menu 2

KEYSTROKES: CHG NXT

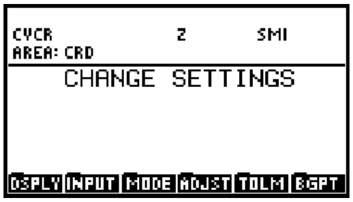


Figure A-17 Change Settings Menu 2

The first soft key you see in the second menu is DSPLY. Press this soft key to access the Display Options Menu.

Display Options Menu

KEYSTROKES: CHG NXT DSPLY

The Display Options menu allows you to adjust how information is presented on your screen and lets you turn Beep on or off.

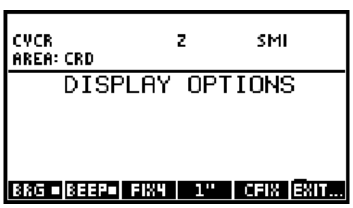


Figure A-18 Display Options Menu

The Display Options menu has the following soft keys:

Display Options Menu Soft Keys

Option	Function
∆RT ■ COOR■ BRG ■ AZ ■	This key toggles the display between Angle Right, coordinate, bearing, and azimuth format (see also *Display Format* on page 287).
BEEP BEEP■	This key turns Beep on and off.

Display Options Menu Soft Keys

Option	Function
FIX4 FIX4 ■	This key toggles between “Will use Fix4 for digits after decimal” and “Won’t use Fix4 for digits after decimal.” The digits after the decimal can be any amount you specify under CHG FIX4. The number you specify will then be displayed after the “FIX” on the soft key. For example, to have your distances, elevations, and Go and Come values set to three digits after the decimal, press CHG 3 FIX4. The soft key toggle will now be FIX3 / FIX3 ■ to turn on and off ‘”Will use Fix3 for digits after decimal” and “Will not use Fix3 for digits after decimal.” (FIX3 ■ is on.)
1" .1"	This key toggles between 1 sec angles and .1 sec angles.
CFIX	This function prompts for a CVC Fix Point. This function lets you fix the number of places after the decimal for station and offset values. ✎ *If you are in Meters mode, you can press* NXT *and you will see an option to toggle between 1+00 and 1+000. This indicates an option for how stations are displayed. The option is between two or three numbers after the plus and before the decimal. When in Feet mode, there will be two numbers after the plus when displaying stations.*
EXIT	Press this key to exit to the previous menu.
1+00 1+000	If Meters mode is on, this key toggles between having stations every 100 meters and every 1000 meters. If Meters mode is off, this key is blank.

The next soft key in the Change/Defaults Menu 2 is INPUT.

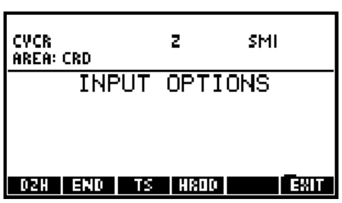


Figure A-19 Input Options Menu

Input Options Menu

KEYSTROKES: CHG NXT INPUT

The Input Options menu has the following soft keys:

Input Options Menu Soft Keys

Option	Function
DZH HZD	This function chooses options for the MAN2 setting (manual instrument input) when using SIDS, TRAV or SHOT and other manual inputs when the electronic instrument is turned off. This key toggles between entry of Slope Distance, Zenith Angle and Horizontal Angle (Angle Right) and HZD Horizontal Angle, Zenith, Angle and Slope Distance.

Input Options Menu Soft Keys

Option	Function
BEG / **END**	This option determines the cursor position of notes. See *Cursor Position in Notes* on page 256 for additional information.
TS	If the Time Stamp is toggled on, it will insert a time stamp after each shot in the raw data file.
HROD / **HROD■**	Enter a new Height of Rod. This key is blank when Elevations are off.This key toggles between prompting for a rod height after the shot and using the current rod setting. When toggled on, you will see "WILL PROMPT FOR HROD BEFORE STORING." Now, when you take a side shot or a traverse, the shot will first be taken; then you will be prompted for the HROD before the point is stored. Height of rod prompting is useful when frequently changing the rod height.
EXIT	This key exits to the previous menu.

The next soft key in the Change/Defaults Menu 2 is **MODE**.

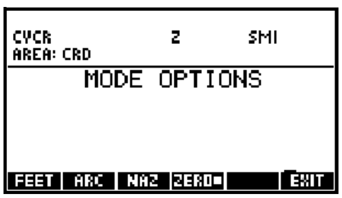


Figure A-20 Mode Options Menu

Mode Options Menu

KEYSTROKES: CHG NXT **MODE**

The Mode Options menu has the following soft keys:

Mode Options Menu Soft Keys

Option	Function
FEET / **METR**	This key toggles between Feet mode and Meters mode.
ARC / **CHORD**	This key toggles between "Arc definition degree of curvature" and "Chord definition degree of curvature."
NAZ / **SAZ**	This toggle key lets you select North Azimuth (NAZ) or South Azimuth (SAZ). SAZ is used for surveys done where a 0 azimuth is pointing south. For example, Hawaii uses a south azimuth grid system. Some DOT controls also are based on south azimuth, but north azimuth is used most often.

Mode Options Menu Soft Keys

Option	Function
ZERO ■ **DTBS ■** **AZIM ■**	This toggle key lets you use zero or a nonzero angle as the angle to the backsight. **ZERO ■** sets the angle to the backsight to zero. ✎ *DCE/CVCE users: when this option is selected,* **ZERO** *appears in other relevant soft key menus to allow you to set the Horizontal Angle in the instrument to zero.* **DTBS ■** lets you use a directional theodolite where you enter an angle in the backsight, enter a foresight angle, and the Angle Right is computed. **ZERO** will be replaced with **DTBS** in all relevant soft key menus. ✎ *DCE/CVCE users: when this option is selected, pressing* **DTBS** *brings in the current Horizontal Angle from the instrument as the angle to the backsight.* **AZIM ■** assumes that the angle to the backsight is the back azimuth. When selected, **AZIM** (azimuth survey) will appear in all relevant soft key menus. ✎ *DCE/CVCE users: when this option is selected, pressing* **AZIM ■** *sends the backsight azimuth to the instrument (this may not be available on all instruments).*
EXIT	This key returns to the previous menu.

The next key in the Change/Defaults Menu 2 is the **ADJST** soft key.

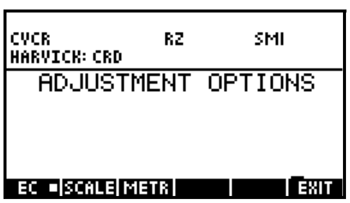


Figure A-21 Adjustment Options Menu

Adjustment Options Menu

KEYSTROKES: CHG NXT **ADJST**

The Adjustment Options menu has the following soft keys:

Adjustment Options Menu Soft Keys

Option	Function
EC **EC ■**	This toggle key lets you select whether to use the Earth's curvature and refraction adjustment to the elevations that are stored with the points in your job calculations. This function should default to ON (**EC ■**). It is recommended that you normally leave this on. The EC adjustment starts to lose accuracy at about 2000 to 4000 feet. After this distance, leave the function on, but go to the other end of the line and use Mean Backsight (SETUP NXT NXT **MBS**).
SCALE	This key prompts for a scale factor. Entering `1` will disable the option. When working with State Plane Coordinates, you may enter a scale factor here. A shortcut to this function is ↰ × (the multiplication key). If Scale is on in the **2PFS** function (Two Point Free Station program), ***SMI*** will automatically find the scale factor for you and use it when collecting points from the free station position.
METR	This key toggles between Feet mode and Meters mode.

Adjustment Options Menu Soft Keys

Option	Function
EXIT	This key returns to the previous menu.

The next key in the Change/Defaults Menu 2 is **TOLM**.

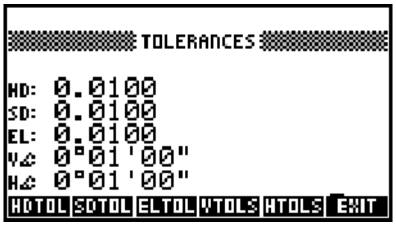


Figure A-22 Tolerances Menu

This soft key presents a submenu that allows you to modify current tolerance values for vertical and Horizontal Angles, elevations, and horizontal and Slope Distances when taking multiple angles and distances in your current job. Whenever a tolerance is exceeded, the data collector will signal with a beep and/or an arrow pointing to the error.

Tolerances Menu

KEYSTROKES: **CHG** **NXT** **TOLM**

Tolerances Menu Soft Keys

Option	Function
HDTOL	This key is used to change the horizontal distance tolerance. The default is .01 feet.
SDTOL	This key is used to change the elevation tolerance. The default is .01 feet.
ELTOL	This key is used to change the Slope Distance tolerance. The default is .01 feet.
VTOLS	This key is used to change the vertical angle tolerance. The default is 1'.
HTOLS	This key is used to change the Horizontal Angle tolerance. The default is 1'.
EXIT	This key returns to the previous menu.

The last soft key in the Change/Defaults Menu 2 is **BGPT**.

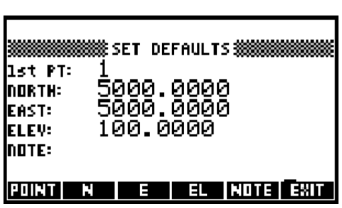


Figure A-23 Beginning Point Defaults Menu

Beginning Point Defaults Menu

KEYSTROKES: CHG NXT BGPT

This soft key lets you set your beginning point defaults. The normal defaults are 5000 for north and 5000 for east. If Elevations are on, the default elevation is 100 for the first point. The default first point number is 1. When you change these default values, they will be used for the first point each time you create a new job.

Beginning Point Defaults Menu Soft Keys

Option	Function
POINT	This key is used to change the default first point number created with a new job. The default is set to point 1.
N	This key is used to change the default north coordinate of the first point created with a new job. The default is 5000.
E	This key is used to change the default east coordinate of the first point created with a new job. The default is 5000.
E L	This key is used to change the default elevation of the first point created with a new job. The default is 100.
NOTE	(ACE + users): This key is used to change the default note for the first point created with a new job.
EXIT	This key returns you to the Change/Defaults menu.

Codes

KEY: ,

PRODUCT: SCE+

KEYSTROKES: ↰ , (the . key)

This function key lets you enter a code with a note.

Procedure

If you wish to assign a code to a point, it can be stored with the note.

First, enter the note. Then press ↰ , (the . key) and key in the desired code.

Press ENTER to store the note/code with the point.

✎ *It may be best to enter the code first, depending on how well your PC software is able to recognize (and search) codes or notes.*

Compass Rule Menu

KEY: COMPAS

PRODUCT: SCE+

KEYSTROKES: ➦ COMPAS (the SPC key)

This menu key allows you to perform compass rule or angle adjustment operations (***ACE*** and above) on points in the current Random Points file.

When running the CR command once while the raw data flag is set on (↰ 2), the distance adjustment factor and the angle adjustment are stored to the raw file.

✎ *Remember to copy or back up your job before performing a compass rule adjustment.*

Procedure

At the Compass Rule menu, you will see the following soft key options:

Compass Rule Menu Soft Keys

Option	Function
EDIT	This key is used to modify the current Random Points file. Press ON to clear the old data and type in the points to be adjusted. When you have finished editing your Random Points file, press ENTER to save the file. See AA and CR in this table for more on how to enter points in the Random Points file. (SCE +): you may store multiple Random Points files (see *Random Points* on page 329).
∡ ERR	(ACE+): This function calculates and displays the angle of error for your Random Points file without changing your points. (Use this before making any adjustment; after adjusting the points, this will show an error of zero.)
AA	(ACE+): This key is used to perform an angle adjustment using the current Random Points file. The last two traverse points in the Random Points file should define the direction assumed to be correct; the two traverse points immediately before the last two points should define the error direction (See *Angle Adjustment* on page 244).
CRERR	This key is used to find the compass rule error (see *Angle Adjustment* on page 244.)
CR	This key lets you perform a compass rule adjustment using the current Random Points file. The last point in the Random Points file should be the accepted point. The second-to-last traverse point in the file should be the point shot to the accepted point at the end of the traverse.

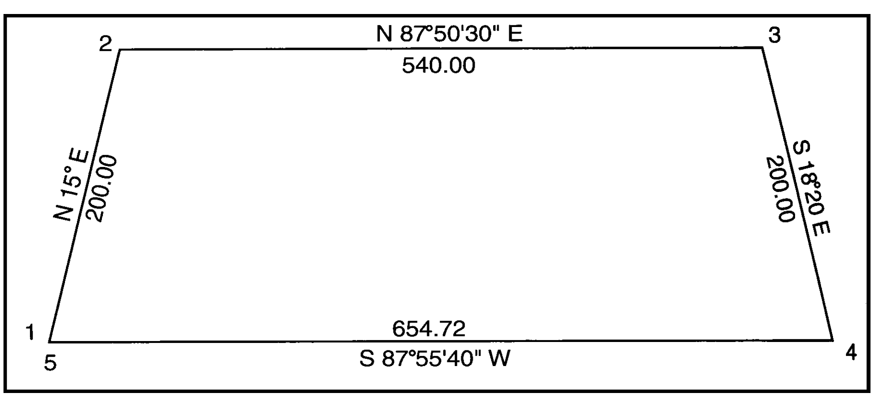


Figure A-24 Performing a Compass Rule Adjustment

Refer to Figure A-24 on page 263 to perform a compass rule adjustment:

1. **Points 1 through 5 should be stored in the data collector.**
2. **Press RPTS, key in** `1.5` **SPC** `1` **and press ENTER.**
3. **Press NXT and CR.**

   A compass rule adjustment will be performed.
4. **To check, key in** `5` **SPC** `1` **and press the P-P key.**

   The distance should now be zero.

Compass Rule Adjustment with an Open Traverse Example

Once the angle adjustment is performed, change the Random Points file to look like this: 1.49 149. After keying in the random point values and pressing ENTER, press PREC. This gives the precision of the open traverse. Press NXT and CR (for Compass Rule Adjustment). When you inverse from point 49 to point 149, you should now have a zero distance and the points from 3 to 49 should be appropriately adjusted. Side shots should be entered as negative numbers as illustrated in the example below.

✎ *You can also find the compass rule error by pressing ➦ COMPAS and CRERR. Compass rule error (CRERR) should be pressed before CR.*

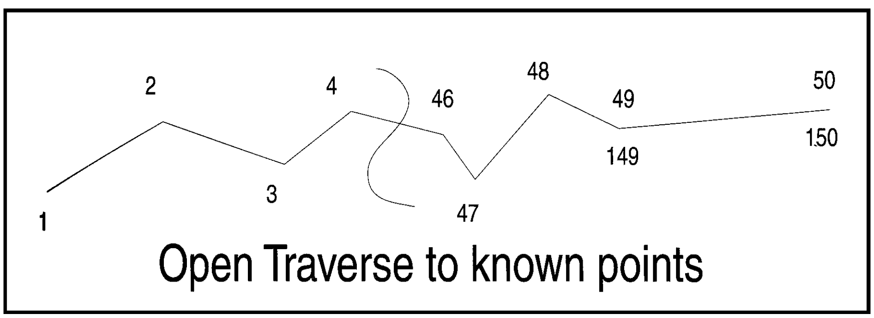


Figure A-25 Open Traverse to Known Points Illustration

Compute Angle Right

KEY: CAR

PRODUCT: SCE+

KEYSTROKES: MORE CAR

This function is used to compute the Angle Right from the back bearing, or from the back azimuth.

Procedure

You also can use azimuth values to compute Angle Right. This function assumes you are occupying the point where the two lines meet. This routine makes it easy to get an Angle Right from two lines (defined by two points on each line), or by two azimuths defining the direction of the two lines.

This key calls up a submenu:

Compute Angle Right Submenu Soft Keys

Option	Function
BKAZ	Enter the back azimuth or two points that define the back azimuth.
BKBR	Enter the back bearing.
FSBR	Enter the foresight bearing.
FSAZ	Enter the foresight azimuth or two points that define the foresight azimuth.

Construction Five

KEY: CONST

PRODUCT: CVC

KEYSTROKES: CONST

This key is used for staking and slope staking by station and offset using horizontal, vertical, and template control files.

Procedure

Construction Five has several submenus, so this section provides an explanation of those keys here. For examples on using ***Construction Five***, see *Construction Five*, which begins on page 151.

Construction Five Menu 1

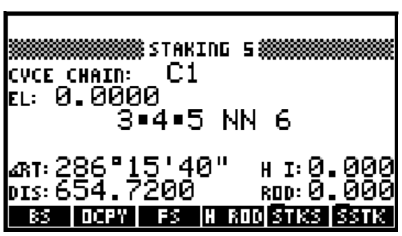


Figure A-26 Construction Five Menu 1

✎ *Note that keys that use a station and offset, such as* BS*,* OCPY*, and* F S*, will also accept just a station or a station, offset, and skew angle. If just one number is on the stack when the key is pressed, it will be used as a station with a zero offset. If two numbers are on the stack, they are used as* *a station and offset. If three numbers are on the stack, they are used as a station, offset, and skew angle. When a skew angle is entered, skew is measured clockwise from ahead with the offset measuring along the skew.*

Construction Five Menu 1 Soft Keys

Option	Function
BS	Enter the backsight station and offset. Press ↰ BS to enter a backsight point.
OCPY	Enter an occupied station and offset Press ↰ OCPY to enter an occupied point.
F S	Enter the foresight station and offset. If only the station is given, then the offset indicated by COFS or CBFS in the CVC Options (OPT) menu is used. If nothing is on the stack when F S is pressed, then the station is incremented to the next station interval. Press ↰ F S to use a point number to get a station and offset. Press ↱ F S to store a foresight to the cutsheet.
HROD	Enter a new Height of Rod. This key is blank when Elevations are off.
STKS	Stake Shot: Press to take a shot. Even if the shot is outside the shoulder, the Station Stakeout menu will appear.
SSTK	Press to take a slope stake shot. If the shot is inside the shoulder, the Station Stakeout menu will appear. If the shot is outside the shoulder, the Slope Stake menu will appear.

Construction Five Menu 2

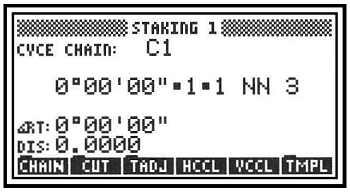


Figure A-27 Construction Five Menu 2

Construction Five Menu 2 Soft Keys

Option	Function
CHAIN	Chain menu (see *Chain Menu* on page 271).
CUT	Cutsheet menu (see *Cut Menu* on page 272).
TADJ	Template Adjustments menu (see *Template Adjustments Menu* on page 272).
HCCL	Used to enter the horizontal control for the current chain.
VCCL	Used to enter the vertical control for the current chain.
TMPL	The Template menu.

Construction Five Menu 3

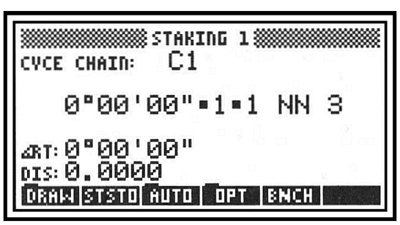


Figure A-28 Construction Five Menu 3

Construction Five Menu 3 Soft Keys

Option	Function
DRAW	The CVC Draw menu (see *Draw Menu* on page 274).
STSTO	Store a point at a given station and offset or station, offset, and skew.
AUTO	The Automatic Cutsheet/Points menu (see *Auto Stationing Menu* on page 275).
OPT	CVC Options menu (see *Construction Five Options Menu* on page 276).

Construction Five Menu 3 Soft Keys

Option	Function
BNCH	Enter the bench offset, elevation, and back slope to slope stake to a bench. This uses the backslope as a cut/fill from the bench for slope staking.

Station Stakeout Menu

When a shot is taken inside the shoulder or if Elevations are turned off, the Station Stakeout Menu appears.

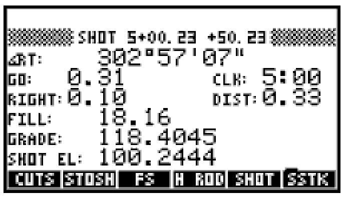


Figure A-29 Station Stakeout Menu

Station Stakeout Menu Soft Keys

Option	Function
CUTS	This key saves shot information to the cutsheet.
STOSH	This key stores the last shot. Press ↰ STOSH to store the point being staked.
F S	Enter foresight station and offset. Press ↰ F S to enter the foresight point.
HROD	Enter a new Height of Rod. This key is blank when Elevations are off.
SHOT	Stake Shot: Press to take a shot. Even if the shot is outside the shoulder, the Station Stakeout menu will appear.
SSTK	If the shot is outside the shoulder, the Slope Stake menu will appear.
EXIT	Return to the ***Construction Five*** menu.

Slope Stake Menu

To access this menu, you must have a vertical and horizontal control and template already entered in the job. If you do not have a template, you can use Bench. Then press the SSTK soft key in the first menu of ***Construction Five***.

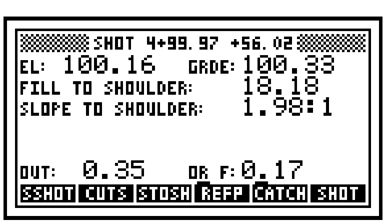


Figure A-30 Slope Stake Menu

Slope Stake Menu Soft Keys

Option	Function
SSHOT	Press to take a second shot. The SDIN/SDOUT value will be a distance along the slope of the existing ground.
CUTS	This key saves shot information to the cutsheet.
STOSH	This key stores the last shot to a point number. Pressing [↰] STOSH stores the catch point to a point number.
REFP	The Reference Point Stake menu: If a distance is on the stack when this key is pressed, that distance is used as the reference point distance from the catch point. This will turn servo-driven instruments to the reference point.
CATCH	The Catch Point Stake menu: This will turn servo-driven instruments to the catch point. This also computes a catch point.
SHOT	Press to take a shot, ignoring the previous shot. If the shot is inside the shoulder, the Station Stakeout menu will appear. If the shot is outside the shoulder, the Slope Stake menu will appear.
BRKC	Pressing this key shows cut/fill and distances from the catch point to the breakpoints.
BRKR	Pressing this key shows cut/fill and distances from the reference point to the breakpoints.
BRKI	Pressing this key shows cut/fill, distances, and intervals from the catch point to the breakpoints.
CELS	Enter a change in elevation from the last shot to the existing ground to simulate another shot. Use on flat ground when there is a sudden change in elevation.
CELF	Enter a change in elevation from the last shot to the existing ground to simulate another shot. Use on flat ground.
EXIT	Return to the ***Construction Five*** menu.
HROD	Enter a new Height of Rod. This key is blank when Elevations are off.

Reference Point Menu

KEY: REFP on the first page menu of the Slope Staking menu

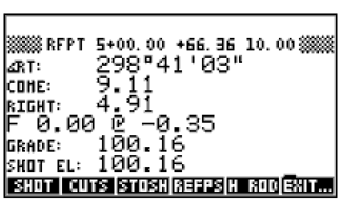


Figure A-31 Reference Point Menu

Reference Point Menu Soft Keys

Option	Function
SHOT	Press to take a shot on the reference point.

Reference Point Menu Soft Keys

Option	Function
CUTS	This key saves shot information to the cutsheet.
STOSH	This key stores the last shot. Pressing STOSH stores the point being staked.
REFPS	Press this key to store a new distance for the reference point.
HROD	Enter a new Height of Rod. This key is blank when Elevations are off.
EXIT	Press this key to return to the Slope Staking menu.
BRKC	Press this key to show cut/fill and distances from the catch point to the breakpoints.
BRKR	Press this key to show cut/fill and distances from the reference point to the breakpoints.
BRKI	Press this key to show cut/fill, distances, and intervals from the catch point to the breakpoints.

Catch Menu

KEY: CATCH on the first page menu of the Slope Staking menu

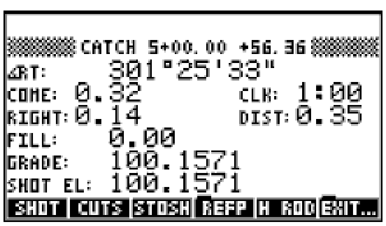


Figure A-32 Catch Menu

Catch Menu Soft Keys

Option	Function
SHOT	Press this key to take a shot on the catch point.
CUTS	Press this key to save shot information to the cutsheet.
STOSH	Press this key to store the last shot. Pressing STOSH stores the point being staked.
REFP	The Reference Point Stake menu: If a distance is on the stack when pressed, that distance is used as the reference point distance. This function will turn servo-driven instruments to the catch point.
HROD	Enter a new Height of Rod. This key is blank when Elevations are off.

Catch Menu Soft Keys

Option	Function
EXIT	Press this key to return to the Slope Staking menu.
BRKC	Press this key to show cut/fill and distances from the catch point to the breakpoints.
BRKR	Press this key to show cut/fill and distances from the reference point to the breakpoints.
BRKI	Press this key to show cut/fill, distances, and intervals from the catch point to the breakpoints.

Chain Menu

KEY: CHAIN on the second page menu of the Construction Five menu

KEYSTROKES: CONST NXT CHAIN

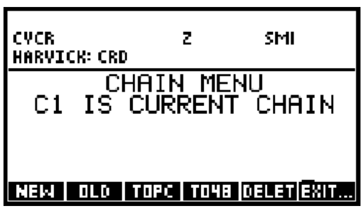


Figure A-33 Chain Menu Screen 1

Chain Menu Screen 1 Soft Keys

Option	Function
NEW	Press this key to create a new chain.
OLD	Press this key to select a chain to become the current chain.
TOPC	Press this key to transfer a chain to a PC using the ***Versions 5*** and ***6*** methods.
TO48	Press this key to transfer a chain from a PC using the ***Versions 5*** and ***6*** methods.
DELET	Press this key to delete a chain.
EXIT	Press this key to return to the ***Construction Five*** menu.
COPY	Press this key to copy the current chain into a chain with a new name.

Cut Menu

KEY: **CUT** on the second page menu of the Construction Five menu

KEYSTROKES: CONST NXT **CUT**

Cut Menu Soft Keys

Option	Function
VIEW	Press this key to view the cutsheet for the current chain.
PRINT	Press this key to print the current cutsheet.
TOPC	Press this key to send the current cutsheet to a PC using the ***Versions 5*** and ***6*** methods.
DELET	Press this key to delete the current cutsheet.
EXIT	Press this key to return to the ***Construction Five*** menu.

Template Adjustments Menu

KEYSTROKES: CONST NXT **TADJ**

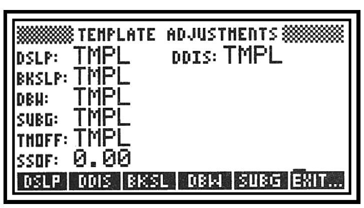


Figure A-34 Template Adjustments Menu Screen 1

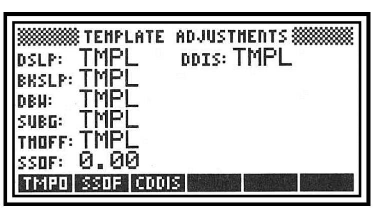


Figure A-35 Template Adjustments Menu Screen 2

Options in this menu override whatever is in the current template. Entries with TMPL in the display mean that the template has not been overridden.

Template Adjustments Menu Soft Keys

Option	Function
DSLP	Ditch slope - the slope from the shoulder to the ditch as a value with a ratio to 1.
DDIS	Ditch distance - the distance from the shoulder to the ditch.

Template Adjustments Menu Soft Keys

Option	Function
BKSL	Back slope.
DBW	Ditch bottom width. ✎ *Note that this is now available in the Template Editor.*
SUBG	This key boots the elevation of the entire template relative to the vertical control.
EXIT	Press this key to return to the ***Construction Five*** menu.
TMPO	Template offset: After entering an offset, indicate whether offsets will be from the centerline or from the template. This is useful when the vertical control is offset from the horizontal control
SSOF	Press this key to enter a slope stake offset. When slope staking, the offset will be shown to where the shot was taken, but the slope stake information will be for the offset minus the slope stake offset (SSOF). This is useful for placing reference stakes.
CDDIS CDSLP	This key toggles between "Constant distance from shoulder to ditch" (CDDIS) and "Constant ditch slope between templates" (CDSLP).

Template View Menu

KEYSTROKES: CONST NXT TMPL for viewing and editing the templates in the current chain

✎ *Your job must have a horizontal control in the job to view before you will see the following keys.*

Template View Menu Soft Keys

Option	Function
LEFT RIGHT	This key toggles between viewing the left and right templates.
PREV	Press this key to view the previous template.
NEXT	Press this key to view the next template.
DEL	Press this key to delete the template being viewed.
EDIT	Press this key to edit the current template.
EXIT	Press this key to return to the ***Construction Five*** menu.
R→L	Press this key to replace all the left templates with the right templates.

Template View Menu Soft Keys

Option	Function
L→R	Press this key to replace all the right templates with the left templates.

Template Edit Menu

KEYSTROKES: CONST NXT TMPL EDIT for editing the current template

Template Edit Menu Soft Keys

Option	Function
STA	Enter the station number of the template to edit. If a template does not exist at that station, then a template is created from the previous template. If STA is pressed without a number, the next template is displayed. If there is not a next template, then the user is prompted for a station number.
SEG1	Enter the segment number to be edited or created. A segment is a slope and distance between the centerline and the shoulder. If no segment number is given, the segment shown on the key will be used. After a segment has been entered, it will be displayed and the key will show the next segment to be edited.
DEL	Enter a segment number to be deleted.
DITCH	Enter the ditch slope, the ditch distance, and back slope.
DBW	Enter the ditch bottom width. If no ditch bottom widths are entered, the chain is still compatible with ***Version 5*** chains.
EXIT	Return to the Template View menu.

Draw Menu

KEYSTROKES: CONST NXT NXT DRAW

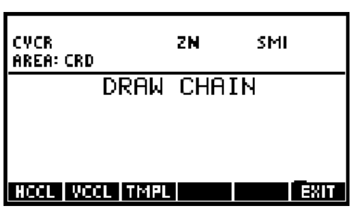
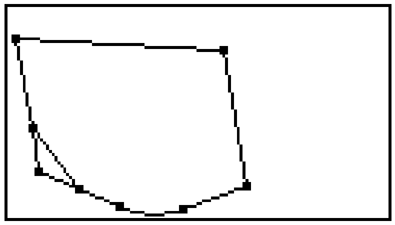
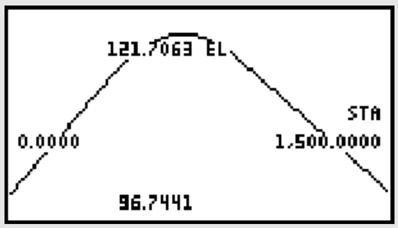
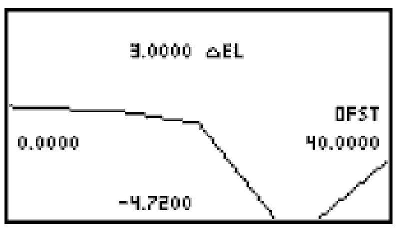


Figure A-36 Draw Menu

Draw Menu Soft Keys

Option	Function
HCCL	Press this key to draw the horizontal control.  ✎ *Note that spirals drawn on the screen are approximated by an arc.*
VCCL	Press this key to draw the vertical control. 
TMPL	Press this key to draw a template given a station and side. 
EXIT	Press this key to return to the ***Construction Five*** menu.

Auto Stationing Menu

KEYSTROKES: CONST NXT NXT **AUTO**

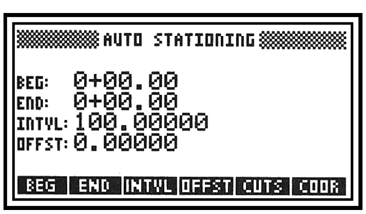


Figure A-37 Auto Stationing Menu Screen 1

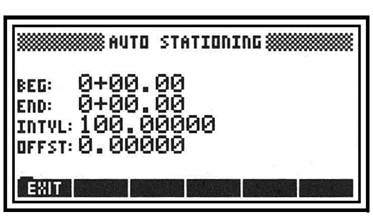


Figure A-38 Auto Stationing Menu Screen 2

This function automatically creates cut sheet entries or points at specified stations and offsets/ breakpoints.

Auto Stationing Menu Soft Keys

Option	Function
BEG	Enter the beginning station.
END	Enter the ending station.
INTVL	Enter the interval distance between stations.
OFFST	Enter the offset. If 0 is used, points will be generated at each of the breaks in the template.
CUTS	Press this key to store all the specified stations and offsets to the cutsheet.
COOR	Press this key to store all the specified stations and offsets to a point number.
EXIT	Press this key to return to the ***Construction Five*** menu.

Construction Five Options Menu

KEYSTROKES: CONST NXT NXT **OPT**

Construction Five Options Menu Soft Keys

Option	Function
STAI	Station interval is used for rounding stations in the cut sheet and automatically incrementing the foresight point.
STAT	Station tolerance indicates how close a station must be to the station interval to be rounded in the cutsheet. Shots that are within the station tolerance distance of the station interval will be rounded to the station interval. For example, if the station interval was 50 and the station tolerance was 5, a shot taken to station 3+51.23 would be stored in the cutsheet as 3+50. A shot to 3+56.34 would be stored as 3+56.34.
CSTA	This is the constant offset to be used when only the station is on the stack when foresight (**F S**) is pressed.
COFS	This is the constant breakpoint number to be used when only the station is on the stack when foresight (**F S**) is pressed. For instance, to take shots on the ditch bottom when there are two segments before the shoulder, enter 3. This is useful when staking the same offset at several stations.
CBFS	Constant breakpoint is used when only the station is on the stack when foresight (**F S**) is pressed. This is useful when staking a particular breakpoint such as the shoulder or curb at several stations. If there are two segments in the template to get to the shoulder, enter 2 to stake the shoulder when you enter a station and press **F S** .
EXIT	Press this key to return to the ***Construction Five*** menu.
MXOF	Maximum offset is used when trying to calculate the station and offset of a particular location. If set to zero, the entire chain is searched for the station with the smallest offset to the location. If not zero, the first station with an offset to the location less than the maximum offset will be used. This can speed up how long the calculations take.

Construction Five Options Menu Soft Keys

Option	Function
XTND	Extend the Horizontal Control past the beginning and ending points of the horizontal control to allow shots.

Horizontal Control with Construction Five

KEYSTROKES: CONST NXT HCCL

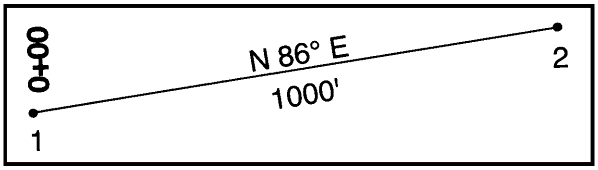


Figure A-39 Horizontal Control

Procedure for entering the above horizontal control in ***Construction Five***:

1. **Press** CONST**.**
2. **Press** NXT **and** HCCL**.**
3. **Key in the following:** `1` SPC `0` SPC `2` **and press** ENTER**.**

   The data will look like this:

   1 0 2 before you press ENTER or after you go back to HCCL.

Breakpoints

Use the same procedure as for a baseline, except you enter more point numbers.

The HCCL file for this water line will look like this: 1 0 2 3 4 5

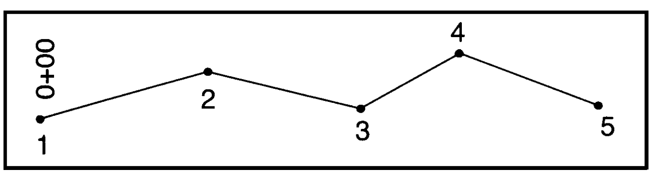


Figure A-40 Breakpoints

Simple Curves

The entry into HCCL is: 1 0 “2 3 4” “5 6 7” 8

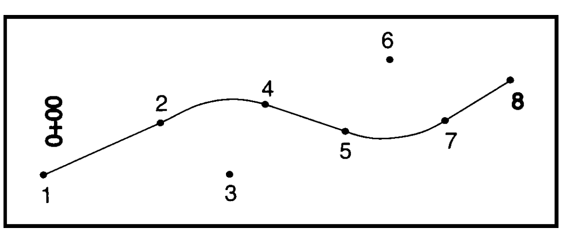


Figure A-41 Simple Curves Illustration

Appendix A: Quick Reference of Menus and Functions

Compound Curves

The entry should look like this: 1 0 “2 3 4” “4 5 6” 7

Notice how point 4 is part of both curves.

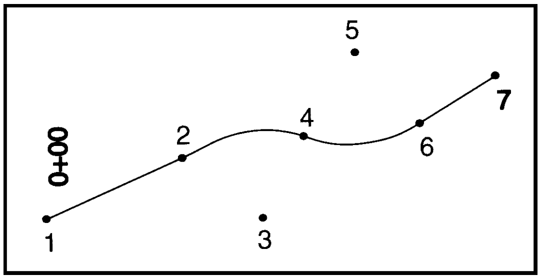


Figure A-42 Compound Curves

Spiral Curves

The illustration below should have an entry that looks like this: 1 0 {2 3 4 500 300 200} {5 6 7 500 300 200} 8 where 2 and 5 are TS points, 3 and 6 are main PI points, and 300 is the spiral length back and 200 is the spiral length ahead.

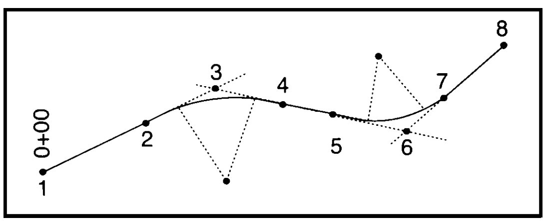


Figure A-43 Spiral Curves Illustration

One of the main features of ***SMI*** is that the spiral can be designed or checked for accuracy. If points 2, 4, 5, and 7 are only guessed positions and are along the tangent, ***SMI*** checks for accuracy and will override the points with the correct coordinates. If you do not wish to override these points, ***SMI*** will warn you that it is about to override the point coordinates. At this time, just change the point number and press **ENTER** to store the new coordinates at a different point number.

Combinations of lines, simple curves, and spirals: The data for this sample should look like this:

1 0 2 “3 4 5” {6 7 8 500 300 300} 9

where the radius of the simple curve is 500 and the SLB is 300.

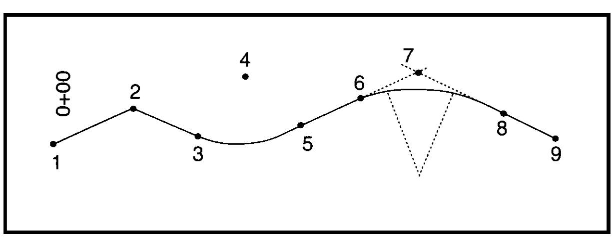


Figure A-44 Spiral Curves

Coordinate to Coordinate Inverse

KEY: **NE-NE**

PRODUCT: SCE+

KEYSTROKES: ↰ **NE-NE** (the x key)

This command inverses between two sets of unstored coordinates.

Procedure

Key in the north coordinate for the first pair and press **ENTER**. Key in the east coordinate of the first pair and press **ENTER**. Key in the north coordinate for the second pair and press **ENTER**. Key in the east coordinate for the second pair and press **ENTER**. With both sets of coordinates entered on the stack, press ↰ **NE-NE** and the inverse will be displayed.

Curve Stakeout – (Horizontal Curve Stakeout)

KEY: **CURVE**

PRODUCT: SCE+

KEYSTROKES: **STAKE** **NXT** **NXT** **CURVE** or press **CURVE**, then enter curve information and press **STA**

This key is used to stakeout a curve by station and offset.

If you need to enter curve information different than radius and delta, you can use the Curve menu to enter the data, then press **STA** in the Horizontal Curves menu. You will be prompted for a beginning station.

Procedure

Using Radius and Delta

Access to the Curve Stakeout function can be found on the third page of the **STAKE** menu as **CURVE**. The program requires that the PC be occupied and that the backsight be along the tangent (away from the PI). When **CURVE** in the **STAKE** menu is pressed, the user is prompted for the radius, delta, and beginning station "`Radius Delta BegSTA`."

Using the Curve Menu

Occupy the PC, backsight on the tangent, press ⌒ (the S key on the data collector), enter two elements of the curve (indicate whether the curve is turning to the left by entering a negative radius), then key in the station number of the PC and press **STA**.

You can now give any station number and get the Angle Right, deflection angle, tangent distance, tangent offset, and chord distance.

You can enter a constant offset for staking by station number, or you can enter tangent distances or chord distances and get stakeout data. Thus, it is easy to stake a simple curve by station or tangent or chord distances. Following are explanations of the menu keys.

Curve Stakeout Menu Soft Keys

Option	Function
STA	Enter a station to be staked. Pressing ↱ STA stores a point at the given station.
INC	Increment to the next station. If a number is on the stack when INC is pressed, it will be used as the new increment. The default increment is 100. When the end of the arc is reached, it starts over.
TL CHL	This key is different, depending on the setting of the TAN/CHORD toggle key on the next page. When TL is showing, enter the tangent length to stake. When CHL is showing, enter the distance along the chord to stake.
OFSET	Enter an offset to be staked. The default is 0.
SHOT	Manual or electronic entry of shot info: Changes to shot screen (Go/Come Left/Right). ↰ SHOT (robotic only): Shot screen information constantly updated. ↱ SHOT: Shows the shot screen using the last shot without taking another shot. This is useful to tell the rodman where to go from the previous foresight point instead of a direction and distance from the instrument.
STOPT	Press this key to store the point being staked. Press ↰ STOPT to store the last shot.
TAN CHORD	This key toggles between staking tangent length and offset and staking chord length offset. This toggle key changes the setting of the TL/CHL soft key and the second line of the display. The display toggles between showing TL (Tangent Length) and TOFF (Tangent Offset) for the TAN option and CHL (Chord Length) and COFF (Chord Offset) for the CHORD option.

Curves

KEY: ⌒

PRODUCT: SCE+

KEYSTROKES: ⌒ (the S key)

This function allows you to perform curve computations. The Curves functions are very flexible. You can choose in the CHG menu whether you wish to work with Arc Definition Curves or Chord Definition Curves. The default is Arc Definition Curves. To change this setting, press CHG NXT MODE ARC and you will see CHORD (or if CHORD is displayed, pressing CHORD will display ARC).

Procedure

When sufficient information has been entered, the curve can be computed and displayed. Usually, any combination of two of the elements described in this section will be enough to compute the missing data for the curve.

The Curves menu includes the following:

Curves Menu 1 Soft Keys

Option	Function
△	This key is used to enter a delta angle in degrees (interior angle of arc).
R	This key is used to enter a radius length.
T	This key is used to enter a tangent length.
L	This key is used to enter a tangent length when in Arc Definition mode. If in Chord Definition mode, the key changes to CCL and is used to enter a chord curve length. The Arc and Chord Definition modes can be changed by pressing CHG NXT MODE ARC / CHORD.
CH	This key is used to enter a chord length.
E	This key is used to enter an external length.

Press NXT for the second Curves menu screen; the soft key options are listed next:

Curves Menu 2

KEYSTROKES: ⌒ NXT

✔ ***Do not use the PC, CC, POC, or PT keys on the second menu when using the soft keys on the third menu.***

Curves Menu 2 Soft Keys

Option	Function
DEGC	This function is used to enter the degree of curvature. An arc length definition of 100’ is the default (flag 52 is clear). However, if flag 52 is set, the 100’ chord length definition is used. This flag is changed automatically using the ARC / CHORD soft toggle key in the Change menu: CHG MODE (see *Change/Defaults* on page 255).
PC	This key is used to enter the point of curvature and occupy that point. If this is not entered, the current occupied point is assumed to be the point of curvature. Key in a point number for the PC and press PC. Key in a point number for the PT and press PT. Now you will have the option of keying a point number for the RP, PI, or POC and the curve will be computed. Find the radius of a curve defined by three points on the curve by using the PC, POC, and PT.
RP	This key is used to enter the point number at the center of the curve. The radius is calculated from this point to the point of curvature (the occupied point). The point of curvature should be occupied before using this function in order to compute a valid radius.
PI	This key is used to enter the point of intersection. This is the point at the intersection of the two tangents to the curve.
PT	This key is used to enter the point of tangency. The chord of the circle is calculated from this point if the point of tangency (PT) and the point of curvature (PC) have been defined.
POC	This key is used to enter a point on the curve. The curve can be calculated from this point if the point of tangency (PT) and the point of curvature (PC) have been defined.

Curves Menu 3

KEYSTROKES: NXT NXT

When using the functions on this menu, it is assumed the occupied point is the PI and the backsight is along the tangent line through the PC.

The keys on menu 3 are designed to calculate the delta of the arc based on the direction of the forward tangent. Any other information about the arc may be entered before or after entering the direction of the forward tangent.

✔ ***Do not use the PC, CC, POC, or PT keys on the second menu when using the soft keys on the third menu.***

Curves Menu 3 Soft Keys

Option	Function
NPIPT	This key can be used to enter the point number of the next PI.
NPISH	This key can be used to take a shot on the next PI and store it as a side shot. If you are using electronic data collection, pressing this key will cause the instrument to take a shot on the PI.

After the direction to the forward tangent and one other known dimension of the arc have been entered, the PC, CC, and PT points will be stored in that order.

If you have entered only the direction to the forward tangent, after you store the points, the display shows the Distance submenu of the Traverse menu. This allows you to enter the distance and Zenith Angle to the PI and traverse to the PI of the next arc.

If the next PI point is already stored using the NPIPT or NPISH keys, the program traverses to that point and shows the third page of the Curves menu.

After the curve has been calculated, the display will present the curve data; additional soft keys now are available to store points and traverse through the curve. You can traverse around the curve by defining the direction in which the curve is turning; press LEFT or RIGHT.

The direction of the curve is always defined from the PC toward the PT. You may view the curve data at any time by pressing VIEWC from the soft key menu.

Or press AREA to see area information for the curve: sector, segment, and fillet. The curve routine presents a final set of soft keys to help you further define and store the curve data.

Curve Menu 4 Soft Keys

Option	Function
FATN	This key allows you to change the forward tangent of the curve. If a value is not entered, the forward tangent from the current back azimuth is used. This function is not needed if you have traversed along the tangent to the PC or if the CC is used to define the curve.
STORE	This key is used to store a point on the curve that you have just calculated. (This key also stores the “curve center” point that is used as a reference for calculations.) When finished, you will be presented with the following soft key options:
REP	This key uses the arc length from the previous data to continue traversing around the curve.
L	This key stores a new curve length and recalculates a new point based on the new curve length and radius.
NOTE	This key allows you to store a note with the last point stored. To store a note at a different point, key in the desired point number before pressing NOTE.

Curve Menu 4 Soft Keys

Option	Function
VIEW	This key redisplays the curve data.

Insert Curve at Point of Intersection While Traversing

KEY: IC@PI

This soft key will appear in the Traverse menu after a bearing is entered.

While traversing from PI to PI, you can insert a curve at each PI.

1. **Press TRAV and traverse to the PI of a curve (or you can press SETUP and occupy the PI point and backsight a point along the tangent, then press TRAV). Enter the direction to the next PI (Angle Right, azimuth, bearing, or deflection angle).**

   This automatically computes the delta for the curve you wish to insert.

2. **Press IC@PI.**

   You will see what appears to be the first soft key page of the Curves menu. Use any of these options except delta, since delta is already computed.

3. **Key in a value and press the appropriate key.**

   The curve data for the curve you are about to insert will be displayed and you will see the second page of the Traverse menu soft keys displayed.

4. **Key in the information to move you to the next PI point (like the horizontal distance).**

   The PC, RP, and PT points will be stored, as well as the next PI point. You will be occupying the next PI point, ready to traverse to another PI, and while doing so, insert another curve at this PI, if you wish.

Example

Curves are also illustrated in *Insert a Curve* on page 56. Here non-tangent curves will be illustrated.

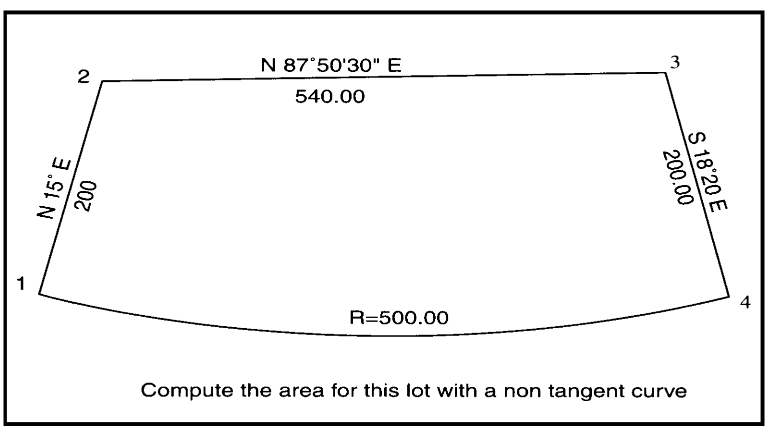


Figure A-45 Non-tangent Curves

1. **If Elevations are on, turn them off (3).**
2. **Traverse from 1 to 4.**

   Keystrokes: JOB NEW NEW

A. **EXAMPLE** TRAV 15 **A Z** 200 **HDIST**.

B. 87.5030 **A Z** 540 **HDIST**.

C. 218.20 **BRG** 200 **HDIST**.

3. **Intersect from 1 to 4 using the radius as distance 1 and 2.**
4. **Store the second solution by point number in point 5.**

A. **(INTERSECT - the T key)** 1 **PT1** 500 **DIST1**.

B. 4 **PT2** 500 **DIST2**.

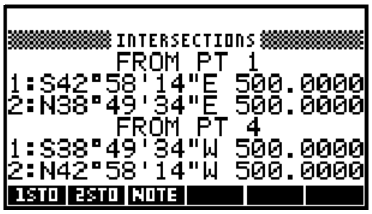


Figure A-46 Intersections

C. **Press** 1 **STO**.

D. RPTS 1.3 SPC ↱ 4 SPC 5 SPC 1 ENTER **AREA**.

E. **Enter the Random Points file as:** 1.3 SPC ↱ — 4 SPC 5 SPC 1 ENTER.

F. **Press** **AREA**.

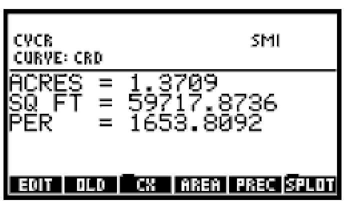


Figure A-47 Area for Lot Displayed

Customize

KEY: CUSTOM

PRODUCT: SCE+

KEYSTROKES: CUSTOM (the O key)

This function lets you customize the functions of the user keyboard and save special values.

Procedure

KEY: **KASN** to assign a number or program to a key

To assign a program or program name or a number, press **KASN**. Type the number, program, or program name. For example, assign a key that will automatically show the software version you are using. Press **KASN**, then type VER (for version) and press ENTER. Now press the key to which you want this function assigned.

If you want it to be assigned with a Shift left, press [↰] then press the desired key. Or, to assign a single key, just press that key. For example, to assign VER to [STAKE], with VER showing on the display, press [STAKE].

After any key change has been done, the SMI at the top right side of the display will change to USER, indicating that the default key assignments have been changed. The rest of the ***SMI*** overlay is still active.

In the [CUSTOM] menu, press USER to switch from having USER to SMI displayed at the top of the screen. Now STAKE is active, rather than VER. This allows you to assign many of your own user key assignments and go to [CUSTOM] and USER to switch back and forth from using your own key assignments and the ***SMI*** key assignments.

Customize Menu Soft Keys

Option	Function
KASN	Press this key to assign a function to a key.
KDEL	Press this key to remove a user key assignment.
RSTO	Press this key to store a number in a numbered register. Type the value to be stored, then the number of the register in which to store it before pressing RSTO.
RRCL	Press this key to recall a number from a register. Type the register number before pressing RRCL.
USER USER ■	Press this key to toggle user keys on and off.
REGS	Press this key to start the Memory Registers menu.

Example

You are traversing north 3 degrees and 30 minutes, and east for 33 1/2 poles. Multiply the poles in the deed by 16.5 and get feet, then use those feet in the traverse.

1. **Press [CUSTOM].**
2. **Press KASN.**
3. **Key in `16.5`.**
4. **Press [×] (the Multiplication key).**
5. **Press [ENTER].**
6. **Press R (this assigns 16.5 and Multiply to R).**
7. **Press [TRAV].**
8. **Key in `3.30` and press AZ.**
9. **Key in `33.5` (poles) and press R.**

   You will see `552.75` (feet).
10. **Press HDIST to traverse to the next point with a distance of 552.75 feet.**

Appendix A: Quick Reference of Menus and Functions

Date/Time

If you are working with sunshots, it is of particular importance that your program be set to the correct date.

Setting or changing the current time:

To set the time of a data collector other than the HP 48, set the system time following the directions in the user manual for that particular device.

To set or change the current time in your HP 48, turn ***SMI*** off (QUIT or the [α] key) and press [↱] [TIME] (the 4 key).

This opens the Time menu window. Press the [▲] or [▼] key to scroll the time menu to "Set time, date..." Press [OK] to accept the menu choice. Press [▼] to move down to the date fields, then press [▶] to highlight the desired time or date field. Once the field is highlighted, key in the appropriate value (month, day, year); the value will appear on the command line. Press [ENTER] to accept it and place it in the field.

Press [OK] when finished. This enters the changes you made and exits the Date menu. Then press [α] K [ENTER] to return to the ***SMI*** program.

Degrees - Minutes - Seconds (HMS or DMS)

(Convert to)

KEY: [DMS→D] or [D→DMS]

PRODUCT: SCE+

KEYSTROKES: [↰] or [↱] then [DMS→D] or [D→DMS] (the Divide key)

Same as Hours - Minutes -Seconds

This function key is used to convert a decimal number to the degrees-minutes-seconds format.

Procedure

Key in your decimal number and press [↱] then [D→DMS]. The resulting number is converted to HMS format.

Delete

KEY: [DEL]

PRODUCT: SCE+

KEYSTROKES: [DEL]

This function allows you to delete points, jobs, Random Points files, raw data, or the entire RAM card.

Procedure

Press the soft key corresponding to the desired function:

Delete Menu Soft Keys

Option	Function
PNTS	Press this key to delete points. The display will prompt you to enter the point number(s) to be deleted. Key in the point number and press ENTER. To delete a range of points, key in the first point number, SPC, and the last point # to be deleted, then press PNTS. The points will be deleted.
JOBS	Press this key to delete a job. The display will prompt you to enter the name of the job to be deleted. The names of your jobs will be shown on a stack (press the up and down arrow keys to scroll through the menu and find the job you wish to delete. To delete it, with the job highlighted, press ENTER then YES or press NO to cancel.
RAW	(DCE+) Delete raw data: The display will ask you to confirm that you wish to delete raw data for the current job. Press the YES soft key to confirm or NO to cancel.
RPTS	(SCE+) Delete a Random Points file: After you have selected this option, the display will show the names of Random Points files in the current job (you may need to press NXT to see additional files). Press the soft key corresponding to the name of the file you wish to delete. Press ENTER then YES to confirm.
CARD	Delete card data: The display will ask you to confirm that you wish to erase the card in port 2. Press the YES soft key to confirm or press NO to cancel.

Display Format

KEY: DISP

PRODUCT: SCE+

KEYSTROKES: ↰ DISP (the 6 key)

This function lets you select the type of display format for your job. It is a shortcut, instead of going to CHG NXT and DSPLY.

Procedure

Press this toggle key to switch between four types of display: Angle Right, bearing, azimuth, and coordinate. The screen will confirm as each is selected (e.g., DISPLAY BEARING). The display format may be changed at any time and does not affect how data is stored or calculated.

DOT Menu

PRODUCT: DOT

KEYSTROKES: ↰ DOT (the Z key)

This menu contains functions specific to the DOT card.

✎ *This section will explain special custom programs/functions that are available as an option with your DOT card.*

Programs include the following:

➥ two-point resection

➥ two- and three-corner shots

➥ manual entry of cross-section data

➥ one-time boot of the rod

➥ store offset points

➥ cross-section offsets

➥ cross-sections

➥ zero the rod

➥ random point station

The following custom programs are designed to simplify or provide more immediate access to special functions and routines that may be used more frequently in certain applications. Many of these special programs were initially developed for the South Carolina Department of Transportation.

To access the DOT menu, press ↰ DOT (the Z key).

The display will show the DOT menu (below).

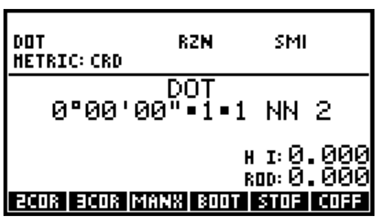


Figure A-48 DOT Menu

The DOT menu includes two soft key screens. Press NXT to scroll to the next menu screen.

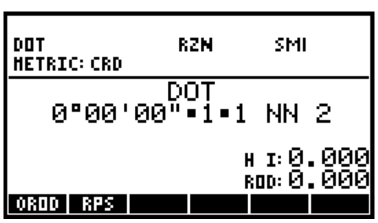


Figure A-49 DOT Menu Page 2

The programs are accessed from their respective menus using the corresponding soft key.

In the following sections you will find a description of each special program.

Two-Corner Calculation

Use this function when you shoot two corners of a building and measure the third side.

Shoot two corners of the building and press 2COR.

The display next asks you to identify whether you are moving clockwise (CLK) or counter-clockwise (CCLK) around the building.

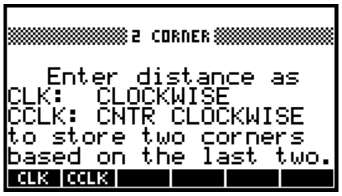


Figure A-50 Two-Corner Calculation Prompt

Press the appropriate soft key to indicate the direction.

The following prompt displays: ENTER LENGTH OF LAST SIDE.

This is the missing side. Key in the distance and press **ENTER**.

Three points will be stored: the two points not shot, and the first point shot. By storing the first point shot, the PC can automatically plot the four sides of the building.

Three-Corner Calculation

Use this function when you shoot three corners of a building and want the data collector to compute the fourth corner.

Shoot the three corners and press **3COR**.

The missing corner is stored and the first point is stored for auto plotting purposes.

Manual Entry of Cross-section Data

Use this function when you are taking cross-section shots and get an obstruction that requires you to switch to manual entry of cross-section data. This program uses the last two points shot to compute manual cross-section data.

Press **MANX**.

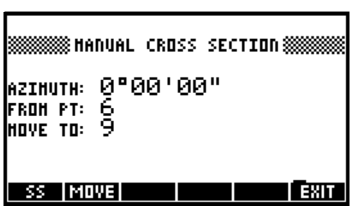


Figure A-51 Manual Cross-section Submenu

The display will show the Manual Cross-section submenu with the following soft key options:

Manual Cross-section Submenu Soft Keys

Option	*Function*
SS	(if Elevations are on) This option prompts you for the change in elevation. Key in the difference in elevation and press **ENTER**. You will then be prompted for the distance from your reference point. Key in the distance and press **ENTER**. The new point ("next number") will be stored.
MOVE	This option prompts you for a distance from your reference point. Key in the distance and press **ENTER**. The new point ("next number") will be stored.

Manual Cross-section Submenu Soft Keys

Option	Function
EXIT	This option returns to the main DOT menu.

Boot the Rod

Use this function when you want to temporarily adjust the height of the rod. This is useful when you need to raise the rod for a clear shot over an obstruction.

Key in the boot value and press BOOT. This value is temporarily stored as the height of rod.

✎ *The boot value may or may not be reset to zero, depending on how you set the* 0ROD *function (DOT menu 2).*

When 0ROD is on and the HI (height of instrument) has a nonzero value, the next shot uses the boot value, after which the HI is automatically reset to zero. This is useful when you want the rod booted for only one shot.

When 0ROD is off, the boot value (or HI) is not reset to zero, and will be carried through to each subsequent shot. This is the default.

Store Offset

This function lets you store offset points.

Press STOF. The display will show the following: CENTERLINE PT?

Key in the point number and press ENTER.

The display will show the following: BACKPOINT?

Key in the backpoint number and press ENTER.

You are now ready to store offset points.

The display will show soft keys to help you identify your offset points.

Figure A-52 Store Offset Screen

Typically, you will use the **DIST→** (distance right) and **←DIST** (distance left) soft keys to store offset points.

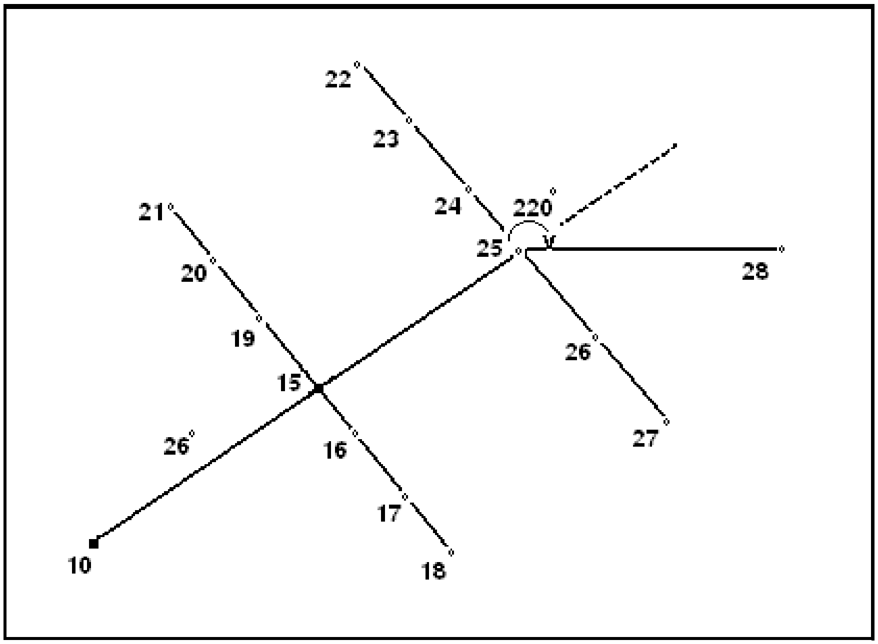


Figure A-53 Store Offset Illustration

In the above illustration, point 15 is the occupied (centerline) point and point 10 is the backsight point. Points 16 through 18 were stored using **DIST→**. Points 19 through 21 were stored using **←DIST**.

DIST↑ was used to move up for storing points 22 through 27.

∠ RT was used to store point 28.

Cross-section Offset

This function allows you to store offset points from a cross-section.

Press **COFF**.

The display prompts you for the occupied point.

Key in the point number and press **ENTER**.

The display will show soft key options to help define offset points.

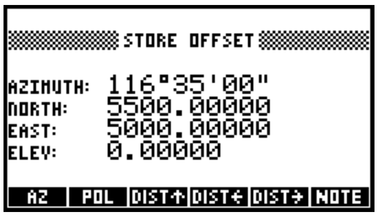


Figure A-54 Cross-section Offset Screen

Cross-section Offset Screen Soft Keys

Option	Function
A Z **POL**	Use either **A Z** (azimuth) or **POL** (point on line) to define the direction from the occupied point.
DIST↑	Use **DIST↑** to identify the distance along the line.
←DIST	Use **←DIST** to define the distance left.
DIST→	Use **DIST→** to define the distance right.
NOTE	If you wish to describe a point, press **NOTE**. Key in the description and press **ENTER**.

Zero the Rod

This function is used in conjunction with the Boot function, described in *Boot the Rod* on page 290.

This is a toggle key; press **0ROD** once to toggle it to on. The display will show 0 ROD EACH SHOT.

The key also will change to **0ROD■** to indicate that this function has been selected.

When 0ROD is on, the height of rod will be reset to zero after the shot.

To deselect this function, press **0ROD■** to toggle the key off. The display shows WILL NOT 0 ROD. The key also will change to indicate that this function is no longer active.

The default for this function is off.

Random Point Station

This function lets you set up within sight of two known stations and shoot the two stations to establish your occupied station.

Press **RPS**.

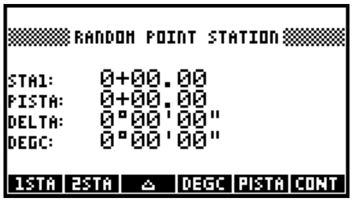


Figure A-55 Random Point Station Menu

The Random Point Station menu includes the following soft key options:

Random Point Station Menu Soft Keys

Option	Function
1STA	(Station 1) This option identifies a station on the centerline before the line enters a curve.
2STA	This option takes a shot to the PI (point of intersection) of the curve.
△	This is the delta of the curve (negative value indicates that the curve turns to the left).
DEGC	This option lets you set the degree of curvature, assuming arc definition.
PISTA	PI (point of intersection) station: This option lets you enter the station number for the point of intersection.
CONT	This option runs the main body of the program. This program occupies the coordinates 5000/5000, and generates a horizontal control file based on the information you have entered using this menu.

Elevations (On/Off)

KEY: **ELEV**

PRODUCT: SCE+

KEYSTROKES: **↰** **ELEV** (the 3 key)

This function allows you toggle Elevations on or off.

Procedure

Press this toggle key to switch between Elevations on and Elevations off. The screen will confirm your setting. When Elevations are on, the letter Z will appear at the top of the display to indicate that this setting is active. Additional soft keys relating to Elevations will appear in various menus; these do not appear when Elevations are off.

CVCE and ***DOT*** users: Elevations must be on when slope staking. See *Construction Five*, which begins on page 151, for more information.

Exit SMI

KEY: **QUIT**

PRODUCT: SCE+

KEYSTROKES: [↰] **QUIT** (the [α] key)

This function key allows you to exit the ***SMI*** program and returns the keyboard to the regular HP assignments.

Procedure

To exit ***SMI*** and be entirely in the Calculator mode, press [↰] and the **QUIT** key. To go back to ***SMI***, press [α] K **ENTER**.

When you use **CUSTOM** to assign keys, the SMI label at the top will automatically change to USER.

For a more detailed explanation of SMI and USER, see *User Mode* on page 33.

Feet to Inches

KEY: **FT → IN**

PRODUCT: SCE+

KEYSTROKES: [↱] **FT → IN** (the 7 key)

If you need to convert decimal feet values to feet and inches, you may run this command to convert the value on the stack.

Procedure

Enter the decimal feet and get feet and inches to the nearest sixteenth on the stack.

First Available Point (FAP)

KEY: **FAP**

PRODUCT: SCE+

KEYSTROKES: [↰] **FAP** (the **ENTER** key)

This function key lets you identify the first available (non-used) point for the current job.

Procedure

When executed, this function will briefly show the first available point for the current job. If there are no point numbers in the command line, this function searches from the beginning of the job for the first unused point number, and assigns it to be the next number to be stored (see *Next Number (NEXTNO)* on page 314). Or key in a point number and press the key; the search will begin from that point. If that point is used, the search goes forward to the next highest unused point number. If the entered point number is unused, the search goes backward until it finds the FAP after the next lowest used point.

For example, to find the last point number stored, enter a point number beyond the end of your job into the command line and press ↰ and the FAP key. The card will search backwards from that point until it finds a stored point. The "first available point" displayed will be the point number just after the highest point stored.

To find an available point number in a gap between a group of points, key in the number of a used point number that falls somewhere in the group of stored points before the gap. The program will search forward for the first empty point; this will be displayed as the next available number.

Free Station (Two-Point Free Station/Resection)

KEY: 2PFS

PRODUCT: ACE+

KEYSTROKES: SETUP NXT 2PFS

SHORTCUT: ↱ 2PFS (the DEL key)

This function establishes an occupied point based on sighting two known points, referred to as points A and B. The program works as though you were occupying A, backsighting B, and traversing to a third point (the instrument position). Therefore, A should be the more accurate position.

Point B can be considered to be a good backsight point from A (on the line from A). If the Scale option is used, a scale factor is applied, giving A and B equal weight. If you are using State Plane Coordinates, you should use the Scale option so the instrument position is a State Plane Coordinate and future shots from this free station position will be stored as State Plane Coordinates.

✎ *The lowest card available with 2PFS is ACE. References to slope staking or station and offset or cross-sections may only be available in **Construction Five**.*

Procedure

Resection programs sometimes are only distance-distance intersection programs. As most surveyors know, distance-distance concerns itself with instrument position and strength of triangles. If the triangle formed is weak, the positional accuracy of the instrument may be in error anywhere from several hundredths of a foot to several feet.

SMI's Resection program has always been a true free station program with a high degree of accuracy, without a need to be concerned with the strength of the triangles. However, just as you would not want a short backsight, you would want to avoid too short a distance between the two control points from which you are free stationing.

SMI added the option to mean any number sets of points stored by 2PFS. Even though it is called 2PFS, it is actually a multiple point free station program. However, it is referred to as 2PFS (rather than MPFS) because the procedure uses only two points at a time. Each time 2PFS is used, an instrument position can be stored by point number. Multiple instrument points can be stored for various sets of control points for the same instrument position. These instrument points can then be meaned using RPTS and MEAN.

The result can be evaluated for errors. If one point is found to be too much in error, the remaining points can be meaned and stored.

Free Station/Resection Menu 1

Free Station Resection Menu 1 Soft Keys

Option	Function
A DIR	Press this key to take a direct shot on point A. Press ↰ and this key will display the shot information without taking a shot. If a point number for A has not yet been given, pressing A DIR will prompt for a point number.
A REV	Press this key to take a reverse shot on point A. Press ↰ and this key will display the shot information without taking a shot. If point A has not yet been given, it will prompt for a point number. If Elevations are turned off, or in GPS mode, this key is blank.
B DIR	Press this key to take a direct shot on point B. Press ↰ and this key will display the shot information without taking a shot. If point B has not yet been given, it will prompt for a point number.
B REV	Press this key to take a reverse shot on point B. Press ↰ and this key will display the shot information without taking a shot. If point B has not yet been given, it will prompt for a point number. If Elevations are turned off, or in GPS mode, this key is blank.
RSLTS STORE	When RSLTS is pressed, the shot information is used to calculate and display the occupied coordinate information. The RSLTS key is replaced by the STORE key to allow storing the occupied coordinates to a point and to the raw data file.
HOLD REAL SCALE	The 2PFS command automatically calculates the scale factor for a project based on making a comparison between two known sets of coordinates and the raw measurements during the 2PFS made to them. The calculated scale factor is set as the scale for the current job by using the SCALE option. By selecting the HOLD option, you will hold the current scale factor without applying the recomputed scale to the project. Selecting REAL does not calculate or apply a scale factor. Use this toggle key to choose between calculating a scale factor (REAL) and calculating real world coordinates (SCALE) where the scale factor is 1.

Free Station/Resection Menu 2

Free Station Resection Menu 2 Soft Keys

Option	Function
PT A	Enter the point number. Point numbers for A and B can be entered at any time, even before you go to the 2PFS program. These control point numbers are remembered when you go to another program and return even if you press 2PFS instead of ↰ 2PFS .
PT B	Enter the point number.
MNEL	This key toggles between using the mean elevation, the elevation from point A, and the elevation from point B. If Elevations are turned off, this key is blank.
ELFA	Elevation from point A.
ELFB	Elevation from point B.
ROD A	Enter the rod height for point A. If Elevations are turned off, this key is blank.

Free Station Resection Menu 2 Soft Keys

Option	Function
ROD B	Enter the rod height for point B. If Elevations are turned off, this key is blank.
H I	Enter the height of the instrument. These values (ROD A, ROD B, and HI) are also remembered, even when you exit and return to 2PFS. If Elevations are turned off, this key is blank.
HAR	This toggle key determines whether reverse shots will collect a Horizontal Angle.
ZAR	This toggle key determines whether reverse shots will collect a Zenith Angle.
SDR	This toggle key determines whether reverse shots will collect a Slope Distance.

For an example using 2PFS, see *Free Station Resection Example* on page 108.

GPS Menu

PRODUCT: GPS/Robotic

KEYSTROKES: [→] [GPS] (the Z key)

The GPS menu contains the functions specific to GPS. See details in *Guide to GPS*, which begins on page 215.

Grads

Here is a quick fix for how to traverse in Grads: Key in `Grads` and press [←] G→D (the 9 key) to convert from grades to degrees, minutes, and seconds and tenths of a second. This angle on the stack can be used in the Side Shot or Traverse menu by pressing the A Z key.

To convert from DMS (degrees, minutes, and seconds) to Grads, key in a `DMS` angle and press [→] D→G (the 9 key).

Example

Problem: Traverse 60.555 Grads for 500 meters.

Solution: You will need FIX 5 for this one.

1. **Press [CHG], key in `5`, and press FIX4.**

   You will see FIX5.

2. **To work in Meters mode, press [CHG] [NXT] and MODE.**

3. **Press FEET to toggle to METR.**

4. **Press [TRAV], key in `60.555`, and press [←] G→D.**

   This converts to 54 degrees 29 minutes and 58.2 seconds.

Appendix A: Quick Reference of Menus and Functions

5. **Press AZ.**

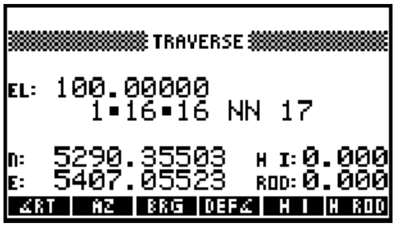


Figure A-56 Grads Example

6. **Key in `500` and press HDIST.**

If you now wish to convert 54 degrees 29 minutes and 58.2 seconds to Grads, key in `54.2958` or press , AZ to recall the azimuth to the stack and press D→G. You will see `60.555`.

HMS Trig Functions

PRODUCT: SCE+

KEYSTROKES: HSIN (the S key)

HASIN (the S key)

HCOS (the T key)

HACOS (the T key)

HTAN (the U key)

HATAN (the U key)

The normal calculator trig functions assume that angles entered are in decimal degrees and that inverse trig functions should return decimal degrees. These HMS trig functions assume HMS degrees instead of decimal degrees. Enter the value to be operated on and press the keys to execute the desired functions.

Hours - Minutes - Seconds (HMS) - Adding

(Add)

KEY: HMS+

PRODUCT: SCE+

KEYSTROKES: HMS+ (the + key)

This function adds two numbers in HMS format.

Procedure

You should have two numbers in the stack, in HMS format. Press HMS+ (the + key) to see the sum in HMS format.

Hours - Minutes - Seconds (HMS) - Subtracting

(Subtract)

KEY: "/HMS-

PRODUCT: SCE+

KEYSTROKES: "/HMS- (the – key)

This function subtracts two numbers in HMS format.

Procedure

You should have two numbers in the stack, in HMS format. The resulting value is in HMS format.

Inches to Feet

KEY: IN → FT

PRODUCT: SCE+

KEYSTROKES: IN → FT (the 7 key)

If you need to convert feet and inches to decimal feet values, you may run this command to convert the value on the stack.

Procedure

Enter the feet and inches and get decimal feet. Enter the feet, inches, numerator, and denominator on the stack in that order. If there is no fraction of an inch, you can just enter feet and inches. If there are no feet, enter 0 for the number of feet.

Instrument Functions

PRODUCT: GPS/Robotic

KEYSTROKES: INFN (the O key)

The Instrument Functions menu contains functions that are specific to the current instrument driver. If the current instrument driver does not have an instrument functions menu, the data collector will just beep and not change the menu.

Instrument Position

PRODUCT: GPS/Robotic

KEYSTROKES: POS (the O key)

The Instrument Position screen shows a live update of the angles, distance, and tracking status of a robotic instrument. The current menu is not changed. If the current driver does not support this feature or there is a communication problem, the screen will display the message “POSITION DATA NOT AVAILABLE.” See *Robotic Functions*, which begins on page 195 for more information.

Instruments

KEY: INST

PRODUCT: DCE+

KEYSTROKES: SETUP NXT NXT INST (or MORE NXT LEVEL NXT INST for electronic levels)

SHORTCUT: ↱ INST (the × key)

This function allows you to select an instrument for electronic data collection; it also permits you to select manual data entry.

Procedure

From the Setup menu, press ↱ INST for the Instrument soft key menu.

Press NXT to scroll through the menu screens to see available instruments (for a description of each instrument supported, see *Instrument Configuration*, which begins on page 383). Press the appropriate soft key to select the instrument you will be using.

✎ *When you select an instrument, the program will switch the data collector to Electronic Instrument mode. When the data collector is set for electronic data collection, the letter I will appear at the top of the display to indicate that this option is active.*

See *Instrument Configuration*, which begins on page 383, for detailed information about setting up electronic instruments and which driver to select.

For manual side shots and traverses:

Even if you are using an instrument to collect data, you can select manual data entry for side shot and traverse functions.

Press MAN 1 to use menu-driven data entry (via the soft keys).

Press MAN 2 to emulate the electronic data entry format (you will be prompted to enter Slope Distance, Zenith Angle, and Angle Right on the command line).

Press MAN3 to enter coordinates instead of angles and distances when taking a shot.

Instruments – On/Off

KEY: MAN

PRODUCT: DCE+

KEYSTROKES: ↰ MAN (the 5 key)

This key lets you toggle between instrument (electronic data collection) and manual data entry.

Procedure

Press this toggle key to switch between On (electronic entry) and Off (manual entry). The screen will confirm your setting.

When instruments/electronic data entry are on, the letter **I** will appear at the top of the display to indicate that this setting is active. The default is Off.

Intersections

KEY:

PRODUCT: SCE+

KEYSTROKES: (the T key)

This function allows you to define the intersection from any two stored points, which include bearing-bearing, bearing-distance, distance-distance, and perpendicular offset.

Procedure

Press to begin.

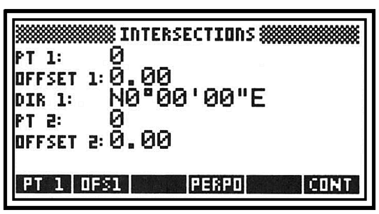


Figure A-57 Intersections Menu

To use an offset from line one, give an offset value and press **OFS1** before you press **PT1** **CONT**, which allows you to use an old point number without reentering. Just press **CONT**. If a direction from point 1 has been entered, you may also use **CONT**, etc.

The display will prompt you to define line 1. Use the soft keys to enter a reference point for line 1. Key in a point number, and press **PT1**.

Next, further define line 1 by keying in either the direction (press **BRG1** or **AZ1**), a point on line (press **POL1**), or the distance to point (press **DIST1**).

The direction also can be defined by keying in two point numbers (separated by a space) and pressing **A Z**.

The display will now prompt you to define line 2. Use the soft keys to enter a reference point for line 2. Key in a point number, and press **PT2**.

Next, further define line 2 by keying in either the direction (press **BRG2** or **AZ2**), a point on a line (press **POL2**), the distance to point (press **DIST2**), or press **PERPO** to get a perpendicular distance to the first defined line.

The display will show the intersection.

Perpendicular offset lets you move a point to a line while occupying a remote point.

Example of Perpendicular Offset

✎ *The job must first have points in it to perform this function.*

1. **Take a shot near the line.**
2. **Press ✕.**
3. **Key in** #2 **and press PT1 to enter it as point 1.**
4. **Key in** #3 **and press POL1 to enter it as a point on line 1 (to define the line).**
5. **Key in** #1 **and press PT2. Then press PERPO for a perpendicular offset.**

   The display will show the distance to the right or left of the line on which that point number is located (as a + or - value). If you press STORE here, the point will be stored on the line between points 2 and 3 and perpendicular from point 1.

✎ *The Intersections menu lets you enter an offset distance from point 1 and/or point 2. The perpendicular offset example above can be accomplished even more efficiently (and more easily) using **SMI's** Stake to a Line routine.*

Job

KEY: JOB

PRODUCT: SCE+

KEYSTROKES: JOB (the G key)

This function allows you to create a new job, select an existing job, delete, copy, move, or transfer a job, and define parameters for your job.

Procedure

At the Job menu, press the soft key to make your selection. Press NXT to scroll to the next soft key menu (Menu 2).

✎ *The soft key functions vary, depending on the card you are using.*

Job Menu 1

Job Menu 1 Soft Keys

Option	Function
OLD	Use the ▲ and ▼ arrow keys to highlight the job you want to select. Use the PGUP and PGDN soft keys to move up and down the list a page at a time. When the correct job is highlighted, press ENTER. Press EXIT or CANCEL to cancel the selection.
COPY	Select the job to be copied and press ENTER. Type the destination name. The :48M and .CRD should not be typed in. If you have a RAM card, press the soft key indicating where to place the job. If you are copying a job between the RAM card and the internal memory, the job name can be the same.
MOVE	Select the job to be moved and press ENTER. If you have a RAM card, press the soft key indicating where to place the job. If you are moving a job between the RAM card and the internal memory, the job name can be the same.
XFER	Press this key to transfer an entire job, including points, raw data, etc., to a PC or to another HP 48. You can toggle between WIRE (for transferring data to the PC) and IR for transferring data to another HP 48. The data collector receiving the job cannot already contain a job with the same name. Refer to your *Transfer User's Guide* for more information on transferring to/from a PC.
KERM	This function is an alternate transfer utility and is used to send and receive coordinates to/from a PC. Use this method if you do **not** wish to send an entire job or if you only have Kermit on your PC. When coming from the PC, Kermit allows you to merge a job with an existing job on the data collector. ✔ ***CAUTION: If you are in the wrong job in the data collector, sending a job from the PC using Kermit will replace points without warning.***
NEW	Press this key to see the submenu for creating a new job. This menu has the following soft keys:

New Key Submenu Soft Keys

Option	Function
POINT	Press this key to change the beginning point number for the next job to be created.
N	Press this key to change the north default value for the first point in the next job to be created.
E	Press this key to change the east default value for the first point in the next job to be created.
E L	Press this key to change the elevation default value (providing you have selected elevations – see *Change/Defaults* on page 255) for the first point in the next job to be created.
NOTE	Enter a note for the first point in the next job to be created. The note should be keyed in only after NOTE is pressed; when you are finished, press ENTER or press ON twice to cancel.
NEW	Press this key to create a new job using the default values on the screen for point 1. The display will prompt you for a job name. Key in the name and press ENTER (this will also bring up this job as the current job), or press ON twice to cancel and return to the Job menu.

Job Menu 2

Job Menu 2 Soft Keys

Option	Function
DEL	This key allows you to delete a job. Select the job to be deleted and press ENTER. Press ENTER to confirm or press ON to cancel and return to the Job menu.
SFLG	Press this key to save the current flag settings of the CHG menu.
RFLG	Press this key to recall the flag settings.

Latitude and Departure

KEY: LT DP

PRODUCT: SCE+

KEYSTROKES: MORE NXT LT DP

You may display the difference in latitude, departure, and elevation from any two points. This may be used to check closure data on a known point.

Procedure

The command prompts you to select the first and second points that you want to inverse between, then it reports the change in latitude, departure, and elevation from the first point to the second point.

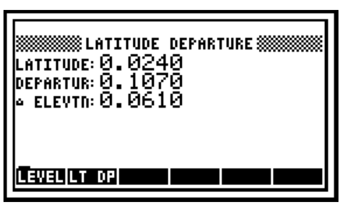


Figure A-58 Latitude and Departure Screen

Level Notes

KEY: **LEVEL**

PRODUCT: SCE+

KEYSTROKES: MORE NXT **LEVEL**

MORE NXT ↰ **LEVEL** (to clear previous data)

SHORTCUT: ↱ LEVEL (the L key)

This function lets you run 1-wire or 3-wire levels with a rod and manual or electronic level.

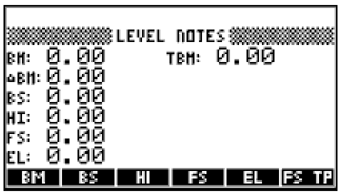


Figure A-59 Level Notes Screen/Soft Keys

Level Notes Screen/Soft Keys Definitions

Option	Function
BM:	This is the original benchmark elevation.
TBM:	This is the Elevation of the original benchmark or last turning point (**FS TP**).
∆BM:	This is the difference between the original benchmark and the last turning point (BM - TBM). This should be close to 0 when you complete the loop by pressing **FS TP** while pointing at the original benchmark.
BS:	This is the last entered rod reading at the backsight.
HI:	This is the elevation of the level at its axis.
FS:	This is the last entered rod reading at the foresight (**F S** or **FS TP**).
EL:	This is the elevation of the last shot.
B M	This soft key is used to enter the starting benchmark. All other values are cleared when this key is used.
BS	This soft key takes a reading on the backsight.
H I	This soft key is not normally used, but will manually update the elevation of the HI.
F S	This soft key takes a reading without moving up the benchmark. EL in the display shows the elevation at the point measured to.
E L	Use this soft key to enter the desired elevation and the FS field in the display will show the desired rod reading.
FS TP	This soft key takes a reading on the foresight turning point. The TBM and ∆BM values are updated. Data is stored to the raw data file if the STO option on the next menu page is toggled on.
STO	This soft key toggles between storing or not storing data to the raw data file. The coordinate file does not get updated.
GRDE	Use this soft key to enter a grade elevation to see a Cut or Fill value on the screen when FS and EL are used.
1WIRE **3WIRE**	This soft key toggles between using a 1-wire or 3-wire level. When a 3-wire level is used, distances are shown and accumulated, as well as the elevations.
INST	Use this soft key to select an Instrument. If you are using a supported electronic level, you can select the driver for your level by pressing ↱ LEVEL NXT **INST**.

Level Notes – Instrument Selection Screen Soft Keys Definitions

Option	Function
MAN	Select this option to do manual entry of level measurements.
2002	This is the Leica NA 2002 level. Use settings of 2400-Even-7-1. This used to be named DGT.
DINI	This is the Zeiss DiNi series levels. Use settings of 9600-None-8-1.
DL100	This is the Topcon DL 100 Levels. Use settings of 1200-Even-7-1.

Procedure

See a diagram of this example in Figure A-67 on page 308.

1. Press MORE NXT LEVEL.

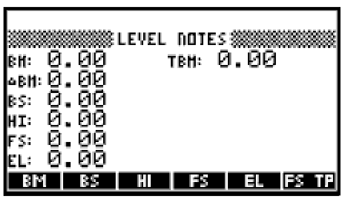


Figure A-60 Level Notes Screen

2. Give it a benchmark (100) and backsight (5.42). Type `100` and press B M. Type `5.42` and press BS.

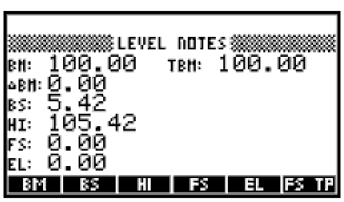


Figure A-61 Specifying Benchmark and Backsight

3. Now you can give it a foresight reading. Enter foresight (10.68) and press F S.

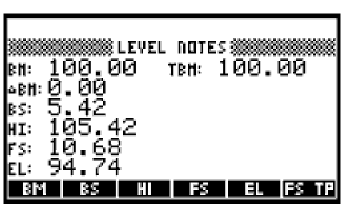


Figure A-62 Specifying Foresight

The elevation at the foresight is shown as 94.74 in the display. If the STO soft key on the next page is turned on, this entry will be saved to the raw data file. The F S key does not change the location of the level.

4. **If the card is DCE or above, it will prompt for a description if Notes are on. Key in the description and press ENTER.**

   These level notes with the description will be stored in the raw data file, even if Notes are off.

5. **If there is a design grade on a project, and a desired elevation of 96’: key in** `96` **and press EL.**

   It will provide the desired rod reading.

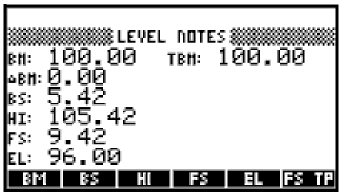


Figure A-63 Desired Rod Reading

   This tells us what the foresight needs to be (9.42) to have a desired elevation of 96’.

6. **Press the FS TP key and enter** `10.2` **to move the level to Station 2.**

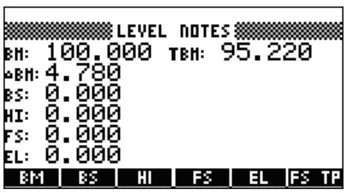


Figure A-64 Move Level to Station 2

7. **Press the BS key and enter** `8.02` **to see that the elevation at Station 2 is 103.24.**

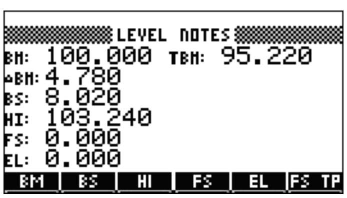


Figure A-65 Station 2 Elevation

8. **Press the FS TP key and enter** `2.25` **to calculate the elevation at the last benchmark.**

   The ending benchmark elevation is 101, which is a .01 difference from the TBM elevation shown. This means we have an open loop error of .01. Notice that the ΔBM shown is -0.99. If this had been a closed loop (the ending benchmark is the same as the beginning benchmark), the ΔBM would show the closed loop error.

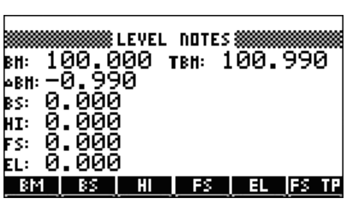


Figure A-66 Benchmark Elevation

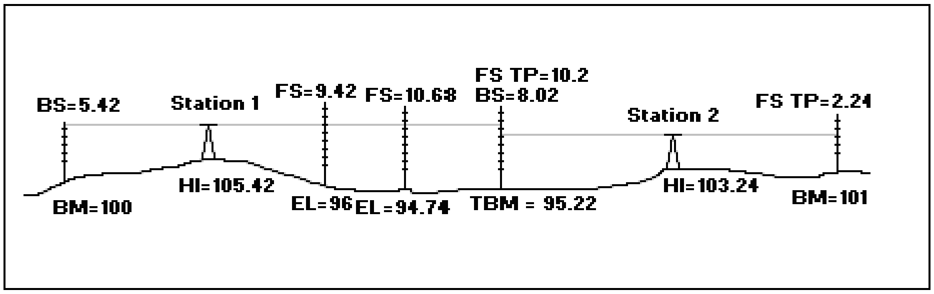


Figure A-67 Level Notes Example

Line Stakeout

KEY: **LINE**

PRODUCT: ACE+

KEYSTROKES: **STAKE** **NXT** **NXT** **LINE**

This function is used to stakeout a tangent line by station and offset, and is found on the third page of the Stake menu. Unlike the Curve Stakeout menu, the program does not require that a point on the line be occupied. When **LINE** is first pressed, the user is prompted for the beginning point, the beginning station, and the ending point “BegPT BegSTA EndPT”.

Procedure

Press **LINE**, type in the beginning point number, press **SPC**, type the beginning station, press **SPC**, type the ending point number, and press **ENTER**. You will see a screen similar to the following:

Figure A-68 Line Stakeout

Put the rodman on line, sight on the prism, and press **SHOT** to get the Go/come, Left/Right information. After staking the point, press **INC** to stake the next station.

Line Stakeout Menu Soft Keys

Option	Function
SETUP	When you press this key, you are prompted for same information as the **LINE** function.
STA	Enter a station to be staked. Pressing ↱ **STA** stores a point at the given station.
INC	Increment to the next station. If a number is on the stack when **INC** is pressed, it will be used as the new increment. The default increment is 100. When the end of the line is reached, it starts over.
OFSET	Enter an offset to be staked. The default is 0.

Line Stakeout Menu Soft Keys

Option	Function
SHOT	Manual or electronic entry of shot information: Press this key to change to the shot screen. If you have a GPS/Robotics card, ↰ SHOT will take repeated shots and do a live update of the screen.
STOPT	Press this key to store the point being staked. Pressing ↱ STOPT stores the last shot.

Manual Data Entry

Manual data entry can be accessed almost immediately, even if you are collecting data electronically.

For manual side shots, press ↱ SIDS (The H key).

For manual traverses, press ↱ TRAV (The K key).

Mean Backsight

KEY: MBS

PRODUCT: DCE+

KEYSTROKES: SETUP NXT NXT MBS

SHORTCUT: ↰ MBKS (the 8 key)

This function allows you to shoot a backsight point twice: directly, and with the scope flopped. These two measurements are then meaned to recreate the elevation of the occupied point.

The comment record (CM) reports the resultant horizontal angles.

Procedure

The new elevation and the new horizontal distance are meaned with the occupied point's elevation and horizontal distance from the backsight point. These values are then used to restore the occupied point.

If you are using an electronic instrument, the direction and distance will be collected automatically; otherwise, you will be prompted to enter the data. Once MBS data is entered, the display will show an additional submenu:

Mean Backsight Submenu Soft Keys

Option	Function
MBSR	Press this key to bring in the Zenith Angle and Horizontal Angle after the scope has been flopped. The data collector will show an arrow symbol next to the error if any of the tolerances have been exceeded. If you decide to store the occupied point based on the meaned backsight, press STORE, or key in a point number and press STORE.
SHOT2	Press this soft key if you want to take two direct backsights instead of flopping the scope.
VTOLS	Press this key to change the Zenith Angle tolerance.

Appendix A: Quick Reference of Menus and Functions

Mean Backsight Submenu Soft Keys

Option	Function
HDTOL	Press this key to change the horizontal distance tolerance.
ELTOL	Press this key to change the elevation tolerance.

Mean Points (Random Points Menu)

KEY: MEAN

PRODUCT: DCE+

KEYSTROKES: RPTS (type points to be meaned) ENTER NXT MEAN

This key is used for calculating the mean coordinates of a group of points, which is useful for averaging several shots made to the same point or averaging several free station shots. One value of this function is that you can find the midway point between two points.

After MEAN is pressed, the points are averaged and shown on the screen. MNER shows the MEAN ERRORS display, WORS shows the point that is the farthest from the average.

Mean Points Menu Soft Keys

Option	Function
MNER	Press this key to show the mean errors display.
WORS	Press this key to show the worst point display.
MEAN	Press this key to show the mean coordinates display.
STORE	Press this key to store the mean coordinates to a point.
EXIT	Press this key to return to the Random Points menu.

Procedure

1. **Press** RPTS**, type** 1 SPC 4 ENTER**.**
2. **Press** NXT**.**

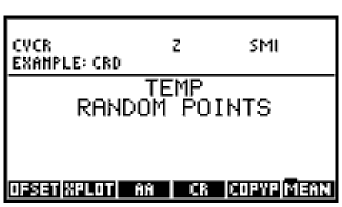


Figure A-69 Random Points Screen

3. **Press MEAN.**

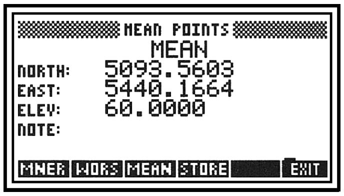


Figure A-70 Mean Points Screen

✎ *Your display numbers will most likely not be the same as shown here.*

4. **You can now press STORE to store a point there (or enter a point number and press STORE).**

   Another value of mean is that it allows you to use 2PFS (two-point free stationing) to store points from several sets of points and mean the position along with the elevation, and store it.

Using SC, enter new points 15 and 16, 17.

5. **Press SC.**
6. **Key in** `5093.5603` **and press N for the north coordinate.**
7. **Key in** `5440.1664` **and press E for the east coordinate.**
8. **Key in** `60` **and press EL for the elevation.**
9. **Key in** `15` **and then press STORE (if you just press STORE, the program will use the Next Number (NN) as the point.)**

Figure A-71 Entering Point 15

Now enter point 16 in the same manner so that it matches the following screen.

Figure A-72 Entering Point 16

Now enter point 17 in the same manner so that it matches the following screen.

Figure A-73 Entering Point 17

10. To mean the above points, press RPTS, key in `15.17` **and press ENTER.**

11. Press NXT and MEAN.

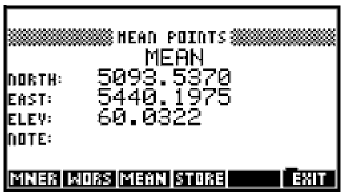


Figure A-74 Mean Points 15, 16, and 17

12. Press MNER to get the mean error of points.

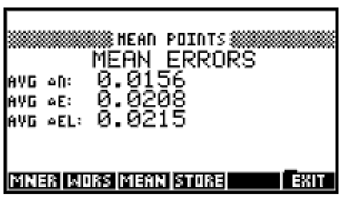


Figure A-75 Mean Error of Points

13. Press WORS to get the worst point.

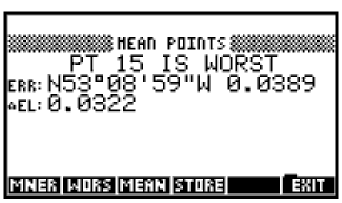


Figure A-76 Worst Point

14. Point 15 was the worst, so you can now delete it by going to the Delete menu or, if the errors are within your tolerances, you can press STORE. This stores the mean point as the next available point number. Or you can key in a point number and press STORE.

Memory Clear

KEY: **ON** **A** **F**

PRODUCT: SCE+

Hold **ON** and press **A** and **F** to clear the internal memory of your HP 48. The display will ask TRY TO RECOVER MEMORY?

Press **NO** to clear the memory. This will erase all job data stored on the data collector's internal memory. If you are using a RAM card, the jobs will not be erased. This erases only the internal memory of the calculator.

If you are using a Pocket PC or Titan, click on "File" then "Clear Calculator" then choose "no" when asked to "TRY TO RECOVER MEMORY." Again, this will not erase the jobs.

Metric Mode

KEY: **METR**

PRODUCT: CVCE+

KEYSTROKES: **CHG** **NXT** **MODE** **FEET** **METR**

This function toggles between feet and meters. All distances are assumed to be in meters when in Meters mode.

Meters mode affects how stations, precisions, areas, volumes, degree of curvature, Earth's curvature, and distances are used and displayed.

If you open another job that you do not want to be in, Meters mode makes sure you toggle back to feet before making any changes. The program will stay in Metric mode until you change it back to feet, regardless of which job you are working in.

An M will be shown in the display when Meters mode is active.

More

KEY: **MORE**

PRODUCT: SCE+

KEYSTROKES: **MORE** (the Z key)

This function lets you carry out miscellaneous functions, including compute Angle Right, compute volume, contouring (ACE+), and triangle solutions, etc.

In the More menu, soft key options will vary, depending on the card you are using; press **NXT** to scroll the menu screens.

More Menu 1

More Menu 1 Soft Keys

Option	Function
CAR	Compute Angle Right is used to compute the Angle Right from the back bearing and the foresight bearing, or from the back azimuth and foresight azimuth. (You also can use azimuth values to compute Angle Right.) This function assumes you are occupying the point where the two lines meet. CAR makes it easy to get an Angle Right from two lines (defined by two points on each line), or by two azimuths defining the direction of the two lines. This key accesses a submenu that lets you key in the appropriate data values: BKBR enters the back bearing. BKAZ enters the back azimuth or two points that define the back azimuth. FSBR enters the foresight bearing. FSAZ enters the foresight azimuth or two points that define the foresight azimuth.
ZSLOP	Zenith and Slope Distance is used to enter a zenith and Slope Distance on the stack or command line and get a change in elevation and horizontal distance on the stack.
VC	Vertical Curve is used to access the Vertical Curve menu (see *Vertical Curves* on page 375). This soft key accesses a submenu, allowing you to enter: ➥ PVC Point of Vertical Curvature ➥ PVI Point of Vertical Intersect
TRI	Press this key to perform triangle solutions (see *Triangle Solutions* on page 371).
VOL	Press this key to compute volumes (see *Volume* on page 379).
TOPO	Topographic/Contouring scales the distance to each contour line from an elevation point in the direction of another elevation point (see *Topo (Contouring)* on page 366).

More Menu 2

More Menu 2 Soft Keys

Option	Function
LEVEL	Press this key to run levels with a rod and a level (See *Level Notes* on page 305).
LT DP	This function calculates the latitude, departure, and change in elevation between two points. Latitude is the distance north and departure is the distance east.

Next Number (NEXTNO)

KEY: NEXTNO

PRODUCT: SCE+

KEYSTROKES: [➦] NEXTNO (the ENTER key)

This function key lets you determine the next point number to be stored in your current job.

Procedure

Key in the point number you wish to use as your next point for storing data, then press [↱] NEXTNO. Or press [↱] NEXTNO first; the display will show the next default point number. Key in your desired point number and press ENTER, or press ON twice to cancel.

Next Point (NXTP)

KEY: NXTP

PRODUCT: SCE+

KEYSTROKES: STAKE NXT NXTP

If there is no point on the stack, it searches the Random Points file for the closest point to the last shot and gives the Go/Come value. If there is a point on stack, it gives the Go/Come value to that point from the last shot. If two points are on the stack, NXTP searches the range of points for the one closest to the last shot and gives the Go/Come value.

If several points are to be staked, you can select EDIT from the RPTS menu and enter the point numbers or range of points, separated by a period, to stake.

After entering the points in the Random Points file, FSNXT (Foresight Next Random Point) and FSPRV (Foresight Previous Random Point) can be used to walk through the points in the Random Points file instead of entering one point at a time in FSPT.

North-East Bearing

PRODUCT: SCE+

✎ *When the bearing is in the northeast quadrant, bearing and azimuth have the same value.*

North-West Bearing

KEY: N-W

PRODUCT: SCE+

KEYSTROKES: [↱] N-W (the 4 key)

This function key converts the northwest bearing to azimuth.

Procedure

Key in the bearing and press [↱] N-W. The display will show the value in azimuth format.

✎ *This is a toggle key; with the azimuth showing in the northwest quadrant (between 270° and 360°) press [↱] N-W to get azimuth-to-bearing.*

Note Search

KEY: NOTE

PRODUCT: ACE+

KEYSTROKES: RPTS NXT NXT NOTE

As an example to demonstrate usage of this command, suppose you want to enter a range of points and sort out only the points with a note of IPS.

Procedure

1. **Press the RPTS key and enter a range of points, then press the ENTER key.**
2. **Press the NXT key twice and then the NOTE key.**

   You are prompted for the note to search for.
3. **Type** `IPS` **and press ENTER.**
4. **Press the RPTS key again.**

   Note that the Random Points file has been changed to include only the points that have the note IPS.

Note Table

Figure A-77 Note Table

KEY: NOTE

PRODUCT: ACE+

KEYSTROKES: α ↑TBL

This function allows you to view and use notes stored in a note table.

Procedure

Whenever you are prompted to enter a note (with the cursor flashing on the command line), you may view the note table by first pressing the α to turn alpha keys off, then pressing ↑TBL. Scroll through the notes and press ENTER to select the desired note.

There are a few predefined notes available to you which can be edited, deleted, or added.

Note Table Predefined Notes

Option	Function
ECHO	This function lets you edit the currently highlighted note.
ADD	This function lets you add a new note to the note table.
DEL	This function deletes the currently highlighted note.
USE	This function uses the currently highlighted note by placing it in the point number. (Pressing ENTER will perform the same function as USE when the note is highlighted.)
EXIT	This function exits the note table and repeats the last note used.

✎ *These options only appear when you are using the Note Table option and only appear when you are being prompted to select a note from the table.*

Notes (Four-Way Toggle)

KEY: NOTE

PRODUCT: ACE+

KEYSTROKES: ↰ NOTE (the 4 key)

This overlay function allows you toggle on and off the note prompt last note recall and note table prompting.

Procedure

Press this key to toggle between four settings:

- Prompting Off - will not store last note
- Prompting Off - will store last note
- Prompting with Last Note
- Prompting with Note Table

The display will confirm your selection. When Notes are turned on, the letter N will appear at the top of the display to indicate that this function is active.

If using a note table is preferred to typing in a note, use the Notes toggle key to turn on Prompting with Note Table. Then the note table will start immediately, instead of having to press α ↑TBL.

✎ *These also may be toggled using the Change/Defaults menu.*

Appendix A: Quick Reference of Menus and Functions

Occupy a Point

KEY: OCPY

PRODUCT: SCE+

KEYSTROKES: ↱ OCPY (the M key) or SETUP OCPY or STAKE OCPY or CONST ↰ OCPY

This function key allows you to occupy a given point.

Procedure

Key in the desired point number and press ↱ OCPY . This point will now be occupied in the current job 1.

Occupy a Station

PRODUCT: CVC+

KEYSTROKES: CONST OCPY (the M key)

This function key allows you to occupy a station and offset.

Procedure

Key in the desired station and offset and press CONST OCPY.

Offset from Random Points

KEY: OFSET

PRODUCT: ACE+

KEYSTROKES: RPTS NXT OFSET

This command stores offset point perpendicular, left or right, to points in the Random Points file.

Procedure

1. **Press the RPTS key and enter a range of points, then press the ENTER key.**
2. **Press NXT and then OFSET.**
3. **Key in the offset distance and press ENTER. To store an offset to the left, key in the offset distance and then press the +/− key.**

   The offset points are automatically stored.

Offset Intersection

KEY: **OFS1** or **OFS2**

PRODUCT: SCE+

KEYSTROKES: ✕ **OFS1**

This soft function key lets you store a point at an offset distance from any intersection.

Offset Random Points

Procedure

To demonstrate this function, use the following illustration:

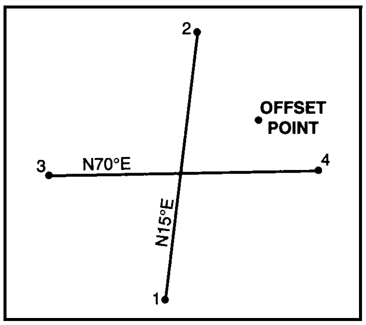


Figure A-78 Offset Procedure

Create an intersection 50' north of the line defined by points 3-4, and 75' east of the line defined by points 1-2.

1. **Press ✕ for the Intersections menu.**

   The display will show:

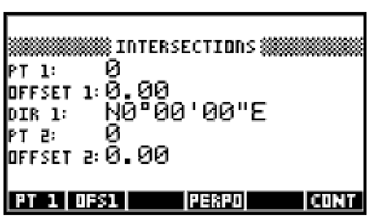


Figure A-79 Intersections Screen

2. **First, enter the offset distance from line 1-2. Key in** 75 **and press** **OFS1**.
3. **Key in** 1 **and press** **PT1**.

Appendix A: Quick Reference of Menus and Functions

4. **Key in** 2 **and press** **POL1**.

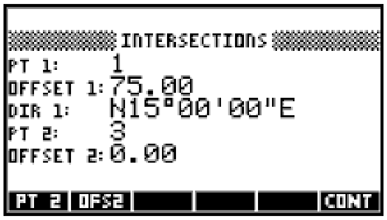


Figure A-80 Defining Line 1

5. **Enter the offset distance from line 2. Key in** 50 **and press** **OFS2**.

   The offset distance is entered as a negative value because the offset point occurs to the left of the line.

6. **Key in** 3 **and press** **PT2**.

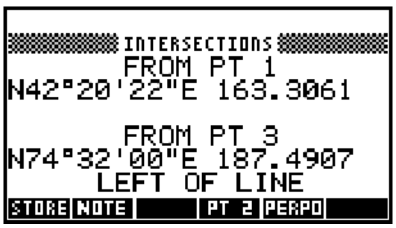


Figure A-81 Intersections from Points 1 and 3

7. **Key in** 4 **and press** **POL2**.

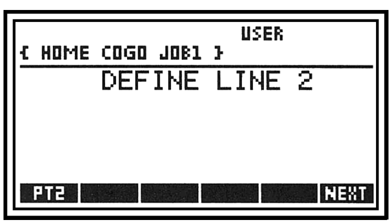


Figure A-82 Defining Line 2

8. **To store your new intersection as a new point, key in a point number and press** **STORE**. **If you do not key in the point number, it will store the point with the next number.**

   If you would like to see the point that has just been stored, go to random points, key in 1.5 and press ENTER. Then press SPLOT, choose the option you wish, and then press SPLOT again.

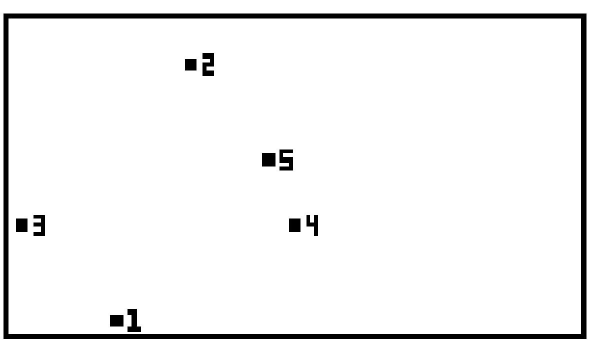


Figure A-83 Offset Example

Pause

KEY: **Pause**

PRODUCT: DCE+

KEYSTROKES: P key

This command pauses the Robotic Tracking mode and any search the instrument is attempting. Running the Pause command again will resume instrument tracking.

Perpendicular Offset

KEY: **PERPO**

PRODUCT: SCE+

KEYSTROKES: (the T key) **PERPO**

This function allows you to determine distance from a point to a line.

Using the example in Figure A-83 on page 320:

1. **Press for intersections.**
2. **Key in** 1 **and press** **PT1**.
3. **Key in** 2 **and press** **POL1**.
4. **Choose the point you that you want to find the perpendicular offset of. Key it in, (use** 3 **for this example) and press** **PT2**.
5. **Press** **PERPO**.

   This shows the distances from two points.

   If you press **STORE** here, a new point will be stored on the line that you designated, and it will be perpendicular to the point that was designated.

Point Inverse

KEY: PINV

PRODUCT: SCE+

KEYSTROKES: PINV (the P key)

This function key lets you inverse (compute the direction and distance) from the occupied point to another point in the current job.

Procedure

Starting from the desired occupied point (see *Occupy a Point* on page 318), key in the value for the point you are inversing to and press and the PINV key. The display will show the inverse from the occupied point.

Appendix A: Quick Reference of Menus and Functions

A Point Inverse submenu presents additional options:

Point Inverse Submenu Soft Keys

Option	Function
BKPT	Press this key to enter a backsight point number.
OCPY	Press this key to occupy the next available point, or key in a specific point number before pressing this soft key to occupy that point.
PINV	Press this key to execute another point inverse from the current occupied point to any other point in the job. The display will prompt you to enter the “inverse to” point.
PTRA	Press this key to execute a point traverse from the current occupied point to another point in the job. The display will prompt you to enter the “traverse to” point.
AREA	Press this key to show the area traversed since the last time a point was occupied.

Point on Grade

KEY: POG

PRODUCT: DOT

KEYSTROKES: ➦ POG (the V key)

This function computes additional points along a grade between two stored points; Elevations must be on.

Procedure

This function computes the grade and distance between two stored end points, and stores new points at a predetermined interval (or stores a predetermined number of points) between those two end points.

The display will prompt you to enter both end points. Key in the points (separated with a space) to define your line and press ENTER. A soft key menu will then give you options for creating new points along the line (and grade).

Point on Grade Menu Soft Keys

Option	Function
INTRV	Press this key to enter a distance interval for the new points. For example, 25 INTRV creates and stores points every 25 feet along the grade until the end point is reached.
# PTS	Press this key to enter a number of points to be inserted. For example, 3 # PTS creates and stores three equidistant points along the grade between the end points.
XTND	Pressing this key lets you continue storing points beyond the end point for a specified distance. For example, 50 XTND will continue storing point(s) for 50 feet beyond the end point. When a soft key is pressed, the calculations are automatic, and the new points are stored.

Point-to-Point Inverse

KEY: **P - P**

PRODUCT: SCE+

KEYSTROKES: **P - P** (the X key)

This function key inverses between any two points in the current job and is used to check distance and direction (azimuth and bearing, delta elevation, and grade) between two points.

When using a scale factor other than 1.00, both the scaled distance and the ground, or the non-scaled distance, display. The scaled distance is marked with an asterisk (*).

Procedure

Key in the point numbers, separated by a space (the **SPC** key), and press the **P - P** key. The display will show the inverse between the two points, including distance, bearing, and azimuth.

✎ *If Elevations are on when you store points and inverse between two points, you will get bearing and distance, and change in elevation and % grade between the two points.*

Point Traverse

KEY: **PTRA**

PRODUCT: SCE+

KEYSTROKES: **↱** **PTRA** (the R key)

This function lets you traverse from the occupied point to another point in the current job.

Procedure

Starting from the current occupied point (see *Occupy a Point* on page 318), key in the point number you are traversing to and press **↱** and the **PTRA** key. The display will show the new occupied point, as well as the backsight and foresight points. Point Traverse has the same submenu as Point Inverse (see *Point Inverse* on page 321).

Polar to Rectangular

PRODUCT: SCE+

KEYSTROKES: **↰** **P→R**

Use this command to convert from polar to rectangular coordinates. Type a distance and press **ENTER**. Type an HMS degree angle and press **↰** and the **P→R** key.

Appendix A: Quick Reference of Menus and Functions

Predetermined Area

KEY: PREA

PRODUCT: SCE+

KEYSTROKES: ↰ PREA (the SPC key)

This function lets you compute a predetermined area using either the Hinge (pivot) method or Slide method.

Procedure

The Predetermined Area menu offers Hinge and Slide computation methods. In addition, there is a simple trapezoidal computation routine that is a slide method that does not require stored points.

Predetermined Area Soft Keys

Option	Function
HINGE	Press this key to start the Predetermined Area Hinge Method menu. This function holds a defined hinge point and pivots one line of the boundary from that point along another line to create the desired area. The points defining the boundary should be in the Random Points file. The pivot line cannot intersect the boundary on a curve. Please refer to the table named *Predetermined Area Hinge Method Soft Keys* on page 325 and the section named *Hinge Method* on page 325 for additional information.
SLIDE	Press this key to start the Predetermined Area Slide Method menu. This function slides a line from a baseline to form a four-sided figure with the desired area. Please refer to the Predetermined Area Slide Method tables in the section named *Slide Method*, which begins on page 326.
TRAP	This is a simple routine to find the lengths of the sides of a trapezoid. It prompts for the baseline distance, the two interior angles, and the area in square feet or meters. It is assumed that the baseline and opposite side are parallel. After performing the calculations, the lengths of the other three sides are put on the stack.

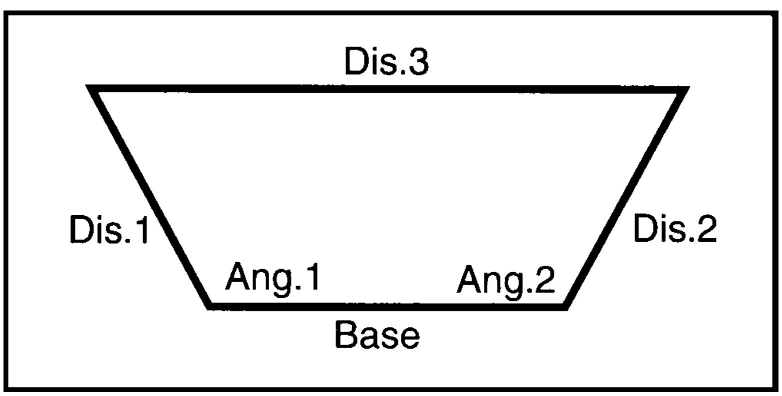


Figure A-84 Trapezoidal Routine

Hinge Method

Predetermined Area Hinge Method Soft Keys

Option	Function
EDIT	Press this key to edit the Random Points file. The Random Points file should begin with the hinge (pivot) point and end with the two points defining the line along which the calculated point will be stored. The last point you enter in the Random Points file must be on the line along which you will be moving to make your adjustment. Curves can be in the boundary, but the calculated point cannot be put on a curve. See *Random Points* on page 329 for help on entering points and curves in a Random Points file.
ACRES **HECTA**	Pressing this key results in a prompt for acres or hectares and calculates where the point should be stored to get the desired area. This function displays the result and starts the Predetermined Area Hinge Method Store menu.
SQFT **M^2**	Pressing this key results in a prompt for square feet or square meters and calculates where the point should be stored to get the desired area. This function displays the result and starts the Predetermined Area Hinge Method Store menu.

The distance shown after entering the desired area is the distance from the second-to-last point in the Random Points file along the line defined by the last point.

Predetermined Area Hinge Method Store Soft Key

Option	Function
STPT	Press this key to store the point that makes the boundary fit the area required.

Slide Method

Predetermined Area Slide Method Point 1 Soft Keys

Option	Function
PT1	Enter the first point on the baseline of the area.

Predetermined Area Slide Method Line 1 Soft Keys

Option	Function
BRG1	Enter the bearing from the first point defining the first side.
AZ2	Enter the azimuth from the first point defining the first side.
POL1	Enter the point on line from the first point defining the first side.

Predetermined Area Slide Method Point 2 Soft Keys

Option	Function
PT2	Enter second point on the baseline of the area.

Predetermined Area Slide Method Line 2 Soft Keys

Option	Function
BRG2	Enter bearing from second point defining second side.
AZ2	Enter azimuth from first point defining second side.
POL2	Enter point on line from first point defining second side.

Predetermined Area Slide Method Area Soft Keys

Option	Function
ACRES HECTA	Enter acres or hectares to calculate the solution. This displays the solution and starts the Predetermined Area Slide Method Store menu.
SQFT M^2	Enter square feet or square meters to calculate the solution. This displays the solution and starts the Predetermined Area Slide Method Store menu.
SLDAZ	Press this key to see the default azimuth of the sliding line, which is defined by the first and second baseline points. Enter a different azimuth to use for the direction of the sliding line. This function must be used before entering the area.

Predetermined Area Slide Method Store Soft Keys

Option	Function
PT3	This function stores a point on the intersection of the first line and the sliding line.
PT4	This function stores a point on the intersection of the second line and the sliding line.
NOTE	This function stores a note for stored points.

Previous Menu/Screen

KEY: **PREV**

PRODUCT: SCE+

KEYSTROKES: [↰] **PREV** (the L key)

This key reverse scrolls the soft key menu screen.

Procedure

Press [↰] **PREV** to scroll backwards through the soft key menu screens – this key is the opposite of the [NXT] key.

Print

KEY: [PRINT]

PRODUCT: SCE+

KEYSTROKES: [PRINT] (the U key)

This function allows you to print point/job information or raw data (DCE+ only).

Procedure

Whenever the data collector is sending data to print, you will see an arrow annunciator flashing at the top right of the display.

At any time, you may interrupt the printing of points by pressing [ON].

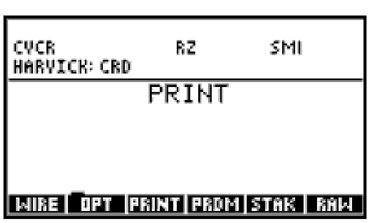


Figure A-85 Print Screen

Print Menu Soft Keys

Option	Function
IR WIRE	Press this key to toggle between an infrared and a wire connection to the printer. Selecting IR will print through the HP 48's infrared port. Pressing WIRE will print through the serial interface (cable required) to a serial printer. The default is infrared.
OPT	Press this key to select different printing options, depending on the card you are using. A submenu will present additional soft keys. See the table named *Print Options Menu Soft Keys* below for additional information.
PRINT	Press this key to print a point, a range of points, or the entire job file. If there are no point numbers entered into the stack, all the points in the current job will be printed. Enter one point number into the stack to print that single point number; or enter starting and ending point numbers to print the range of points between them (inclusive).
PRDM	Press this key to print the points in the current Random Points file.
STAK	Press this key to print staking information about the points in the current Random Points file. The current back azimuth and the occupied point will be used.
RAW	(DCE+): Press this key to print the entire raw data file. If your data collector is in "Serial Print" mode, this soft key may be used to send the raw data to a serial printer or DOS-based personal computer. To send the data to a file in your PC, connect the data collector to your PC's serial port using a serial cable, then set the PC to "Text Receive" mode.

Print Options Menu Soft Keys

Option	Function
COOR■ COOR	Press this key to toggle the printing of coordinates with each point. When selected (on), coordinates will be printed. The default is On.
B-D B-D ■	Press this key to toggle the printing of bearing and distance between the points as they are printed. When selected (on), the bearing and distance will be printed. The default is Off.
N+E ■ N+E	(SCE+): Press this key to toggle the printing of north and east coordinates of each point. When selected (on), the north and east coordinates of each point will be printed. The default is On.
EL ■ E L	(SCE+): Press this key to toggle the printing of the elevation of each point. When selected (on), the elevation of each point will be printed. The default is On.
NOTE NOT ■	(ACE+): Press this key to toggle the printing of the note for each point. When selected (on), notes will be printed. The default is On.
EXIT	Press this key to exit and return to the Print menu.

RAM Card Memory

The HP 48 supports 128K, 256K, 512K and 1Mb RAM cards. Only 256K, 512K, and 1Mb RAM cards are available as of January 2001.

Clearing memory: Clearing the HP 48's internal memory will not erase the RAM card. To erase the RAM card, use DEL and CARD.

Random Points

KEY: RPTS

PRODUCT: SCE+

KEYSTROKES: RPTS (the N key)

This function lets you create or edit a specified list of points which have been stored in a job. This is called a Random Points file. This also lets you run a large number of routines that require a valid Random Points file.

Procedure

The random point display begins with an "Edit" menu that lets you define a temporary Random Points file.

To create a temporary Random Points file, define the range of points by keying in each point number, separated by a space (the SPC key).

(If the display shows another temporary Random Points file on the stack, press ON to clear the stack; you may then begin defining your new Random Points file.)

A number-space-number (e.g., `1` SPC `20`), will only enter points 1 and 20.

A number-point-number (e.g., `1.20`), will enter points 1 through 20.

You can get creative in entering the points you want entered into your Random Points file: `1.5` SPC `7` SPC `10.20` are points 1 through 20 with 6, 8, and 9 being left out. Descending ranges such as 20.10 to indicate 20 through 10 are also permitted.

In some examples (such as angle adjustment) that include side shots, the side shots need to be entered as a negative number. When entering a range of side shots, only one negative needs to be entered. For example, -6.20 is side shots 6 through 20. Do not enter -6.-20; this will cause an error.

Curves are defined using the following points (separated with a space): point of curvature (PC), center of curve (CC) or radius point, and point of tangent (PT). These points are entered on the command line inside double quotes.

Example: "15 18 24".

To find the quotes, press ↱ —.

To move the cursor outside the second double quote, press ▶ (the R key).

To indicate an arc with a delta greater than 180°, make the radius point negative by pressing the +/− key while the cursor is on the radius point.

When you have finished editing your Random Points file, press ENTER to save the file.

Appendix A: Quick Reference of Menus and Functions

Once ENTER is pressed, you will see a menu of functions that can be used with the current Random Points file. These functions also are found in the More menu.

Random Points Menu 1 Soft Keys

Option	Function
EDIT	Press this key to edit the points in the current Random Points file. You may edit and add/delete points to the file using the standard editing keys. After you are finished editing, press ENTER and you will be prompted for the name of the Random Points file. The default file name is TEMP. To save the random points list to a different file name, press CANCEL to clear the command line and enter a new name. Each Random Points file is associated with the job it was created in.
OLD	(SCE+): Press this key to create a menu of old Random Points files to select. When the corresponding soft key is pressed, the old file becomes the current Random Points file. The current Random Points file is then used by all functions that require a valid Random Points file for their computations.
CX	Press this key to perform transformations (see *Transformation (Translating, Rotating, Scaling, and Changing the Elevation)* on page 368).
AREA	Press this key to compute area (see *Area* on page 248).
PREC	Press this key to compute acreage, square feet, perimeter, and precision. When running the PREC command once while the raw data flag is set on (↰ 2), the precision for the random points is stored to the raw file (see *Area* on page 248).
SPLOT	Press this key to plot lines on the data collector display; lines are oriented so that north appears at the top of the display, and they are scaled to fit on the screen. Curves defined by “PC RP PT” will also be plotted. Point numbers may also be turned on or off (see *Computing Area* on page 139).

Press NXT to access the second menu of soft keys:

Random Points Menu 2 Soft Keys

Option	Function
OFSET	Press this key to compute points from a line with break points.
XPLOT	Press this key to plot cross-section areas by point number (see *XPlot* on page 380).
AA	Press this key to perform an angle adjustment. See *Angle Adjustment* on page 244 for additional information.
CR	Press this key to make a compass rule adjustment. See *Compass Rule Menu* on page 263 for additional information.
COPYP	Press this key to copy the points listed in the Random Points file to another job or a different location in the same job. You will be prompted for the destination job, then the beginning point number. The default beginning point number with which you are prompted is the same as the first point number in the Random Points file. If you want to renumber the points, enter a new beginning point number.
MEAN	Press this key to mean (average) the north, east, and elevation values of the points in the Random Point list. See *Mean Points (Random Points Menu)* on page 310 for additional information.

Press NXT again to access the third menu of soft keys:

Random Points Menu 3 Soft Keys

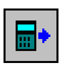
Option	Function
HINGE	(SCE+): Press this key to compute a predetermined area using the Hinge method (see *Predetermined Area* on page 324).

Random Points Menu 3 Soft Keys

Option	Function
ELADJ	Press this key to adjust the elevations in a traverse similar to the way the compass rule adjustment adjusts the north and east coordinates.
STAK	Press this key to stake points within a certain distance of the occupied point. This function will stake all points listed in the Random Points file. If you would like to pre-specify the points you would like to stake, you may place them in the Random Points file and when you occupy a point and backsight a point, go to stake and simply press ← **FSPT**. To back up to a previous point, press → **FSPT**.
NOTE	You can search the Random Points files for a particular point that has a note you are looking for. For example, include your whole job in the Random Points file. Press **NEXT** twice to bring up the **NOTE** soft key. Press it and type the note you are looking for, e.g., `IPS` for Iron Pin Set, and press **ENTER**. Now press **RPTS** again. All the points that have IPS as their note are now the only things in your Random Points file.
TOPC	Press this key to send the points listed in the current Random Points file to another computer. The points are sent in a ASCII comma delimited format. To use ***SMI Transfer*** to get this type of transfer, set the current data collector to "SMI Kermit V6" and select just the coordinate format. See *Transfer Procedure* below for more information.

Transfer Procedure

Using the ***SMI V7 Transfer*** program, you can transfer a random group of points.



1. On the PC, open the *SMI V7 Transfer* program.

2. Select the From DC command from the Main menu.

3. Choose SMI Kermit V6 from the Data Collector drop list.

4. Adjust the options on the Setup tab if necessary and click on the Transfer button.

You are prompted to enter the name of file in which to save coordinates.

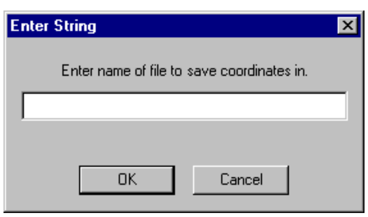


Figure A-86 Enter String Dialog Box

5. Type a path and file name to create on your computer for the random points (e.g., C:\CONTROL.ASC), or just type a file name to be placed in your data directory (e.g., CONTROL) and click on OK.

6. On the SMI data collector, select a group of random points using the RPTS command and press NXT NXT TOPC to send the data.

This displays a dialog box that lists the file name and the amount of data transferred.

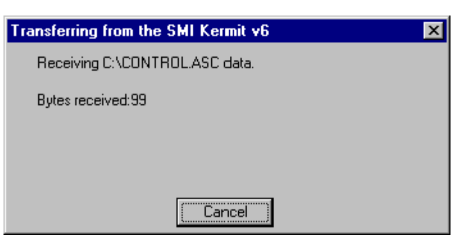


Figure A-87 Transferring from the Data Collector Dialog Box

Real-time Side Shots

PRODUCT: GPS/Robotic

KEYSTROKES: ↱ RSIDS (the Q key)

This command automatically stores side shots at the specified distance interval. See *Robotic Functions*, which begins on page 195, for more information.

Recall Point

KEY: RCLPT or PNTS

PRODUCT: SCE+

KEYSTROKES: S C RCLPT for editing coordinates of points or VIEW PNTS for viewing only

This soft key lets you recall and view the data for any point in the current job.

Procedure

When you execute this soft key function, the display will prompt you to enter the point to recall. Key in the point number and press ENTER, or key in the point number first and then press the appropriate function key(s).

✎ PNTS *does not require a point number; it will automatically display the data for the first point in the current job (see View on page 377).*

Press NEXT to increment to the next stored point (it will automatically skip any point numbers not used and jump to the next stored point).

Rectangular to Polar

PRODUCT: SCE+

KEYSTROKES: ↱ R→P (the 1 key)

This command converts from rectangular to polar coordinates. Type a Northing and press ENTER. Type an Easting and press ↱ then the R→P key. The polar distance and HMS degree angle will be put on the stack.

Reflectorless Mode

PRODUCT: DCE+

KEYSTROKES: ROBOT PRISM / REFL

This button toggles between PRISM to indicate Prism mode and REFL to indicate Reflectorless mode. The mode of the instrument is changed when the key is pressed.

If the current instrument driver does not support Reflectorless mode, you will see the message "REFLECTORLESS MODE NOT SUPPORTED".

Registers (REGS) Menu

KEY: **REGS**

PRODUCT: SCE+

KEYSTROKES: ↰ JOB or CUSTOM **REGS**

This function stores information in "registers" so that a single keystroke can be used to quickly recall the information when needed.

This function basically speeds up your survey work, since a single key assignment will insert frequently used data that would otherwise have to be manually entered.

Procedure

Press ↰ JOB and Memory Registers will appear on the soft keys (**1** through **6**). For more registers, press NXT and you will see **7** through **12**. To store a number in a register, key in the number and press ↰ and a soft key. To recall a value from a stored register, just press the soft key.

Example: Store 5280 into register **1**.

Figure A-88 Registers

1. **Press ↰ JOB to see the registers.**
2. **Key in** `5280` **and press ↰ 1.**
3. **To recall the number in the 1 register, press 1.**

The registers can also be accessed using CUSTOM and **REGS**. You can store and recall numbers using registers **1** through **12**.

Six registers are on the first set of soft keys and six are on the second set of soft keys.

Storing and Recalling Numbers in Registers

1. **Press ↰ JOB.**

   You will see a list of memory registers **1** through **12**.

2. **To store 5280 in register 1, key in** `5280` **and press ↰ 1. To recall 1, just press 1.**
3. **Press CUSTOM and REGS and you will see the same set of registers. Press 1 here and you will see** `5280`**.**

4. **Use RSTO and RRCL to store and recall registers. To store 43560 in register 5, first key in `43560` and press ENTER. Key in `5` and press RSTO.**
   To recall this number from the register, key in `5` and press RRCL. There may be times you would like to recall a register and use it in traverse, side shot, intersect etc., without needing to change your soft keys. Pressing ↰ RRCL and ↱ RRSTO are shortcuts to RRCL and RSTO.

You stored 43560 into register 5 earlier. The following steps show how to recall register 5.

1. **Key in `5` and press ↰ and the RRCL key. You will see `43560` on the stack.**
2. **Key in `1` and press ↰ and the RRCL key. You will see `5280` on the stack.**

Even though there are only 12 numbers shown in the Register Menu, registers 1 through 26 are available via RRCL and RSTO.

Examples

Find the acreage of a 10000 square-foot lot: Key in `10000` ENTER and press 5 ↰ RRCL to recall 43560 stored earlier, and press ÷. You will see `0.2296` (acres).

✎ *A number or a keystroke sequence can be assigned to a key.*

Return

KEY: RTN

PRODUCT: SCE+

KEYSTROKES: ↱ RTN (the . key)

This function allows text to continue on the next line.

Procedure

While keying in a note or Random Points file, it may be easier to read them on the screen if a return is inserted into the text when the characters approach the right edge of the screen.

This will drop your text entry to the next line.

Rezero

PRODUCT: GPS/Robotic

KEYSTROKES: ↰ RE-0 (the 0 key)

This command turns a robotic instrument back to the backsight, shoots a prism, reports the angular difference from the original backsight reading, records the difference in the raw data file, and sets the Horizontal Angle to zero.

✎ *The ↱ ZERO or ZERO key must have been used previously so the data collector knows the Zenith Angle to turn to the backsight.*

Robot Servo Menu

PRODUCT: DCE+

KEYSTROKES: ROBOT (the R key)

The Robot Servo menu contains routines that are useful when using robotic instruments as well as servo motor instruments and conventional total stations.

The Robot Servo Menu is available in ***DCE+*** cards but some buttons may not be available if not using a Robotic capable card. See *Robot Servo Menu* on page 198 for detailed information about the Robot Servo menu.

Scale

PRODUCT: ACE+

KEYSTROKES: CHANGE NXT ADJST SCALE

SHORTCUT: ↰ SCALE (the ✕ key)

This key prompts for a scale factor. Entering 1 will disable the option. When working with State Plane Coordinates, you may enter a scale factor here.

Screen Plot

KEY: SPLOT

PRODUCT: SCE+

KEYSTROKES: RPTS SPLOT

Use this command to plot lines and points on the data collector display; lines are oriented so that north appears at the top of the display, and they are scaled to fit on the screen. Curves defined by “PC RP PT” will also be plotted.

Procedure

To view a graphic representation of the plat, including points, point number, and lines, press SPLOT (screen plot) from the Random Point soft key menu. Any negative numbers will not have lines drawn to them – only points with numbers.

Separate Distance and Angle

KEY: **SDA**

PRODUCT: DCE+

KEYSTROKES: SETUP **SDA**

This function allows you to enter a separate distance and angle, as well as offset distances, to store a point. This is useful when you are trying to shoot power poles, building corners, around trees or creek banks, and for determining elevations of (or distances to) inaccessible objects.

The comment record (CM) in the raw data reports the Height Instrument, Height of Rod, Horizontal Angle (reporting an angle right), Zenith Angle, and Slope Distance.

Procedure

If your data collector is set for electronic data collection, the instrument takes a reading and collects the distance to the prism when you press the **SDA** key.

If your calculator is set for MAN2 collection, the display will prompt you for Slope Distance, Zenith Angle, and Angle Right (Horizontal Angle).

Once data has been collected (or manually entered), the display shows a submenu with the following soft keys:

Separate Distance and Angle Submenu Soft Keys

Option	Function
ZHA	When not in GPS mode, **ZHA** is the first soft key. Pressing this key brings in the Horizontal and Zenith Angles. The horizontal distance of the first shot taken when **SDA** was pressed is used with the new angles to calculate a new position. If the Zenith Angle is different by more than 1 foot, the Height of Rod is not used in the calculations. This allows a spot high above the prism to be pointed to on the second shot and you can get an accurate elevation without having to set the Height of Rod to 0. Pressing ↰ **ZHA** instead of just **ZHA** does not take new angle measurements but uses the offset distances to move the shot taken when **SDA** was pressed.
STORE	When in GPS mode, **STORE** is the first soft key. Pressing **STORE** stores the point measured when **SDA** was pressed with the offset distances applied.
HD↑	Press this key to add the specified distance to the distance just measured. Key in the distance, then press **HD↑**.
HD↓	Press this key to move the point toward the instrument the desired distance. Key in the distance, then press **HD↓**.
HD→	Press this key to move the point to the right the desired number of feet. Key in the distance, then press **HD→**.
HD←	Press this key to move the point to the left the desired number of feet. Key in the distance, then press **HD←**.

If the HD keys are used, they should be used before the **ZHA** key.

✎ *When working with elevations, if you move the crosshair more than 1 foot vertically, the program will give the elevation at the crosshair (it zeroes the height of the rod).*

Example: Shooting a Tree

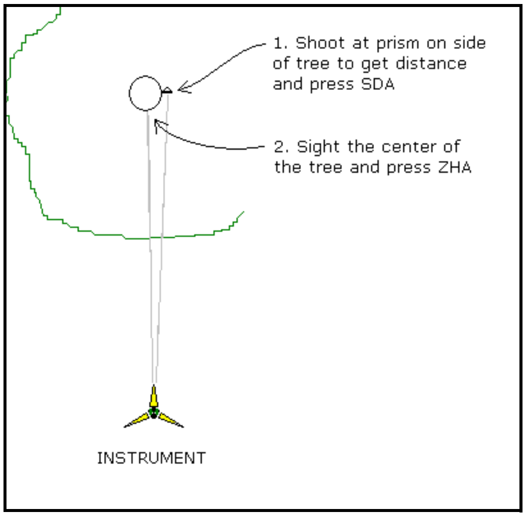


Figure A-89 Shooting a Tree

Point the instrument to a prism at the side of the tree (1) and press **SDA** . Next, turn 90° to the center of the tree (2) and press **ZHA**. The distance and angle to the tree will be stored as the point.

Another equivalent method:

1. **Point the instrument to a prism at the side of the tree (1) and press SDA.**
2. **Type the radius of the tree and press the correct direction key:** .5 **HD←.**
3. **Press ↰ ZHA to store a point in the center of the tree.**

Example: Shooting the Top of a Telephone Pole

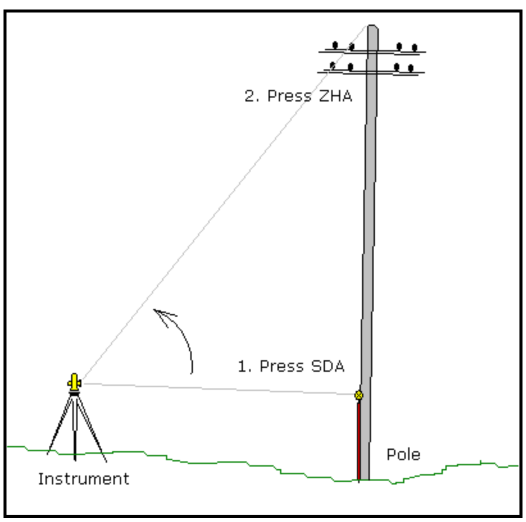


Figure A-90 Shooting a Telephone Pole

1. **Point the instrument to a prism at the side of the telephone pole and press SDA.**
2. **Point the instrument to the center of the top of the telephone pole.**
3. **Press ZHA to store a point in the center of the top of the telephone pole.**

Setup

KEY: SETUP

PRODUCT: SCE+

KEYSTROKES: SETUP (the I key)

This menu key allows you to enter setup parameters for side shots and traverses; it also contains routines for specialized side shots. The Setup menu includes various soft keys, depending on your card. Press NXT to scroll through these soft key menus.

Setup Menu 1 Soft Keys

Option	Function
BKPT	Press this key to create a back azimuth, based on the inverse between the current occupied point and the backsight point entered using this soft key. Pressing ↰ BKPT prompts for a backsight point number, takes a reading on the back point, and gives data as though you were staking the point. The purpose is to make sure this is the right backsight point. If the instrument is turned on, it will take a reading on the prism on the backsight point and display the discrepancy, if any. This will automatically be stored to the raw data file, even if Raw Data is turned off.
OCPY	Press this key to occupy a point in the current job. Enter the desired point number and press the soft key to occupy that point, or press the soft key first, and you will be prompted for a point number.
NOTE	Press this key to put a note at the last point stored, even if note prompting is off. NOTE can also be used to enter a note for any point that has been previously stored. Key in the point number before pressing NOTE.
H I	(SCE+): Press this key to store the height of the instrument. This soft key is blank if Elevations are turned off. Press ↰ ELEV (the 3 key) to toggle Elevations mode.
HROD	(SCE+): Enter a new Height of Rod. This key is blank when Elevations are off. If you wish to be prompted for HROD after the shot is taken, press CHG NXT INPUT and HROD. To toggle this feature off, press HROD again.
SDA	Press this key to electronically take separate distance and angle measurements for a point (see *Separate Distance and Angle* on page 336). Shortcut: ↰ +/− (the Y key).

Setup Menu 2 Soft Keys

Option	Function
2PFS	Two-Point Free Station Resection: This function is also used for Multiple Point Free Station Resection. Shortcut: ↱ 2PFS (the DEL key). See also *Free Station (Two-Point Free Station/Resection)* on page 295.
B M	Press this key to bring a benchmark elevation to the occupied point. Shortcut: ↰ DEL (labeled BMRK). See *Benchmark Menu* on page 253.
SHOTS	Press this key to make multiple shots to the same point, or to multiple points, either directly or with a flopped scope. Shortcut: ↱ BACKSPACE. See *Shots* on page 340.

Setup Menu 2 Soft Keys

Option	Function
△ PT	Angle to Point is used with X PT Intersection to Point to create a point at the intersection of angle measurements from two different occupied locations. Coordinates and elevations may be collected from the remote points without a prism. From one instrument location, use △ PT to store angles to a point (or points), such as towers, bridge abutments, road centerlines, fence lines, and so on. The coordinates of the occupied point are stored in the next number and the Horizontal Angle is stored in the note with a tag. See *Angle Point and Intersection Point* on page 246.
X PT	Intersection to Point should be pressed after sighting on the point shot to using △ PT after moving the instrument to a new location. If a point number is not entered before pressing X PT, it is assumed that the first point shot using △ PT is being pointed again. To shoot points out of order, type the point number assigned by △ PT at that location before pressing X PT. X PT calculates the coordinates and elevation of the remote and stores it in the same point number that △ PT used. See *Angle Point and Intersection Point* on page 246.
ZERO	Press this key to zero the Horizontal Angle in most electronic total stations. Shortcut: ↱ 0.

Setup Menu 3 Soft Keys

Option	Function
INST	Press this key to select an instrument, or select manual data entry using one of two manual entry methods. Shortcut: ↱ ✕ (multiplication key). See *Instruments* on page 300.
MBS	Mean Backsight is used to shoot a backsight point directly and with the scope flopped. These two measurements will be meaned to recreate the elevation of the occupied point. Shortcut: ↰ 8 (labeled MBKS). See *Mean Backsight* on page 309.
TRIG	Press this key to do trig leveling on a shot. Shortcut: ↱ 8. See *TRIG (Trigonometric Leveling)* on page 372.
BKAZ	Press this key to set the back- azimuth to the backsight point.
BKBR	Press this key to store the back bearing. After entering the bearing, you will be prompted for the quadrant (NE = 1, SE = 2, SW = 3, NW = 4). If you want to enter the quadrant with the bearing, key it in as the first digit of the bearing. Example: S 69°35’14” W would be entered as 369.3514.
RAWD	Press this key to display the raw shot data from the last shot taken; this option is available only when data is gathered using either MAN2 (manual entry method 2 – see *Instruments* on page 300) or electronic entry.

Shots

KEY: **SHOTS**

PRODUCT: ACE+

KEYSTROKES: **SETUP** **NXT** **SHOTS**

To ensure that old shots are clear, press ↱ **SHOTS**.

To ensure that old shot data is retained, press ↰ **SHOTS**.

SHORTCUT: ↱ ◀

This function allows you to take multiple sets of angles and distances to one or more points, mean them, convert these meaned angles and distances to coordinates, and store them by point number as side shots. If multiple angles are taken to one point, the point may be stored as a side shot or as a traverse point.

Shots Menu 1

KEYSTROKES: **SETUP** **NXT** **SHOTS**

Figure A-91 Shots Menu 1

Shots Menu 1 Soft Keys

Option	Function
ZERO	Use this key to set the Horizontal Angle in the instrument to zero. Zeroing the instrument is optional. ✎ *Do not use* **ZERO** *after you have started taking readings.* ✎ *Some instruments cannot be zeroed from the data collector using this key. In this case, you may choose to zero from the instrument.* **BS** *is used to take a backsight reading whether the scope is direct or reverse. If the instrument has been zeroed, pressing this key with the scope direct is optional if not using the* **AUTO** *function.* ✎ *If you are using an electronic instrument, measurements will be made automatically; otherwise, you will be prompted for the input.*
BS	Backsight is used to read the Horizontal Angle only to the backsight point. A prism is not required for the backsight point unless using the **AUTO** key.
SET1	SET1 is the default beginning set. Once SET1 is finished, press **SET1** to increment to SET2. Pressing **SET2** increments to **SET3**, etc. If you wish to go to a specific set, key in the set number then press the SET key. For example, if you are on SET4 and you wish to go to SET2, key in 2 and press **SET4**. The soft key will switch to **SET2**. ↰ (Shift Left) will decrement to **SET3**, etc.
EVAL	If one or more sets are shot, press **EVAL** and you will see the angles and distance(s) direct and reverse, as well as the meaned angles and distance.

Shots Menu 1 Soft Keys

Option	Function
AZPT	**Azimuth Point:** This function was suggested by Charles Elam of Lincolnton Georgia. It allows you to take multiple angles on a point far away without a prism. It operates like any other point using SHOT, except a prism is not needed and a specific distance is always stored. The distance is 234.0123. AZPT is also found under SETUP and ↰ NXT. At this location, it is used for taking a single side shot to establish the direction to a point without a prism. The distance is always 234.0123. ✎ *To remotely locate points with north east and elevation points without a prism, see Angle Point and Intersection Point on page 246.*
SHOT	This function is used to take both direct and reverse readings to foresight points when taking multiple angle and distance readings. If a specific point is entered before SHOT is pressed, then the reading is taken for the specified point. Each time SHOT is pressed, it first determines whether it is a direct or reverse face shot. It then collects the shot information and assigns that shot to a point number in the current set. The point number shown after DIR in the Shots Menu display is the point where the Shots program thinks the next direct shot will be taken. REV in the display is the point number where the program thinks the next reverse shot will be taken. These point numbers are especially important to watch when taking shots to multiple points at the same time. If the point numbers shown in the display are not where you want to take the next shot, type the correct point number before pressing SHOT. If the next point number is zero when SHOT is pressed, you will be prompted to enter the point number.

Shots Menu 2 Foresight Options

Figure A-92 Shots Menu 2

Shots Menu 2 Soft Keys

Option	Function
FSOPT	**Foresight Options**: This function provides a list of soft keys that let you choose which angles and distances will be used in the Multiple Angles program. The menu is displayed below:  **HA** / **HA ■**: Horizontal Angle **ZA** / **ZA ■**: Zenith Angle **S D** / **SD ■**: Slope Distance **HAR** / **HAR ■**: Horizontal Angle Reversed **ZAR** / **ZAR ■**: Zenith Angle Reversed **SDR** / **SDR ■**: Slope Distance Reversed Each of the previous options are toggles. If the box is displayed, the function is active. If the box is not displayed, the function is not active. Note that the default is On for all, except the Slope Distance reversed. You may wish to turn this on also by pressing the key once.
AUTO	This option is only available with robotic instruments. After using **ZERO** **BS** and **SHOT** to take the first shots on the backsight and foresight points, enter the total number of sets to be taken and the data collector will control the robotic instrument to turn the remaining sets. See *Auto Shots* on page 196 for additional information.
FLOP	This is only available with servo instruments. The instrument will reverse face.

Shots Evaluation Menu Soft Keys

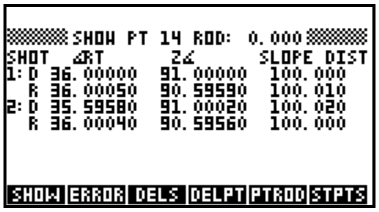
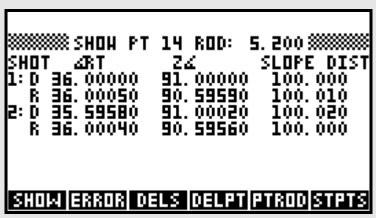


Figure A-93 Shots Evaluation Menu

Shots Evaluation Menu Soft Keys

<table>
<tr><th>Option</th><th>Function</th></tr>
<tr><td>SHOW</td><td>Press this key to show the angles and distances direct and reverse. The mean of these angles and distances is also displayed.
✎ If you have more than one point being used to take multiple readings, each time SHOW is pressed, a new point is displayed. If SHOW is pressed one more time after the last point is displayed, the point number is rotated back to the first point. To see the readings for a specific point, key in the point number before you press SHOW.</td></tr>
<tr><td>ERROR</td><td>This function shows the mean error deviation for each point shot. Pressing ERROR increments just as SHOW. Each time you press ERROR, the error for the next point number will be displayed.


To find the errors of a specific point, key in the point number, then press ERROR.</td></tr>
<tr><td>DELS</td><td>Delete Shot allows you to delete any shot for the current point shown. Press SHOW until the point containing the shot is displayed. The shots are numbered sequentially as shown on the screen. This means that to delete the reverse shot in the second set, enter 4 before pressing DELS. Each set has two shots and the reverse shot is listed after the direct shot, so 4 is the correct number.
✎ If a shot is not acceptable, it is not necessary to delete it. You can just reshoot it. For example, to reshoot point 16 reversed: Press NXT and EXIT (or SETUP NXT ↰ SHOTS). Key in 16, reverse the scope, and press SHOT. Now press EVAL and press SHOW until 16 is displayed.</td></tr>
<tr><td>DELPT</td><td>This function lets you delete an entire point from the list of points on which you are taking readings.</td></tr>
<tr><td>PTROD</td><td>This function lets you enter the rod height for each point. To go to a specific point, key in the point number before pressing PTROD.</td></tr>
</table>

Shots Evaluation Menu Soft Keys

Option	Function
[STPTS]	When all angles are turned and acceptable, press this key and the mean of each angle and distance to each point will be used to convert to coordinates and be stored as side shot points. If data was collected for only one point, the user is prompted to choose whether to store it as a side shot or traverse. ✎ *After* [STPTS] *is pressed when you go to Shots, the angle and distance values for each set will be deleted. If you wish to go back to Shots without deleting these values, press* [↰] [SHOTS]. ✎ *Before* [STPTS] *is pressed, just pressing* [SHOTS] *retains the old values.* ✎ *If you have not pressed* [STPTS] *and you wish to clear old values anyway, press* [↱] [SHOTS].

Close Horizon

This was an option on the previous version cards; however, you can now use the same instrument procedure to turn angles using [SHOTS] as you did using [CH].

1. **Zero on the backsight point.**
2. **Turn to the foresight point and press [SHOT].**
3. **Flop the scope, zero on the foresight point (optional now), and press [SHOT].**
4. **Turn to the backsight point and press [BS].**

   This is one set.
5. **Go to set 2 and repeat steps 1 through 4 or go to step 6.**
6. **Press [EVAL] and [STPTS].**

Procedure

[SHOTS] is used to take multiple angles and distances to one or more points. Any number of sets can be used. A set is defined as direct and reverse readings to one or more points. In some cases, a reverse is not desired, such as when there is a top-mounted electronic distance meter. In this case, we define a set as a direct reading only.

Following are examples and explanations of the [SHOTS] function and how it may be used. ***SMI's*** Shots function is very flexible. You can evaluate your results and reshoot any bad results before you leave the instrument position.

[SHOTS] will not only improve the accuracy of your north and east coordinates, but if Elevations are on, [SHOTS] will compute the elevations more accurately than taking a single side shot. If you are using tripods or different prism heights, you should enter a rod height for each point separately. However, the rod height cannot be entered until some shots have been read. To enter the rod height of each point being shot, press [SETUP] [NXT] [SHOTS] [EVAL] and [PTROD]. You will be prompted for the point number.

When taking shots, you will see something like this near the center of the display:

NN DIR 17   REV 16

This indicates that you can either take another direct on the next point (17), or if you have finished taking direct readings, you can take the reverse on the same point (16). If you prefer to not comply with the suggestion, key in the proper point number before pressing [SHOT]. To see the errors, press [EVAL] and [ERROR].

If you get completely out of the Shots menus, and if you have not used STPTS to store the point or points, press SETUP and NXT and SHOTS to get back into the display. As long as STPTS is not pressed, the shots data will not be lost.

If you have pressed STPTS and press SETUP NXT and SHOTS, the variables will be erased. After STPTS has been pressed, if you wish to go to Shots without erasing the variables, press ↰ SHOTS.

If you have not pressed STPTS, and you wish to erase the shot values anyway, press ↱ SHOTS.

Once the shots have been taken, you can evaluate each reading to each point in each set. If you are uncomfortable with a reading, you may reshoot any point in any set, either direct or reverse. You can then reevaluate the readings. Once you are pleased with each reading, press STPTS to store the mean of all data in all points. The mean of all angles and distance to each point is stored as a side shot.

✎ *If you prefer to traverse to one of these points, key in the point number and press* ↱ *and the* PTRA *key (the R key).*

Using Shots to Take Multiple Angles to One Point

Method 1

1. **You should be occupying a point and backsighting a point.**
2. **Turn the scope to the backsight point and press BS.**
3. **Turn the scope to the foresight point and press SHOT.**
4. **Reverse the scope and press SHOT.**
5. **Turn the scope to the backsight point and press BS.**
6. **Press SET1.**

   The soft key will switch to SET2.
7. **Repeat steps 2 through 5. Perform as many sets as you wish.**
8. **Press EVAL, reshoot any bad readings and press STPTS.**

   You now have the option of storing the point as a side shot or a traverse point.

Method 2

1. **You should be occupying a point and backsighting a point.**
2. **Turn the scope to the backsight point and press BS.**
3. **Reverse the scope to the backsight and press BS.**
4. **Turn the scope to the foresight point and press SHOT.**
5. **Reverse the scope to the foresight and press SHOT.**
6. **Press SET1.**

   The soft key will switch to SET2.
7. **Repeat steps 2 through 5. Perform as many sets as you wish.**
8. **Press EVAL, reshoot any bad readings and press STPTS.**

   You now have the option of storing the point as a side shot or a traverse point.

Replacing a Bad Shot

If you find a point that has a direct or reverse in a set that is outside your tolerance, it can be deleted and reshot. Values that exceed the tolerance have a small arrow next to the value. However, it is not necessary to delete it. You can just reshoot it. Suppose you wish to reshoot the direct reading for set 2 on point 25:

1. **Press NXT and EXIT. (If you are out of the Shots program, press SETUP NXT ↰ SHOT.)**
2. **Key in** 2 **and press the SET key (not necessary if it is showing SET2).**
3. **Point the instrument in the direct position at point 25.**
4. **Key in** 25 **and press SHOT.**

The values for the direct shot in set 2 to point 25 will be replaced with the new reading.

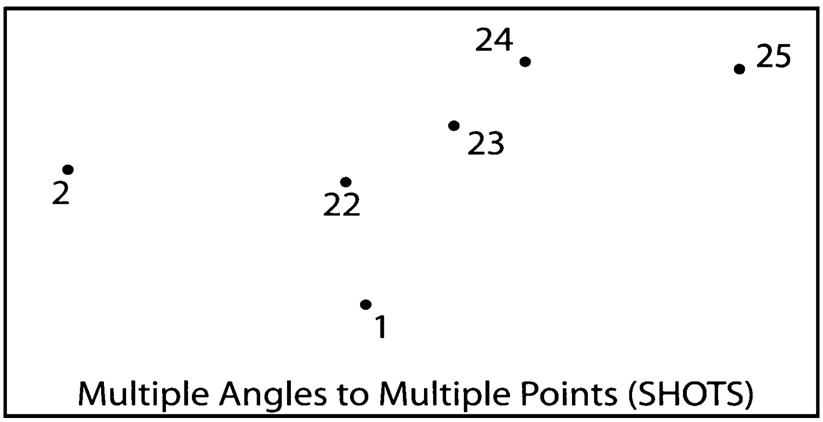


Figure A-94 Multiple Angles to Multiple Points

In the illustration, the instrument is occupying 1 and backsighting 2. You zeroed the instrument on point 2.

✎ *When taking shots, there will be a prompt in the middle of the display that indicates an expected point direct or reverse.*

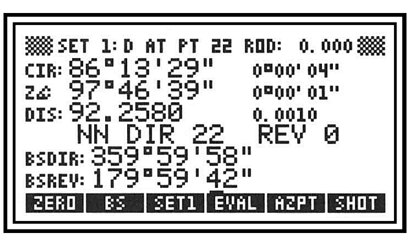


Figure A-95 Replacing a Bad Shot Example Display

For example, in the screen display above, you see NN DIR 22 REV 0. This means you can turn the instrument scope to direct, point at 22, and press SHOT. Since the display shows REV 0, if you take a reading in the reverse position, ***SMI*** will prompt for the point number. However, you can point the instrument at any point at any time in direct or reverse, key in the correct point number that you are sighting, and press SHOT. The data will be collected for that point.

Taking Shots on Multiple Points

Method 1

1. **Point the instrument at 2 and press ZERO then BS.**
2. **Point the instrument at 22 and press SHOT.**

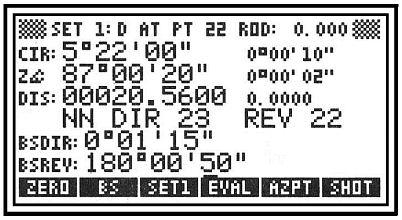


Figure A-96 Taking the Shot at Point 22

3. **Point the instrument at 23 and press SHOT.**
4. **Point the instrument at 24 and press SHOT.**
5. **Point the instrument at 25 and press SHOT.**
6. **Reverse the scope and:**
   A. **Point the instrument at 25 and press SHOT.**
   B. **Point the instrument at 24 and press SHOT.**
   C. **Point the instrument at 23 and press SHOT.**
   D. **Point the instrument at 22 and press SHOT.**
   E. **Point the instrument at 2 and press BS.**
7. **With the scope still reversed, press SET1.**

   The soft key will then change to SET2.

   A. **Point the instrument at 2 and press BS.**
   B. **Point the instrument at 22, key in 22 and press SHOT.**
   C. **Point the instrument at 23 and press SHOT.**
   D. **Point the instrument at 24 and press SHOT.**
   E. **Point the instrument at 25 and press SHOT.**
8. **Flop the scope to direct and:**
   A. **Point the instrument at 25 and press SHOT.**
   B. **Point the instrument at 24 and press SHOT.**
   C. **Point the instrument at 23 and press SHOT.**
   D. **Point the instrument at 22 and press SHOT.**
   E. **Point the instrument at 2 and press BS.**

Additional sets may be taken as needed.

Press EVAL then STPTS and each point will be stored as a side shot.

To traverse to one of these points, key in the point number and press PTRA (and the R key).

✎ *If you have a robotic card and instrument, use* **AUTO** *after the first five steps and all the other shots will be taken automatically.*

Method 2

1. **Point the backsight (point 2) direct and press** **BS**.
2. **Reverse the scope, point the backsight (point 2) and press** **BS**.
3. **Turn to point 22, key in 22, and press** **SHOT**.

Figure A-97 Taking the Shot at Point 22

✎ ***SMI*** *tries to predict the point number and the face (direct or reverse) you will be shooting next (NN DIR 23 REV 22). If you wish to take a reading to a point that* ***SMI*** *does not predict correctly, key in the point number before pressing* **SHOT**.

4. **Flop the scope (to direct), point 22, key in** 22**, and press** **SHOT**.
5. **Turn to point 23, key in** 23**, and press** **SHOT**.
6. **Flop the scope (to reverse), point 23, key in** 23**, and press** **SHOT**.
7. **Turn to point 24, key in** 24**, and press** **SHOT**.
8. **Flop the scope (to direct), point 24, key in** 24**, and press** **SHOT**.
9. **Turn to point 25, key in** 25**, and press** **SHOT**.
10. **Flop the scope (to reverse), point 25, key in** 25**, and press** **SHOT**.
11. **Press** **SET1**.

    The soft key will then change to **SET2**.
12. **Point the backsight (point 2) direct and press** **BS**.
13. **Reverse the scope, point the backsight and press** **BS**.
14. **Turn to point 22, key in** 22**, and press** **SHOT**.
15. **Flop the scope (to direct), point 22, key in** 22**, and press** **SHOT**.
16. **Turn to point 23, key in** 23**, and press** **SHOT**.
17. **Flop the scope (to reverse), point 23, key in** 23**, and press** **SHOT**.
18. **Turn to point 24, key in** 24**, and press** **SHOT**.
19. **Flop the scope (to direct), point 24, key in** 24**, and press** **SHOT**.
20. **Turn to point 25, key in** 25**, and press** **SHOT**.

21. Flop the scope (to reverse), point 25, key in 25, and press SHOT.

Additional sets may be taken as needed by pressing SET2 (***SMI*** will increment to SET3), and repeating these steps. When satisfied with the results, press EVAL then STPTS and each point will be stored as a side shot.

To traverse from the occupied instrument position to one of these points, key in the point number and press PTRA (and the R key).

At any time while taking shots, you can press EVAL and see the results of the angles.

You can press SHOW and the point number will increment.

Press SHOW now to increment to 25 then back to 22.

To show a specific point number, key in the point number before pressing SHOW.

Pressing ERROR shows the errors in angles and distances for each point.

Press ERROR again to increment back to point 22.

Side Shot

KEY: SIDS

PRODUCT: SCE+

KEYSTROKES: SIDS (the H key)

This function/menu key allows you to electronically or manually take a single Horizontal Angle, Zenith Angle, and Slope Distance to a point, convert to coordinates, and store by point number without changing the occupied point and backsight point.

Procedure

When an instrument is not chosen:

If you have not chosen an instrument, SIDS will display soft keys for manual entry.

When an instrument is chosen:

If you have chosen an instrument, SIDS will electronically collect the Horizontal Angle, Zenith Angle and Slope Distance, convert to coordinates, and store by point number. After the data is collected in the electronic mode, the setup menu is displayed on the soft keys for additional data entry options.

Choosing an Instrument

To choose an instrument (***DCE+***), press SETUP NXT NXT INST, or use the shortcut × (multiplication key), and choose your brand. You may need to press NXT to find your instrument brand. Choose the model by pressing the appropriate soft key.

For further information about instruments, see *Instrument Configuration*, which begins on page 383.

Three Ways to Switch from Electronic Data Collection to Manual Input

After you have chosen your instrument, there are three ways to do manual input of data in the Side Shot mode:

➥ Press SIDS for manual entry.

➥ Press [↰] 5. This turns the instrument flag (the I symbol at the top of the display) off. Now press [SIDS] for manual entry. To turn the instrument (I symbol) on again, press [↰] 5. [SIDS] will now electronically collect again.

➥ Press [SETUP] [NXT] [NXT] [INST] and [MAN 1] or [MAN 2]. [SIDS] is always manual now.

If you are using [MAN 2], when you press [SIDS], you will be prompted for Slope Distance, Zenith Angle, and Angle Right. Key in the appropriate values (separated by a space – the [SPC] key). Press [ENTER] to convert the angles and distance to coordinates stored by point number.

Changing MAN2 Order of Input

The order of data entry can be changed by pressing [CHG] [NXT] [INPUT] and [DZH]. The soft key toggles to [HZD]. Now instead of being prompted for

SDIST, ZENITH ANGLE, and ANGLE RT, you will be prompted with ANGLE RT, ZENITH ANGLE, and SDIST.

If you are using manual entry method 1 (MAN1), pressing [SIDS] will present the soft key options shown in the table called *Side Shot Page 1 Soft Keys* below, depending on the card you are using.

Side Shot Soft Key Page 1 for Manual Entry

You may enter the value first and then press the soft key; or press the soft key and you will be prompted to key in the value (then press [ENTER]).

Side Shot Page 1 Soft Keys

Option	*Function*
[∡ RT]	Press this key to enter an Angle Right. For Angle Left, key in the angle, press [+/−] and press [∡ RT].
[A Z]	Press this key to enter an azimuth. Enter two point numbers if you want to use the inverse between those points as the azimuth to the next point. Press [A Z] to see the last azimuth. Press [ENTER] to use this value as the new azimuth. Press [↱] [A Z] to put the last azimuth on the stack. Then you can add or subtract to the azimuth using [↱] [HMS+] or [↱] ["/HMS-].
[BRG]	Press this key to enter a bearing. After entering the bearing, you will be prompted for the appropriate quadrant (NE=1, SE=2, SW=3, NW=4). An optional way to enter bearing and quadrant is to enter the quadrant as the first digit of the bearing. For example, a bearing of S 23° 11’12” W would be keyed in as 323.1112 and then you would press [BRG].
[DEF∡]	Press this key to enter a deflection angle to the right, or key in a negative number to enter a deflection angle to the left. Key in the number first, then use the [+/−] key, rather than the Minus key, to change to a negative number. After a direction has been entered, the angle is presented at the top of the display. Also shown is the Distance submenu that lets you enter a distance.
[H I]	Press this key to enter the height of the instrument. HI is defined as the vertical distance from the point under the instrument to the axis of the scope on the instrument. To change the last height of the instrument, key in the new HI and press [H I]. When Elevations are on, the current height of the instrument is displayed.

Side Shot Page 1 Soft Keys

Option	Function
HROD	Enter a new Height of Rod. This key is blank when Elevations are off. You may choose to have the HROD prompt each time you take a shot. This allows you to take a reading before you enter the HROD. To use this option, press CHG NXT INPUT HROD. In this menu, HROD is a toggle key.

Side Shot Soft Keys Page 2

KEYSTROKES: SIDS NXT

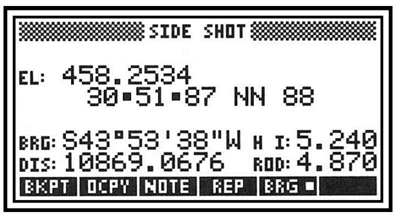


Figure A-98 Side Shot Page 2

Side Shot Page 2 Soft Keys

Option	Function
BKPT	Press this key to enter a backsight point. The backsight azimuth is calculated based on the current occupied point when this key is pressed.
OCPY	Press this key to occupy a point with the data collector. If a back point has been entered, the back azimuth will automatically be updated.
NOTE	(ACE+): Press this key to enter a note for the last point stored. After you press this soft key, the display will prompt you to enter a note. The alpha keyboard will be turned on automatically. ✎ *A note can be stored at any time at any point number that exists. If a point number is keyed in before* NOTE *is pressed, you will see* NOTE FOR POINT 123 *(if you pressed* 123 *before you pressed* SETUP *and* NOTE*). Key in the note and press* ENTER*. The note will be stored at the specified point. If no number is keyed in first, the note will be stored at the last point number stored or staked.*
REP	Press this key to repeat the last direction and distance to store another side shot. If this key is pressed while in Traverse mode, it will use the last direction and distance to create a traverse point (see *Traverse* on page 371).
BRG ■ **AZ ■** **∆ RT ■** **COOR■**	This is a toggle key that lets you switch between the four methods of angle display. 

Side Shot Distance Soft Keys

Option	Function
HDIST	Press this key to enter a horizontal distance. Key in the desired value before pressing the soft key, or enter two point numbers separated by a space to use the inverse between them as the horizontal distance to the next point. To use the last horizontal distance, press **HDIST** before entering a value; the last value used will be shown on the command line. Press **ENTER** to save the value as the current horizontal distance. After the distance has been entered, a point will be stored, and you will be returned to the Side Shot menu. Pressing ↱ **HDIST** displays the last horizontal distance on the stack. Press ↰ **HDIST** to enter feet and inches instead of decimal feet. You will see the prompt "FEET `INCH NUM DEN`". Enter the feet, inches, numerator of the fraction of an inch, and denominator of the fraction of an inch separated by spaces. If there is no fraction, just enter the feet and inches. Example: Traverse North 30 East for 28 feet, 41/2 inches. Press **TRAV**. Key in `30` and press **A Z**. Press ↰ **HDIST**. You will be prompted for FEET INCH NUM (numerator) DEN (denominator). Key in `28` **SPC** `4` **SPC** `1` **SPC** 2 and press **ENTER** The distance will be converted to a decimal value and displayed as `DIS: 28.3750`. ✎ *The numerator and denominator are optional. For example, if you only have 28 feet and 6 inches, you may enter 28* **SPC** *6 and press* **HDIST**. *This will be converted to 28.5 feet.*
SDIST	Press this key to enter a Slope Distance. Key in the desired value before pressing the soft key. To use the last Slope Distance, press **SDIST** before entering a value; the last value used will be shown on the command line. Press **ENTER** to save the value as the current Slope Distance.
Z ∠	Press this key to enter a Zenith Angle. Key in the desired value before pressing the soft key. ✎ *A Zenith Angle is an angle where straight up is zero, and horizontal (level) is 90 degrees or 270 degrees.* To use the last Zenith Angle, press **Z ∠** before entering a value; the last value used will be shown on the command line. Press **ENTER** to save the value as the current Zenith Angle.
V ∠	Press this key to enter a vertical angle. Key in the desired value before pressing the soft key. A vertical angle is an angle where the horizontal (level) is zero. Pointing down below level is negative and above level is positive. To use the last vertical angle, press **V ∠** before entering a value; the last value used will be shown on the command line. Press **ENTER** to save the value as the current vertical angle.
IC@PI	Insert Curve at Point of Intersection: **IC@PI** assumes that the occupied point is on a Point of Intersection (PI) of a curve. The backsight is assumed to be back along the tangent toward the Point of Curvature (PC). The angle entered in the previous side shot or Traverse menu is assumed to be on the tangent toward the Point of Tangency (PT). When **IC@PI** is pressed, the delta is calculated based on these assumptions and a new menu is shown to allow the entry of one more attribute of the curve. After entering that value, the Side Shot Distance menu is restored to allow the entry of the distance of the side shot. When the distance is entered, the following points are calculated and stored in the order shown: PC, Radius Point, PT, and Side Shot. This routine is usually used in the Traverse menu to traverse from PI to PI and store the curve points as the traverse progresses. See *Insert Curve at Point of Intersection While Traversing* on page 283 for additional information.

Sort Stakeout Points

KEY: STAK

PRODUCT: ACE+

KEYSTROKES: RPTS NXT NXT STAK

The STAK function searches the Random Points file for points within a given distance from the occupied point. The resulting Random Points file can be sorted by distance or direction(angle). See *STAK* on page 99 for additional information.

South-East Bearing

KEY: S-E

PRODUCT: SCE+

KEYSTROKES: ↱ S-E (the 2 key)

This function converts southeast bearing to azimuth format.

Procedure

Key in the bearing and press ↱ and the S-E key. The display will show the value in azimuth format.

(If an azimuth is entered in the southeast quadrant, ↱ S-E converts it to a bearing.)

South-West Bearing

KEY: S-W

PRODUCT: SCE+

KEYSTROKES: ↱ S-W (the 3 key)

This function key converts southwest bearing to azimuth format.

Procedure

Key in the bearing and press ↱ S-W . The display will show the value in azimuth format.

(If an azimuth is entered in the southwest quadrant, pressing ↱ and the S-W key converts it to a bearing.)

Spiral Curve

See *Construction Five* on page 265.

Stake

KEY: STAKE

PRODUCT: SCE+

KEYSTROKES: STAKE (the Q key)

This menu key allows the user to stake a point, stake a line, stake a curve, get a cut or fill, store a cutsheet and use the instrument crosshairs to store an elevation at a point, in addition to several other functions.

Procedure

The soft key menu along the bottom of the display includes several stake functions. Press NXT to scroll the soft key menu.

If Elevations are off, here is the first soft key page:

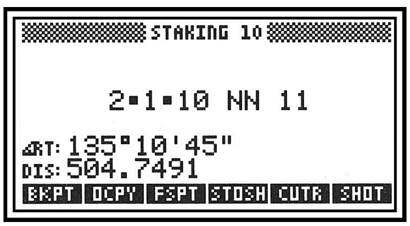


Figure A-99 Elevations Off

If Elevations are on, here is the first soft key page:

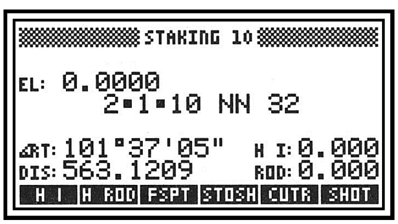


Figure A-100 Elevations On

Note that in the first case, you have BKPT and OCPY on the soft keys. If Elevations are on, you have H I and HROD on the soft keys.

If you have Elevations on, and you want to occupy a point or backsight a point: Go to SETUP or press ↰ NXT.

BKPT is used to enter a backsight point. Key in the backsight point number and press BKPT.

OCPY is used to occupy a point. Key in the occupied point number and press OCPY.

H I is used to enter the height of the instrument. Key in the distance from the point under the instrument to the axis of the instrument and press H I. The ***SMI*** software adds the elevation of the occupied point to the HI value to get the total elevation of the instrument.

HROD is used to enter the height of the rod. Measure the distance from the bottom of the rod to the center of the prism. Key this value into the data collector and press HROD.

✎ *The* BKPT OCPY H I *and* HROD *keys in the* SETUP *menu can be used as well.*

Trigonometric Leveling

There are times when it is very acceptable, and a great time saver, to leave the HI and HROD both set to zero and still do very accurate trig leveling. Other times, the rod should be measured and entered into ***SMI*** as HROD. Still other times, both the HI and HROD should be measured and entered. The following discussion might help you decide your policies regarding measuring and setting these values using ***SMI***. If you can avoid measuring and entering the HI and H ROD, it may be a big time saver. The elevations may be even more accurate than when you measure up.

When it is OK to Use HI and HROD Set to Zero

1. **When using a prism on a rod to shoot a benchmark using the same rod to take readings to other points, whether staking or collecting, the elevation will be transferred from the benchmark to these other points.**

   Principles:

   A. **The rod height should not be changed without changing the HROD in *SMI*.**

✎ *In this case, if you raise the rod 2.5 feet, you should set the HROD to 2.5. If you lower the rod 1.5 feet, you should enter a negative 1.5 in the HROD.*

   B. **The elevation under the instrument will not be correct. Therefore, when you shoot a benchmark, do not store the elevation. The occupied point position will display** COOR **instead of the point number. The instrument will still be occupying the correct north and east coordinates and the elevation will be a "reference elevation" similar to the HI elevation of a level. Note that when using a level, you are never concerned with the elevation of the point under the level.**

2. **When you set the rod height the same as the instrument height, you can leave the HI and HROD set to zero and the elevation under the instrument will be correct.**

When the Rod Should be Measured and Entered

1. **When using a prism on a rod to shoot a benchmark using the same rod to take readings to other points, and when the rod reading is going to be changing frequently, it is desirable to enter a rod reading before the benchmark is shot. When the HROD is changed, that change should be represented by a HROD value.**
2. **When you will be using the horizontal crosshair to store remote points without a prism.**
3. **When using Separate Distance and Angle (SDA) to determine remote elevations without a prism.**
4. **When using STOEL in the Stake menu to store unknown elevations with known coordinates.**

When the HI and HROD Should Both be Measured and Entered

1. **When there is a known elevation stored with the point under the instrument and you will not be bringing an elevation to the instrument using benchmark or *SMI's* Free Station program.**
2. **When using Mean Reverse Reciprocals where you compute the elevation from both ends of the line. This requires using the elevation under the instrument.**
3. **When using tripods and tribrachs for holding prisms for foresight points.**
4. **When checking the elevation of the instrument position.**

Remote Elevation

Press **STOEL** to use Stake to turn to a point of known north and east coordinates. Set the horizontal crosshair on the desired elevation and press **STOEL**. The elevation at the crosshair is stored with the coordinates at that point number. This function is useful when the north and east coordinates of a point are known or can be calculated, but the elevation is unknown and inaccessible.

See *Conditions Necessary to Use the STOEL Function* on page 106 for additional information.

Placing Points in the Random Points File (RPTS) for Staking

If you would like to pre-specify the points you would like to stake, you may place them in the Random Points file and when you occupy a point and backsight a point, go to stake and simply press ↱ **FSPT**. To back up to a previous point, press ↰ **FSPT**.

Stake all Points Within a Certain Distance of the Occupied Point

1. **Press RPTS. Key in the point numbers you wish to search.**

   Example: 201.300 would let you search all points from 201 to 300 inclusive.

2. **Press ENTER NXT NXT and STAK.**

   You will be prompted for the maximum distance you wish to stake points from the occupied point.

3. **Key in a distance and press ENTER.**
4. **Choose whether you wish to sort by distance or by angle.**
5. **To check the numbers that were found to be within that range, press RPTS.**
6. **Delete any points you do not wish to stake and press ENTER.**
7. **To stake these points, press STAKE and use ↱ FSPT.**

Staking a Point

If you press **FSPT** with a point number on the stack or command line, the screen will show the inverse from the occupied point to the point given. When **SHOT** is pressed, the instrument will measure the distance or you will be prompted for the shot information. The screen will show the Go/Come Left/Right information.

Staking to a Line

(ACE+): If you type in two point numbers before pressing **FSPT**, the Stake to a Line (**STKL**) menu is started. See *Stake to a Line* on page 360 for more details.

Staking to a Curve

(ACE+): If you type in three point numbers before pressing **FSPT**, the Stake to a Curve (**STKC**) menu is started. See *Stake to a Curve* on page 359 for more details.

Stake Menu Page 1 Soft Keys

Option	Function
H I	Press this key to store the height of the instrument.
HROD	Press this key to store the height of the rod.
FSPT	Foresight point is used to enter a point number for staking a point. Also used to enter two points to stake a line, or three points (PC, RP, PT) can be entered for staking a curve. **FSPT** will stake the next point in the Random Points file. **FSPT** will stake the previous point in the Random Points file.
STOSH	Press this key to store the last shot to a point number. Press **STOSH** to store the point being staked.
CUTR	Press this key to store the difference between the foresight point and the shot in the raw data file. This will also store a “PT”, “LINE”, or “CURVE” label in the raw data with the points used to define a point, line, or curve. The “DERR” value in the raw data shows how far the shot was from the point, line, or curve.
SHOT	Press this key to bring in a distance from the instrument to get Go/Come, Right/Left, and cut/fill values. Press **SHOT** (Robotic only) to continuously update the measured distance. Press **SHOT** to switch to the Go/Come Left/Right screen without taking another shot.

Appendix A: Quick Reference of Menus and Functions

Stake Menu Page 2

Figure A-101 Stake Menu Page 2

Stake Menu Page 2 Soft Keys

Option	Function
HDIST	Press this key to enter a horizontal distance and a change in elevation to get Go/Come and cut/fill values.
SDIST	Press this key to enter a Slope Distance and Zenith Angle to get go/come and cut/fill values.
FSEL	Press this key to enter the desired (grade) elevation for a foresight point and get a cut or fill based upon the shot elevation.
ZERO	(DCE+): Press this key to zero the instrument from the data collector. In SCE and ACE versions, it is necessary to manually zero the instrument. ZERO (Robotic Only): Press these keys to turn the instrument to the backsight and rezero the instrument after displaying and storing in the raw data the circle reading
NXPT	Next Point: Press this key to change the foresight point and display the Go/Come, Left/Right values to get from the last shot to the new foresight point. The new foresight point is found in one of three different ways: ➥ If no points are on the stack, it searches the Random Points file for the closest point to the last shot. ➥ If one point number is on the stack, it becomes the new foresight point. ➥ If two point numbers are on the stack, it searches that range of points, including the two point numbers, for the closest point to the last shot.
STOEL	Store Remote Elevations: Press this key to use Stake to turn to a point of known north and east coordinates. Set the horizontal crosshair on the desired elevation and press STOEL. The elevation at the crosshair is stored with the coordinates at that point number. This function is useful when the north and east coordinates of a point are known or can be calculated, but the elevation is unknown and inaccessible. See *Conditions Necessary to Use the STOEL Function* on page 106. Note that to have the elevation stored correctly: ➥ Elevations must be on. ➥ The HROD must be measured and entered; use 0 if not using a rod. ➥ You must bring an elevation to the instrument using Benchmark or Free Station. If you are occupying a point of known elevation and not shooting a benchmark or free stationing from a point or points of known elevation, you must measure up and enter the H I (height of instrument from the point under the instrument to the axis of the instrument).

Stake Menu Page 3 Soft Keys

Stake Menu Page 3 Soft Keys

Option	Function
LINE	This function replaces the Stake Offset function in ***Version 5***. Line Stakeout allows you to stake a line by station and offset. See *Line Stakeout* on page 308.

Stake Menu Page 3 Soft Keys

Option	Function
CURVE	This function is used for stakeouts of curves and offsets of curves by deflection angle. See *Curve Stakeout – (Horizontal Curve Stakeout)* on page 279.
STKL	This is another way to enter the Stake to a Line program. It is the same as pressing STAKE, keying in two stored points separated by a space, and pressing FSPT. See *Stake to a Line* on page 360.
STKC	This is another way to enter the Stake to a Curve program. It is the same as pressing STAKE, keying in the PC, Radius Point and PT separated by spaces, and pressing FSPT. See *Stake to a Curve* (below).
BKPT	Press this key to create a back azimuth, based on the inverse between the current occupied point and the backsight point entered. Pressing BKPT prompts for a backsight point number, takes a reading on the back point, and gives data as though you were staking the point. The purpose is to make sure this is the right backsight point. If the instrument is turned on, it will take a reading on the prism on the backsight point and display the discrepancy, if any. This will automatically be stored to the raw data file, even if raw data is turned off.
OCPY	Press this key to occupy a point in the current job. Enter the desired point number and press the soft key to occupy that point, or press the soft key first, and you will be prompted for a point number

Stake to a Curve

KEY: STKC

PRODUCT: ACE+

KEYSTROKES: STAKE STKC or STAKE FSPT

✎ *Depending on the program you are running, you may have to press the* NXT *key once or twice to find the* STKC *key.*

This function allows you to take shots and find out how close you are to a curve. It also interpolates the elevation along the curve between the PC and PT points to create a grade elevation at any station.

Procedure

STKC prompts for the PC, RP, and PT. Enter the point numbers separated by spaces and press ENTER.

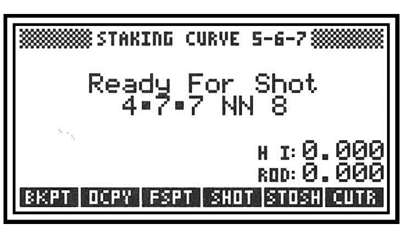


Figure A-102 Entering the Point Numbers

You are now ready to take a shot near the curve.

Once you press SHOT and the measurement is taken, you will get a screen display similar to this:

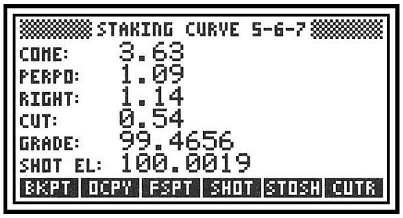


Figure A-103 Stake to a Curve Measurement

This screen indicates the curve you are staking is defined by points 5, 6, and 7. The first shot is 1.09 feet away from the curve (PERPO).

To stake the curve, the rodman can move toward the instrument 3.63 feet or move 1.14 feet to his right. The grade is the elevation on the curve perpendicular to the shot. The rodman should measure over 1.14 feet to his right as he faces the instrument and the instrument man should take another reading.

The keys in the Stake to a Curve menu work just like the keys in the main Stake menu (STAKE). See *Stake* on page 354 for more information about these soft keys.

Stake to a Line

KEY: STKL

PRODUCT: ACE+

KEYSTROKES: STAKE STKL **or** STAKE FSPT Depending on the program you are running, you may have to press the NXT key once or twice to find the STKC key.

This function allows you to take shots and find out how close you are to a line. It also interpolates the elevation between the points to create a grade elevation at any station.

Procedure

STKL prompts for the beginning point and ending point on a line. Key in the beginning point, press SPC , key in the ending point, and press ENTER . Put the rod at a point near the line specified and press SHOT .

Following is an example where we have pressed STKL , keyed in 1 SPC 2 and pressed ENTER , pointed the prism, and pressed SHOT .

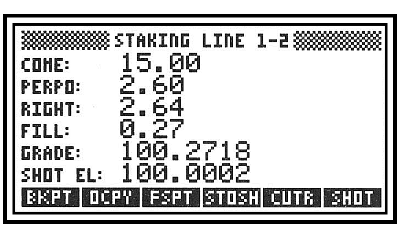


Figure A-104 Staking Line 1 - 2

This screen indicates that the line we are staking is defined by points 1 and 2. The first shot is 2.6 feet away from the line (PERPO). To stake the line, the rodman can move toward the instrument 15 feet or move 2.64 to his right.

The grade is the elevation on the line perpendicular to the shot. The rodman should measure over 2.64 feet to his right as he faces the instrument and the instrument man should take another reading.

The keys in the Stake to a Line menu work just like the keys in the main Stake Menu (STAKE). See *Stake* on page 354 for more information about these soft keys.

Store Coordinates (Enter and Assign)

KEY: S C

PRODUCT: SCE+

KEYSTROKES: S C (the J key)

This menu key lets you enter points using coordinates and data for existing points.

Procedure

The Store Coordinates screen displays data for the last point stored.

The soft key menu allows you to modify point data, and includes these options:

Store Coordinates Menu Soft Keys

Option	Function
N	Press this key to enter a new north coordinate. Key in the value and press N, or press the soft key first; you will be prompted for the north value. Key in the number and press ENTER.
E	Press this key to enter a new east coordinate. Key in the value and press E, or press the soft key first; you will be prompted for the east value. Key in the number and press ENTER.
E L	(SCE+): Press this key to enter a new elevation. Key in the value and press E L, or press the soft key first; you will be prompted for the elevation. Key in the value and press ENTER.
NOTE	(ACE+): Press NOTE; you will be prompted to enter a description. Key in the note (up to 128 characters; alpha will be automatically turned on). When you are finished, press ENTER.
STORE	Store the north and east coordinates, elevation, and note as a new point; the point will automatically be stored as the next number indicated on the display.
RCLPT	Press this key to recall a point number (see *Recalling a Point for Editing* below and *Recalling a Point for Viewing* on page 362).

Defining the Point Number for Storing the Coordinates

To store the data at a specific point, key in the point number first, then press STORE. If that point already exists, you will be asked whether you want to overwrite the existing point. Press ENTER to confirm or ON to cancel.

Recalling a Point for Editing

RCLPT function: Recall the data for an existing point. Key in the point number and press RCLPT (or press the soft key first, and you will be prompted to enter the point number; then press ENTER). The values for that point will be displayed. You are now ready to edit the coordinate and description, then store at the same point or at any other point number.

Recalling a Point for Viewing

If you want to view a large number of points, use the PNTS soft key in the VIEW menu (see *View* on page 377). Now press NEXT or PREV to view additional points or RCL to view specific points.

Sunshot

KEY: SUN

PRODUCT: SCE+

KEYSTROKES: SUN (the Y key)

This function key lets you find Astronomic North or Grid North from the sun.

Procedure

The Sunshot menu presents soft keys that help you define the sunshot; press NXT to scroll the menu screens.

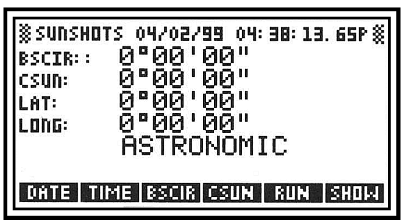


Figure A-105 Sunshot Menu 1

Sunshot Menu 1 Soft Keys

Option	Function
DATE	Press this key to enter the current (or desired) date. The format is MM.DDYYYY (for example, October 23, 1997 would be entered as 10.231997). If a date is not entered on the stack when the key is pressed, the program will use the current date in the calculator (the data collector has a running clock to maintain date and time – see *Date/Time* on page 286).
TIME	Press this key to enter time of day (military time, or a 24-hour clock, is used). The format is HH.MMSS (for example, 2:32:15 P.M. would be entered as 14.3215). If a time is not entered on the stack when the key is pressed, the program will use the exact time (as maintained by the calculator) when the key is pressed.
BSCIR	Press this key to enter the backsight circle reading.
CSUN	Press this key to enter the circle (Horizontal Angle) to the sun.
RUN REP	Press this key to perform the calculation using the values already stored. If one or more sunshots have already been made, REP appears as the soft key instead of RUN. The resulting average circle to the sun is put on the stack.
TCR	Press this key to record the current time (TIME), the current circle to the sun (CSUN), and perform the calculations (RUN) all in one step.

About Time

The Sun program expects Greenwich Mean Time.

- For Eastern Standard Time, add five hours to the local time. (For Daylight Savings Time, add four hours).
- For Central Time, add six hours.
- For Mountain Time, add seven hours.
- For Pacific Time, add eight hours.

The easiest method is to listen to WWV (broadcast from Hawaii and Colorado) and get the current Greenwich Mean Time. It is desirable that the time be accurate to 1/10 of a second. Being off 1 second could affect azimuth accuracy by 7 seconds.

For more accurate time, it is desirable to factor double ticks. A double tick represents 1/10 of a second needed.

For example, if you get 2 immediate double ticks after the time, add 2/10 of a second to the time stated. For 3 double ticks, 9 seconds after the time, subtract 3/10 of a second from the time stated.

Sunshot Menu 2

Sunshot Menu 2 Soft Keys

Option	Function
LAT	Press this key to enter the latitude of the point of observation.
LONG	Press this key to enter the longitude of the point of observation. ✎ *Sufficient accuracy should be achieved if you scale the latitude and longitude from a USGS quadrangle map. The accuracy should be +/- 300 feet.*
TRAIL CNTR LEAD	This is a toggle key used to select the trailing edge, the center of the sun, or leading edge for pointing. LEAD is for use in the southern hemisphere. The default is set to TRAIL.
C. L.	Press this key to enter the longitude constant.
Z. C.	Press this key to enter the zone constant.
SHOW	Press this key to see the average circle reading to the sun, calculated from the sunshots made since REP was pressed.

Both the longitudinal constant and zone constant should be zero for computing Astronomic North. Refer to *State Plane Grid Constants*, which begins on page 405, for entering longitude and zone constants for your area. When these constants are entered, the Sunshots program will automatically give you State Plane Grid North, rather than Astronomic North.

Built-in Ephemeris

This Sunshots program has a built-in ephemeris accurate to normally within +/- 10 arc seconds. However, under worst-case conditions, assuming the user does everything perfectly, it is possible to be off by 42 arc seconds. With careful observations, you should get a consistency of readings within approximately 2-4 arc seconds.

Large Traverses

For large traverses, a desirable way to control direction would be to take a sunshot at each fifth traverse point. While the errors in the sunshot can be up to 42 seconds, if you take sunshots over a 1-5 day period, the variation in consistency should not exceed 1-3 arc seconds.

Using State Plane Grid North

When traversing east and west for 1 mile, the Astronomic North from the sun will converge approximately 1 minute. Therefore, when surveying large boundaries with great east/west movement, it is better to use State Plane Grid North requiring longitudinal constant and zone constant. Thus, North remains parallel throughout the survey.

Leveling is Important for High Accuracy

In taking sunshots, leveling of the instrument is critically important, especially as the sun gets higher in the sky. **More dependable readings can be taken when the sun is close to the horizon.**

Trailing Edge Readings

When taking a reading on the trailing edge, move the vertical cross-hair slightly into the sun and, at the instant the vertical cross-hair passes the trailing edge, press **TIME**. The rest of the data can be entered before or after Time, but all data must be entered (except the optional longitude constant and zone constants) before **RUN** is pressed.

Repeated Readings

For repeated readings, you only need to re-establish TIME and CSUN readings. Backsight Circle is optional.

If the instrument is flopped, the backsight circle should be reread, as well as time and circle to the sun.

If an electronic instrument has been chosen, backsight circle and CSUN angles will be brought in electronically.

For more information, see *Sunshots* on page 79.

The Importance of Accurate Time

How important is time accuracy to your calculations? If the time entered is 1 second off, the angle error may be as much as $\pm$ 7 seconds. (You can test this by entering your data at a certain time, then entering it again after adjusting your time by 1 second.)

The Best Time to Take Sunshots

The best time to take sunshots is early in the morning or late evening, when the sun is closer to the horizon. The worst time is when the sun is greater than 45° from horizontal.

Please also note that Earth's curvature and refraction do not seem to affect the accuracy of the angle. Therefore, a low angle is most desirable.

How to Avoid Sunshot Problems

If you take consecutive sunshots spaced a few minutes apart and your resulting angle tends to drift in a certain direction, this is an indication that the date, time, latitude, or longitude is incorrect. See *Sunshots* on page 79 for more information about sunshots.

For information on setting time for sunshots, see *Time* (below).

Swap

KEY: **X<>Y**

PRODUCT: SCE+

KEYSTROKES: [left-shift] **X<>Y** (the M key)

This function key lets you swap, or exchange, the last two items on the stack (level 1 and level 2).

Procedure

Make sure the items to be swapped appear in the first and second levels of the stack.

Press this function key, and their respective positions on the stack will be reversed.

Three-Corner Shot

KEY: **3 COR**

PRODUCT: DOT

KEYSTROKES: [right-shift] **3 COR** (the W key)

This function key is used when shooting three corners of a building.

Procedure

Shoot the three corners and press [right-shift] and the **3 COR** key. The missing corner is stored. The first point also is stored for auto plotting purposes.

Time

KEY: **TIME**

PRODUCT: all HP 48s

KEYSTROKES: [right-shift] 4

This function sets or changes the current time.

Procedure

If you are working with sunshots, it is of particular importance that your HP 48 be set to the correct time.

Setting or Changing the Current Time

To set or change the current time in your HP 48:

1. **Exit *SMI's* software by pressing [↰] QUIT and press [↱] 4.**

   (Underneath the ***SMI*** overlay, you will see that the 4 key also has TIME labeled above it.) This opens the Time menu window.

2. **Press the [▲] key to scroll the Time menu to "Set time, date..."**
3. **Press [OK] to accept the menu choice.**
4. **Press [▶] to highlight the desired time or date field.**
5. **Once the field is highlighted, key in the appropriate value (hour, minutes, seconds, etc.); the value will appear on the command line.**
6. **Press [ENTER] to accept it and place it in the field.**
7. **In the "time format" field (AM, PM, or 24-hour), press the [+/–] key to toggle between your choices.**
8. **Press [OK] when you are finished.**

   This enters the changes you have made and exits the Time menu.

9. **Go back into *SMI's* software by pressing [α] K [ENTER].**

How to Check the Current Time

For greatest accuracy in your measurements, you should set your time based on Greenwich Mean Time. This generally is broadcast from the Naval Observatory in Washington, DC.

You may call the US Naval Observatory's Master Clock for a recorded time announcement. Time is broadcast in Universal time and EST (adjust for your local time zone) and includes a beep every five seconds for accurate time synchronization.

Topo (Contouring)

KEY: [TOPO]

PRODUCT: ACE+

KEYSTROKES: [MORE] [TOPO]

This soft function key allows you to scale the distance to each contour line from a starting elevation point in the direction of another elevation point.

Procedure

After pressing the [TOPO] and then the [INTVL] soft key, the display will prompt you: INTERVAL?.

This defines the elevation intervals between the two points at which you want to see the distance to the interval. Key in the number of feet and press [ENTER].

(For example, if you want to see how often the elevation changes by 2 feet, type 2 and press [ENTER].)

The TOPO menu then lets you define the elevation points.

Topo Menu Soft Keys

Option	Function
PT1	Press this key to define the starting elevation point. The elevation should be stored with the point number and the elevation of point 1 should be lower than point 2.
PT2	Press this key to define the elevation of the second point. The elevation should be stored with the point number. The elevation of point 2 should be higher than point 1 and the difference in elevation should be larger than the interval.
INTVL	Press this key to define the interval or difference in elevation of the topo lines.
INC	Press this key to execute the function. As you press INC, the display will show the distance from point 1 to each topo interval and the elevation at that point.

Transfer Files from One Data Collector to Another

KEY: XFER

PRODUCT: SCE+

KEYSTROKES: JOB XFER

This function key allows you to transfer data via a cable from one data collector to another. The HP 48 can also use the infrared port to transfer data.

✔ ***You cannot transfer data directly between a V5 or earlier card with a V6 or newer card, as the data formats are incompatible. You must transfer the data to a PC, then to the other collector.***

Procedure

Both data collectors must be running SMI surveying software.

If you have an SMI Hard Case with each data collector and a PC cable for the hard case:

1. **Plug the PC cable to each hard case.**
2. **Press JOB XFER and RECV on the receiving data collector.**
3. **Press JOB XFER and SEND on the sending data collector.**

   The current job will be sent.

✔ ***Make sure that the transfer setting is set to WIRE on both collectors.***

If you do not have a cable that plugs into the HP 48's, you may use infrared:

1. **Line up the two calculators for infrared transfer by pointing the top of each HP 48 at the other.**
2. **Locate the raised arrow at the top of each calculator (above the "Hewlett Packard" identification). These arrows should line up with each other. The calculators may be almost touching or up to two or three feet apart. Normally, closer is better.**
3. **Press JOB XFER and RECV on the receiving HP 48.**

4. **Press JOB XFER and SEND on the sending HP 48.**

   The current job will be sent.

✔ ***Make sure that the transfer setting is set to IR on both collectors. Switch this setting back when finished.***

Sending data by cable is preferable because it is faster, uses less battery power, and data integrity is better.

Transfer Jobs to/from the PC

KEY: XFER

PRODUCT: SCE+

KEYSTROKES: JOB NEXT and PC SEND or RECV

This function allows you to transfer data from your data collector to an IBM-compatible PC (a serial cable is required).

Procedure

Requirements on the PC

You should have one of SMI's ***Transfer*** programs to communicate with SMI's data collector software. However, there are a few PC software manufacturers who can receive ***SMI*** files directly into their programs.

See the ***Transfer*** manual for information about transferring data to and from the PC.

Transformation (Translating, Rotating, Scaling, and Changing the Elevation)

KEY: CX

PRODUCT: SCE+

KEYSTROKES: RPTS, then CX. To see the CX key, a Random Points file must be entered after pressing the RPTS key.

This soft function key allows you to perform a transformation.

Procedure

Press RPTS. Key in the point numbers you wish to transform and press ENTER and CX. Define the changes to be made to the points and press the RUN key.

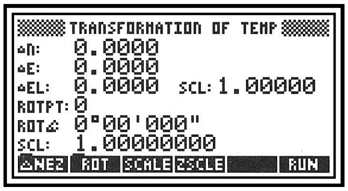


Figure A-106 Transformation of Point Numbers

Transformation Menu Soft Keys

Option	*Function*
△NEZ	Press this key to start the Translation submenu.
ROT	Press this key to start the Rotation submenu.
SCALE	Press this key to enter a scale factor and apply only to horizontal measurements. Scale factors greater than 1 increase the distance between points, while scale factors less than 1 decrease the distance between points.
ZSCLE	Set ***SMI*** up to scale the elevations of all the points in the RPTS file. This can be used to scale the elevations from feet to meters or meters to feet.
RUN	Press this key to perform the actual transformation based on the values displayed.

Translating

△NEZ should be pressed if you wish to translate coordinates.

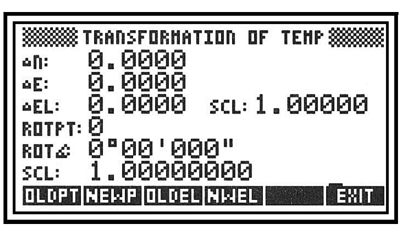


Figure A-107 Translating Coordinates

You can enter the old incorrect point (OLDPT) and the new correct point (NEWPT). This sets ***SMI's CX*** program to translate the coordinates of the Random Points file from the old point to the new point. OLDPT is also used as the rotation point. This is ignored if there is no rotation angle or is replaced if ROTPT is used in the ROT (Rotation) menu.

Old elevation (OLDEL) and new elevation (NEWEL) can be used to change the elevation of each of the points.

Press NXT to see another option. If you do not have the new coordinates stored by point number, use New North (NEWN) and New East (NEWE) to enter the north and east coordinates you wish to translate to. If NEWP is used, you do not need to use NEWN and NEWE.

When Elevations are On

If Elevations are on, and the elevations are stored in the old point (**OLDPT**) and new point (**NEWPT**), the elevation difference will be applied to the elevations of the random points. However, entering **OLDEL** and **NWEL** will override this value.

The difference between the old and new elevations will be applied to all the elevations of the points involved in the transformation.

✎ *If you have turned off Elevations in the Change menu, this soft key will be blank.*

Press **EXIT** to go to the main Transformation page.

Rotating

If you wish to rotate the points of the Random Points file, press **ROT**.

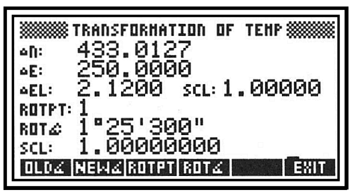


Figure A-108 Rotating the Points

Rotating Menu Soft Keys

Option	Function
OLD ∆	Press this key to enter the direction from which the rotation angle is turning. If two points are on the stack (in levels 1 and 2), the inverse between the points will be used. **OLD ∆** will be subtracted from **NEW∆** to get the rotation angle.
NEW∆	Press this key to enter the direction to which the rotation angle is turning. If two points are on the stack (in levels 1 and 2), the inverse between the points will be used. ✎ **OLD ∆** *and* **NEW∆** *values can be entered as azimuths, or as two points (separated by a space) to define direction. If you have a bearing (e.g., S 23° E), you can convert this angle to an azimuth. For a bearing of S 23° E, key in 23 and press* ↱ *2 (to indicate Southeast direction).* ✎ *The **SMI** program will automatically convert the SE bearing to the correct azimuth value; this can then be used to indicate direction.*
ROTPT	Press this key to enter the point around which the other points in the Random Points file will be rotated. This point number is also set by **OLDPT** in the Translation (**∆NEZ**) menu.
ROT ∆	Press this key to enter the rotation angle. If **OLD ∆** and **NEW∆** are used, it is not necessary to use this key.

Scaling

If you wish to enter a scale factor, key in the scale factor and press **SCALE**.

Traverse

KEY: TRAV

PRODUCT: SCE+

KEYSTROKES: TRAV (the K key)

This function key allows you to electronically or manually traverse to a new point and occupy that point.

Procedure

The traverse soft keys work exactly as the side shot soft keys, with one exception: after the point has been stored, the new point is occupied and the backsight point and direction are updated. If you would like to see an example of traversing, please see *Inputting Points Manually* on page 43.

For a detailed explanation of the soft key menus and how to enter the data, see *Side Shot* on page 349.

Triangle Solutions

KEY: TRI

PRODUCT: SCE+

KEYSTROKES: MORE TRI

The Triangle Solutions menu shows soft key options for triangle solutions when sides or a combination of sides and angles are known.

Procedure

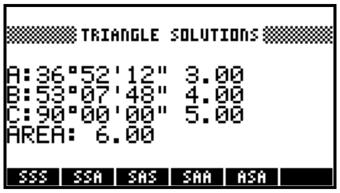


Figure A-109 Triangle Solutions Menu

Triangle Solutions Menu Soft Keys

Option	Function
SSS	Enter three sides.
SSA	Enter two sides and an opposite angle.
SAS	Enter two sides with an included angle.
SAA	Enter a side, opposite angle, and another angle.
ASA	Enter two angles and an included angle.
SOL1 SOL2	This key toggles between two different solutions when SSA is used. The key is blank for other types of solutions. Press NXT to see the second page of the Triangle Solutions menu.
AAA	Enter the area and two angles.

Press the soft key that corresponds to the known variables. The display will prompt you to enter those variables on the command line (remember to separate each with a space).

When your known variables are keyed in, press ENTER. The display will show the solution, as well as the area of the triangle.

SSA has two solutions. After using SSA, a toggle key labeled SOL1 appears as the last soft key. Press it to toggle to SOL2 and see the other solution.

TRIG (Trigonometric Leveling)

KEY: TRIG

PRODUCT: SCE+

KEYSTROKES: SETUP NXT NXT TRIG

SHORTCUT: ↱ TRIG (the 8 key)

This function takes a side shot on a point collecting north, east, and elevation values. TRIG takes a single Horizontal Angle and Slope Distance on a point, but unlike SIDS, TRIG requires a reverse reading on the point where the Zenith Angles are meaned, thus taking out the vertical circle error of the instrument, which gives a more accurate elevation.

In the comment record (CM), the Trig Leveling command (TRIG) reports angles if the raw data (↰ 2) is toggled on.

Procedure

The first shot should be done with the instrument in face 1 position (direct); the second shot assumes face 2 where the scope is in reversed position (flopped).

If you are using an electronic instrument, the measurement will be made automatically; otherwise, you will be prompted to enter the appropriate data: Slope Distance, Zenith Angle, and Angle Right (separate each value with a space).

Manual Entry

Once TRIG is pressed, enter the data for the face 1 data and press ENTER. REV will now appear in the soft key menu, indicating that you should take the second shot. Press REV, key in the Zenith Angle in face 2, and press ENTER. The Angle Right, mean Zenith Angle, and Slope Distance will be displayed along with the vertical circle error. To store the coordinates and meaned elevation as a side shot, press STORE.

Electronic Entry

If you are using an electronic instrument, the measurement will be performed automatically. The data collector will display an arrow symbol beside the angle error if the vertical angle tolerance is exceeded. The data will be displayed (average Zenith Angle and error). Press STORE from the soft key menu to store the point if you are satisfied with the results.

Turbo 48 Collectors

KEY: HALF

PRODUCT: DCER+

KEYSTROKES: SETUP NXT NXT INST

Purpose

Some radios used on robotic total stations require a baud rate of 19200 instead of the traditional rate of 9600 that is standard on the HP 48 calculator. The Turbo 48 calculator is fitted with speed doubling capability that allows it to exchange data at 19200. However, when you want to use your Turbo 48 collector with an instrument that requires a baud rate of 9600, you may choose the HALF option when configuring your instrument. This option is either ON or OFF.

Two-Corner Shot

KEY: 2

PRODUCT: DOT only

KEYSTROKES: ← 2 (the W key)

This function/menu key is used when shooting two corners of a building and measuring the third side.

Procedure

Shoot two corners of the building and press ← 2. You are prompted with a menu showing CLK (clockwise) and CCLK (counterclockwise). Select the key that indicates the direction for your shots.

You will then be prompted for the length of the last (missing) side. Key in the distance and press ENTER.

Three points will be stored: the two points not shot, and the first point you shot. By storing the first point shot, the PC can automatically plot the four sides of the building.

Units

KEY: UNITS

PRODUCT: SCE+

KEYSTROKES: → UNITS (the number 6 key)

This function provides access to the HP units application and menu.

Procedure

This HP units application contains a catalog of 147 units that you can combine with real numbers to create unit objects. This lets you convert, factor, and calculate between different units of measurement.

To convert from one unit to another, type the value to convert and press the soft key with the units of that value. The value will be tagged on the stack with those units. Press ← and the soft key with the new units. The new value will be shown on the stack with the new units.

Example

1. **Press → UNITS.**
2. **Press LENG.**
3. **Type `100` and press the M soft key.**

   You will see `100_m` on the stack.
4. **Press NXT NXT ← FTUS.**

   You will see `328.0833_ftUS` on the stack.

Version

KEY: **VER**

PRODUCT: SCE+

KEYSTROKES: [↰] V (the [√x] key)

To determine the version of your SMI program card, press [↰] V.

Vertical Curves

KEY: **VC**

PRODUCT: SCE+

KEYSTROKES: **MORE** **VC**

This function lets you access the Vertical Curve Equation menus; these use the equation solver programming built into the data collector.

Procedure

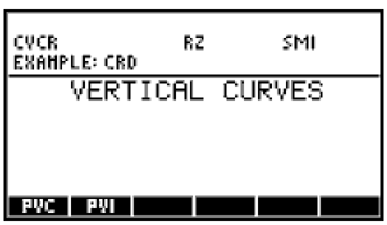


Figure A-110 Vertical Curves Screen

As you see from the display, you have two options: **PVC** and **PVI**.

PVC (Point of Vertical Curve)

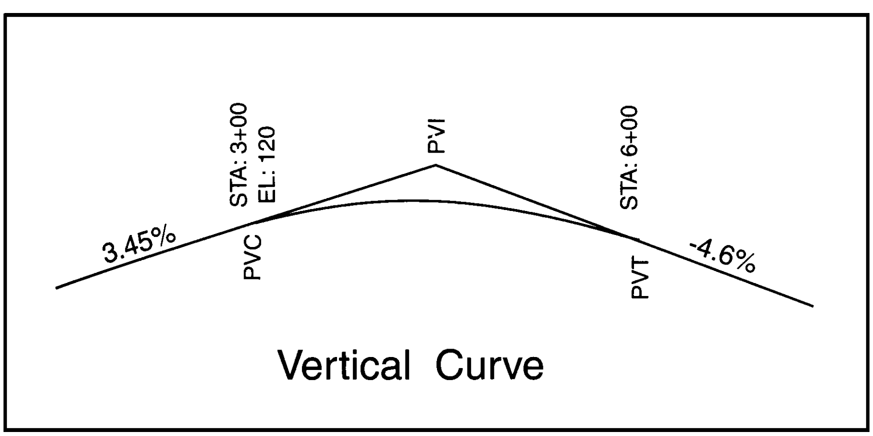


Figure A-111 Vertical Curve

Use the information in the illustration to find elevations at 50-foot increments.

1. **Press MORE VC and PVC.**
2. **Press ON to clear the display.**
3. **Key in `300` (the station number) and press ENTER.**
4. **Key in `120` (the PVC elevation) and press PVCEL.**
5. **Key in `3.45` and press % IN.**
6. **Key in `4.6`, press +/–, and press % OUT.**
7. **Key in `600` and press PVT.**

   You will see the first station interval (3+00) and the elevation at that station.
8. **Key in `50` (for a 50-foot interval) and press INC.**

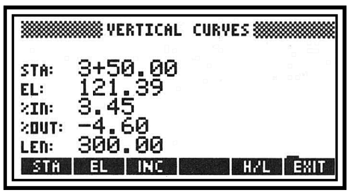


Figure A-112 Entering the Interval

9. **Press INC and *SMI* will increment to the next station.**

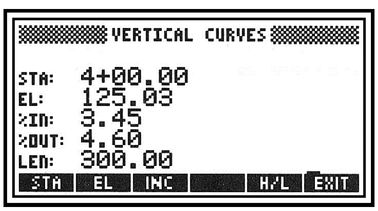


Figure A-113 Incrementing to the Next Station

10. **Continue pressing INC as needed until you get to the PVT.**

    You may enter any station along the vertical curve and get the elevation at that point. Or you may enter any elevation and get the station or stations for that elevation.
11. **To get the high or low point on the vertical curve, press the H/L soft key.**

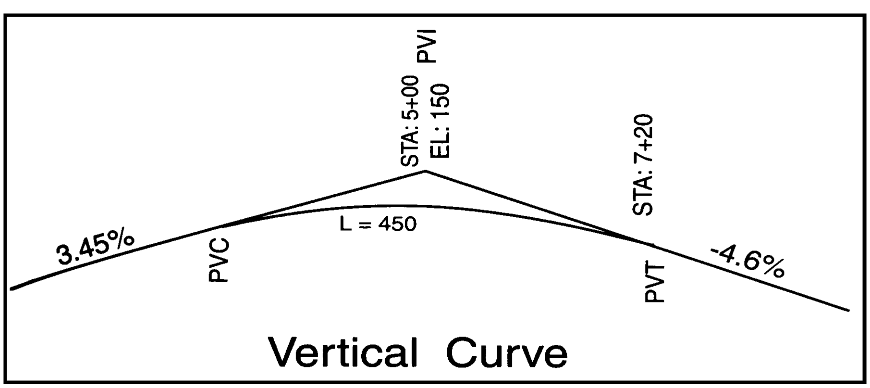


Figure A-114 Getting the High or Low Point on the Vertical Curve

PVI (Point of Vertical Intersection)

Use the data in Figure A-114 on page 376 to compute various elevations at 25-foot increments.

1. **Press** MORE VC and PVI.

   You will be prompted for the PVI.

2. **Press** ON **to clear the current display.**
3. **Key in** `500` **and press** ENTER.
4. **Key in** `150` **and press** PVIEL.
5. **Key in** `3.45` **and press** % IN.
6. **Key in** `4.6`**, press** +/– **and press** % OUT.
7. **Key in** `450` **and press** LEN.

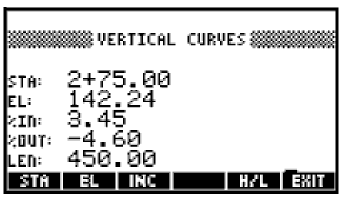


Figure A-115 Entering the Length

8. **To increment the stations 25 feet at a time, key in** `25` **and press** INC.

   Now each time INC is pressed, the station will be incremented 25 feet and the appropriate elevation will be displayed.

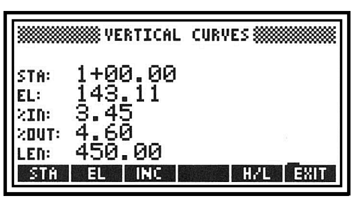


Figure A-116 Displaying the Elevation of a Point Along the Vertical Curve

You may now enter any station along the vertical curve and get the elevation at that point, or you may enter any elevation and get the station or stations for that elevation.

9. **To get the high or low point on the vertical curve, press** H/L.

View

KEY: VIEW

PRODUCT: SCE+

KEYSTROKES: VIEW (the V key)

This menu key lets you view points, area, the back azimuth, or raw data (DCE+).

Procedure

1. Press VIEW.

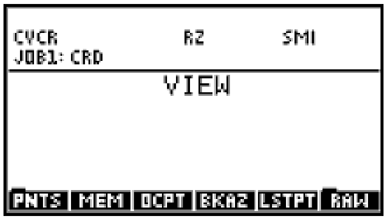


Figure A-117 View Menu

View Menu Soft Keys

Option	Function
PNTS	Press this key to show the View Points menu. If a point number is entered before pressing PNTS, that is the point that will be shown. See the screen shots to see how the menus are arranged.
MEM	Press this key to display available points as shown.
OCPT	Press this key to view the current occupied point information.
BKAZ	Press this key to view the current back azimuth.
LSTPT	Press this key to view the last point stored.
RAW	Press this key to view the current raw data file. The display will show the last raw data record and a soft key menu to select another record. NEXT lets you view the next raw data record. PREV lets you view the previous raw data record. RCL lets you jump to any raw data record number. DESC creates a description record of any length and inserts it after the last raw data record. TS stores a time and date (Time Stamp) after the last raw data record.

2. Key in the point number you wish to view and press PNTS.

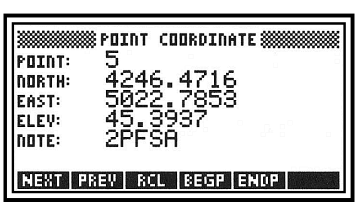


Figure A-118 View Points Menu

View Points Menu Soft Keys

Option	Function
NEXT	Press this key to increment to the next point number.
PREV	Press this key to decrement to the previous point number.
RCL	Press this key to recall any point number. Key in the point number and press RCL, or press RCL and you will be prompted for a point number.
BEGP	Press this key to show the values of the beginning point in the job.
ENDP	Press this key to show the values of the last point in the job.

3. Press VIEW again to get to the first soft key page of View.

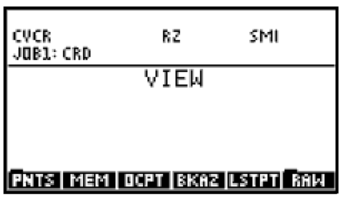


Figure A-119 View Menu Page 1 Soft Keys

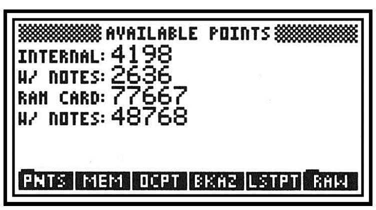


Figure A-120 Displaying Available Points

This shows the approximate number of points yet available in the internal memory of the data collector and in the RAM card.

Volume

KEY: VOL

PRODUCT: SCE+

KEYSTROKES: MORE VOL

This soft key allows you to use cross-sectional areas (in square feet or meters) and the distance between them (in feet or meters) to compute the volume in cubic yards or meters.

Procedure

To calculate in metric units, set Metric mode by pressing CHG NXT **MODE** **FEET** to toggle to **METR**.

AREA is used to enter the next end area and calculate the new volume.

DIST is used to enter the instance between the end areas. If the distance is the same as the last distance, it does not need to be entered again.

CLEAR is used to clear all values and start over.

Enter the first area using the **AREA** key, then the distance to the next end area using **DIST**. When the second end area is entered using **AREA** again, the volume is calculated and displayed. Continue entering end areas and the total volume displayed will accumulate each new volume. If the distance between the end areas changes, enter the distance using **DIST** before entering the next end area.

See the example in *XPlot* below for a more detailed explanation.

XPlot

KEY: **XPLOT**

PRODUCT: SCE+

KEYSTROKES: RPTS NXT **XPLOT**

This soft function key lets you perform a cross-section plot to calculate area and volume.

Procedure

This routine requires a valid Random Points file.

Example 1: Calculate the volume of a gravel pile.

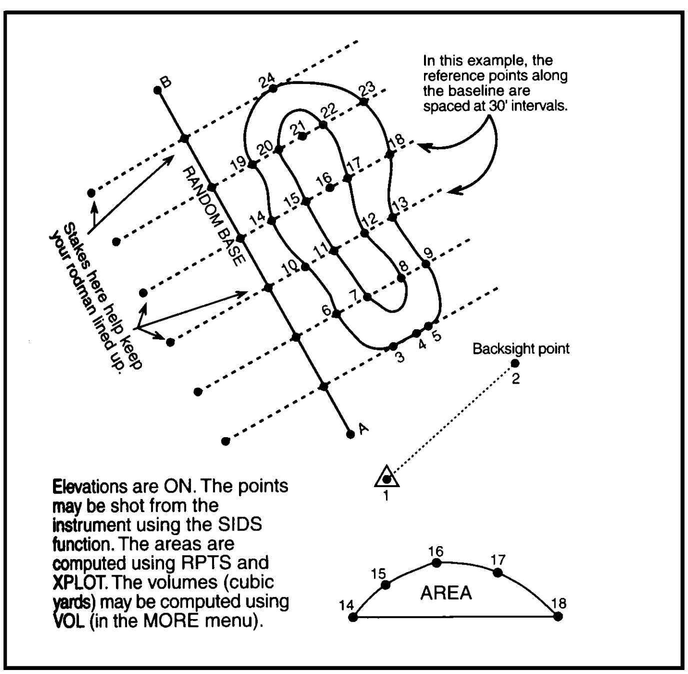


Figure A-121 Calculating the Volume of a Gravel Pile

In this example (a gravel pile), Elevations must be on.

1. **Position the instrument and occupy point 1, then shoot a backsight (point 2).**
2. **After establishing a base line, shoot points to define the perimeter and topography of the gravel pile you are measuring. To simplify your calculations, place reference stakes equally spaced along your base line and use them as reference markers to line up your shots. For this example, assume that the markers are spaced 30 feet apart.**

   After taking your shots (storing points 3-24 in the example), you need to calculate the area for each cross-section. In this example, refer to the cross-section defined by points 3-5 as "AA" – the cross-section defined by 6-9 will be called "BB" and so on.

3. **Press [RPTS].**
4. **Key in `3.5` (to define the cross-section of "AA") and press [ENTER].**
5. **Press [NXT] [XPLOT].**

   The program will calculate the area of the "AA" cross-section; write down the value displayed (you will need these values later to calculate volume).

6. **Repeat the process in step 4 for each cross-section (points 6-9: "BB"; points 10-13: "CC"; points 14-18: "DD"; points 19-23: "EE"; there is no area calculation for point 24.). Be sure to write down each area value calculated.**
7. **Now calculate volume of the gravel pile: press [MORE] [NXT] [NXT] [VOL].**
8. **Key in the area of "AA" and press [AREA].**
9. **Key in the distance between "AA" and "BB" (in this case, `30`) and press [DIST].**
10. **Key in the area of "BB" and press [AREA].**

    The program will display the volume (cubic yards) of the area between the two cross-sections. The distance between the end areas does not change, so you do not need to press [DIST] again.

11. **Key in the area of "CC" and press [AREA].**
12. **Key in the area of "DD" and press [AREA].**
13. **Key in the area of "EE" and press [AREA].**
14. **Key in the last area at point 24 of 0 and press [AREA].**

    The total volume now shows the volume of the gravel pile.

Example 2: Calculate the area of the barrow pit.

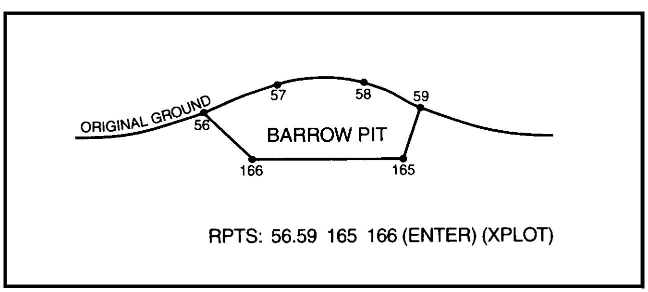


Figure A-122 Calculating the Area of a Barrow Pit

1. **In your design grade, store coordinates and elevation of points 165 and 166 so they are in the same cross-section station (the same plane) as points 56-59.**
2. **Press [RPTS].**

Appendix A: Quick Reference of Menus and Functions

3. **Enter the points (clockwise) by keying in:** `56.59 165 166` **and press** ENTER.

4. **Press** NXT XPLOT.

   The program will calculate and display the area of the cross-section you have defined.

✎ *To calculate volume, you will need several cross-section areas (and the distances between them) to adequately define the perimeter and depth of the pit; you can then compute the volume between each consecutive cross-section area to arrive at a total volume for the pit.*

Zero the Instrument

KEY: ZERO or ZERO

PRODUCT: DCE+

KEYSTROKES: ↱ ZERO (the 0 key)

This function key lets you zero the instrument from the data collector.

Procedure

Pressing this key sets the Horizontal Angle to the backsight to zero.

Instrument Configuration

Appendix

B

Use this appendix if you have an electronic total station and one of the following cards:

- Data Collection
- Construction Five

If you have a Robotic instrument, refer to *Robotic Instrument Drivers* on page 200. If you have a digital level, refer to *Level Notes* on page 305. If you have a GPS receiver, see *Drivers for GPS Receivers* on page 227.

In this appendix:

General

To select an instrument, use the soft key that corresponds to the particular model (see the Instruments in *Quick Reference of Menus and Functions*, which begins on page 241). The soft key installs the driver for the selected instrument. A driver is the software on the data collector that controls the instrument.

Some of the instrument drivers can measure a distance in Fine or Coarse mode. This is selected using the **CRS** / **FINE** key in the **INST** menu or **ROBOT** menu. Because of limitations of some instruments, some instrument functions may not be available. When an instrument function is not supported, usually you will see a message to do it manually or that it is not supported in the current driver.

It is important that the baud rate, parity, data bits and stop bits be set correctly on the instrument. In most cases, these settings are unchangeable on the data collector, so the instrument must be set to match the settings shown in this appendix. In the description of each driver, the communication settings will be shown as baud-parity-data bits-stop bits. For example 9600-None-8-1 indicates 9600 baud, no parity, 8 data bits and 1 stop bit.

If you suspect that the instrument cable may be bad, use the cable diagrams in this appendix and the instructions in *IO Loop-Back Test* on page 418 to test the Send and Receive wires of the cable.

Instrument drivers that are only available on the GPS/Robotic card are indicated with (GPS) or (Robotic). A detailed description of using the GPS/Robotic drivers is in *Robotic Functions*, which begins on page 195.

The instrument menu is found by pressing **SETUP** **NXT** **NXT** **INST** or ➦ **INST**.

The keys in the main menu are:

Instrument Main Menu Soft Keys

Option	Function
CRS FINE	Select Coarse or Fine distance measurement mode.
PRISM REFL	Select Prism or Reflectorless measurement mode. When in Reflectorless mode, the rod height is forced to zero.
LTOFF LTON	Turn the Guide light on or off. This is sometimes called a track light.
HALF HALF ■	This key toggles between cutting the baud rate in half and using the normal baud rate. One use is for instances when using a Turbo 48.
MAN 1	Select the Manual menu mode.
MAN 2	Select the Manual Shot Prompting mode.

Instrument Main Menu Soft Keys

Option	Function
MAN3	(GPS card only) Select the Manual Coordinates mode for simulating a GPS shot.
ZEISS	Select the Zeiss driver menu.
TOPCO	Select the Topcon driver menu.
NIKN	Select the Nikon driver.
LEICA	Select the Leica driver menu.
LIETZ	Select the Lietz driver menu.
GEO	Select the Geodimeter driver menu.
TRIM	Select the Trimble driver menu.
PENT	Select the Pentax driver menu.
GPS	Select a GPS receiver.
OTHER	Select the menu containing the rest of the drivers including Kern, HP3820, Laser Atlanta, Laser Technology Criterion, MDL, and LaserCraft.

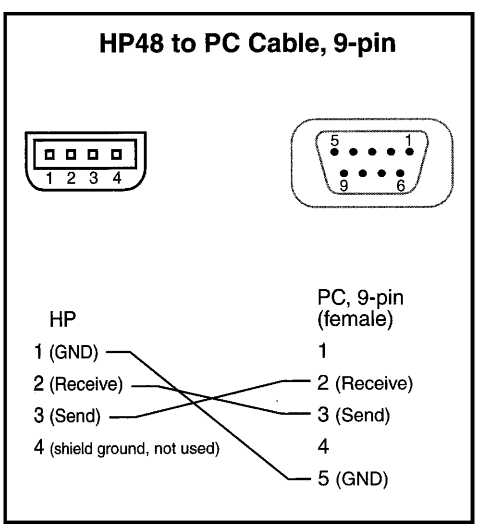


Figure B-1 HP 48 to PC Cable, 9-Pin

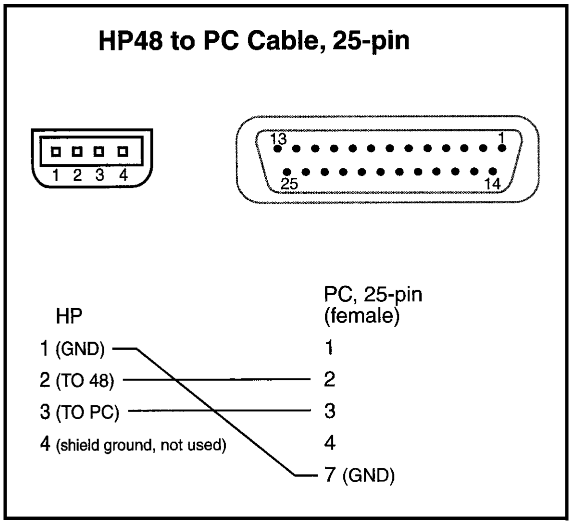


Figure B-2 HP 48 to PC Cable, 25-Pin

Geotronics (Geodimeter)

KEYSTROKES: INST NXT NXT GEO

Models supported:

Driver	*Models*	*Settings*
GEO	100 Series (140, 136, 142 total stations)	2400-None-8-1
GEO4	400 and 500, 610	Variable-None-8-1
G420	400, 420, 422, old style 440, 440LR, 620	Variable-None-8-1
RPU	For certain 600 series RPU models	Variable-Even-7-1
G600	(Robotic) Robotic capable 600 series	Variable-None-8-1

The Geodimeter drivers, except for the GEO driver, prompt for a baud rate. Usually, 4800 baud works the best on the GEO4 driver and 9600 baud on the other drivers.

The G420 driver has two additional options. It prompts for a delay time. This time is how long for the data collector to wait between asking the instrument to measure and asking the instrument for the results of the measurement.

The G420 driver also asks “USING TRACK/AIM KEY?”. When the YES button is pressed, the driver does not try to cause the instrument to measure. Instead, the user is expected to press the AIM key or to have the instrument in Track mode so that the distance is automatically sent by the instrument. The delay time is not used when this option is on.

Setup of Instrument

Press the following keys:

1. **MNU** **4** **1** **(select device)** **2** **(Serial)** **YES** `1.8.0.4800` **ENT**. **If using a baud rate other than 4800, replace 4800 in this step with the correct baud rate.**
2. **If asked** "U.D.S.?" **answer** **NO**.
3. **Set the table number to 0 and press** **ENT**.
4. **If asked** "Request?" **answer** **YES**.
5. **If asked** "REG. key?" **answer** **NO**.
6. **If asked** "slave?" **answer** **NO**.

Comments

In addition to the standard cable, a Y cable also is available that connects the data collector and an external battery to the Geodimeter.

If the instrument has a servo motor, and the **GEO4** driver has been selected, the data collector will turn the instrument to the foresight point when FSPT is used. To turn this feature on and off, use the **F S** toggle key in the Servo menu (**ROBOT**).

The Geodimeter 422 works faster in Coarse mode (@ 10 seconds) than Fine mode (@ 20 seconds). You can switch between Coarse and Fine in the **INSTR** menu.

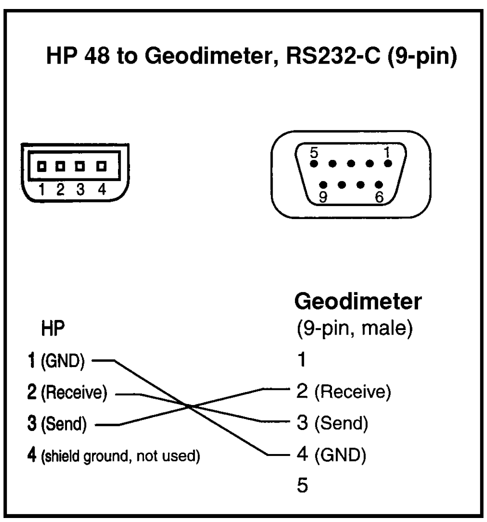


Figure B-3 HP 48 to Geodimeter, RS232-C (9-Pin)

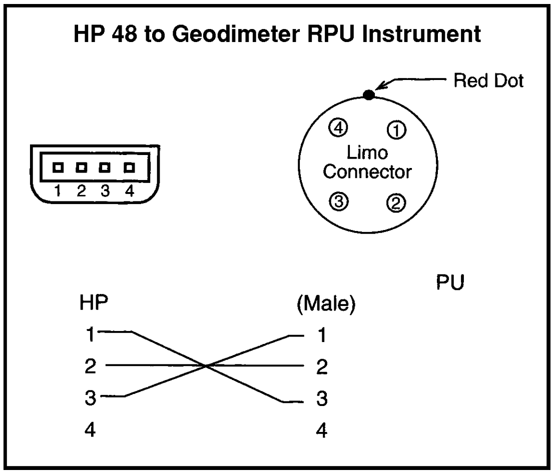


Figure B-4 HP 48 to Geodimeter RPU Instrument

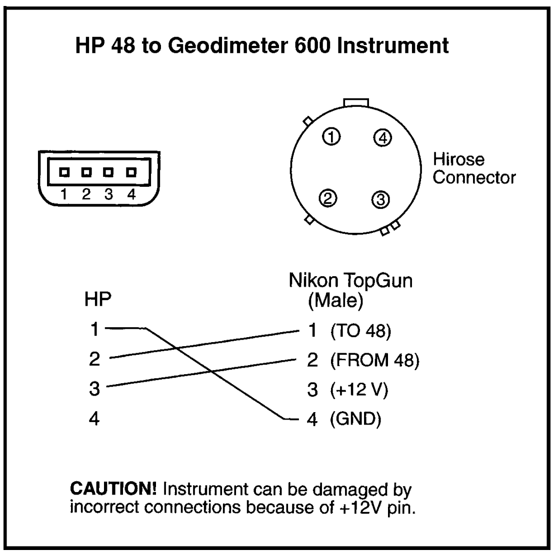


Figure B-5 HP 48 to Geodimeter 600 Instrument

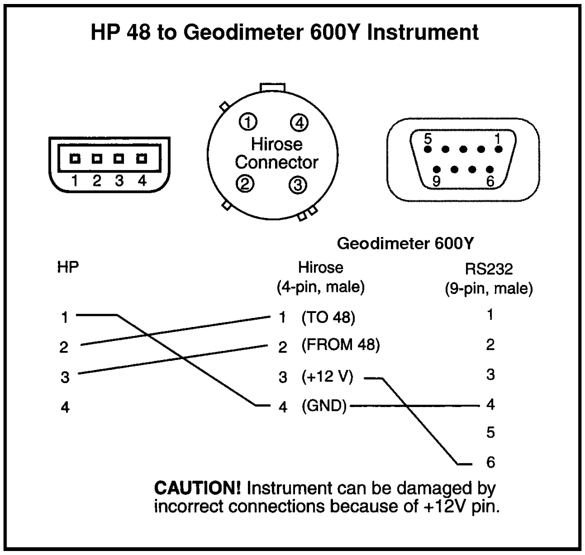


Figure B-6 HP 48 to Geodimeter 600Y Instrument

Hewlett Packard

KEYSTROKES: INST NXT NXT OTHER 3820

Models supported:

Driver	*Models*	*Settings*
3820	HP 3820 Total Station	9600-None-8-1

Setup of Instrument

Set baud rate and parity.

Comments

A special cable from Ingenuity is required for this instrument. When the data collector needs a measurement from the instrument, the user must press certain keys on the instrument. The data collector tells the user which keys to press. The MULTI key can be pressed when measuring a distance to lessen the number of keys pressed.

Kern

KEYSTROKES: ↱ INST NXT NXT OTHER KERN

Models supported:

Driver	Models	Settings
KERN	Any model that uses the Kern ASB system	1200-Even-7-1

Setup of Instrument

None required.

Laser Atlanta

KEYSTROKES: ↱ INST NXT NXT OTHER LASER

Models supported:

Driver	Models	Settings
LASER	ProSurvey 1000 Laser Rangefinder	4800-None-8-1

Setup of Instrument

None

Comments

After pressing the key to measure on the data collector, press the trigger on the Rangefinder to send the data to the data collector.

LaserCraft

KEYSTROKES: ➦ INST NXT NXT OTHER CRAFT

Models Supported

Supported LaserCraft Models

Driver	Models	Settings	Card	Version
CRAFT	XLR, XLRM, XLRi, or XLRic	19200-None-8-1	DCE+	6.04h/7.00o

Setup of Instrument

When you press SIDS on the ***SMI*** data collector, you are instructed to fire the laser and release the trigger. The instrument then sends the distance and angles to the data collector and the point is stored.

Comments

Directions sent from the laser are azimuths from an internal compass instead of an Angle Right from a backsight.

Laser Technologies

KEYSTROKES: ➦ INST NXT NXT OTHER CRIT

Models supported:

Driver	Models	Settings
CRIT	Criterion	4800-None-8-1

Setup of Instrument

None

Comments

After pressing the key to measure on the data collector, press the trigger on the Criterion to send the data to the data collector.

Leica (Wild)

KEYSTROKES: ➔ INST NXT LEICA

Models supported:

Driver	*Models*	*Settings*
WILD1	T1000, TC1000	2400-Even-7-1
WILD2	T1000, TC1000, T2000, TC2000, T1600	2400-Even-7-1
2002	T2002, TC1600	2400-Even-7-1
OLDTC	C800, Reflectorless	2400-Even-7-1
TC	T1010, T/TC1600 T/TC1610, TC1700, TC1800, 500's, TC605, TC600, TC800, TC805L	2400-Even-7-1
TCM	Motorized TCM's, TC1700	9600-None-8-1
TCA	(Robotic) TCA, TDM 5000's	9600-None-8-1

Setup of Instrument

Make sure baud rate and parity are set correctly.

Models listed under WILD1 WILD2 2002: Press SET REC 99 RUN REC. Set mode 78. Set mode 76 to 0 (GRE). Set mode 73 to 0 (CR). If using the WILD2 or 2002 driver, set mode 74 to 1 (T2000 Emulation mode). If using the WILD1 driver, set mode 74 to 0 (T1000 Emulation mode).

Comments

When a Wild driver is selected, the user is prompted for a delay time. Normally the 1.5 second default is sufficient. The user is also asked if the instrument should be left on. If the answer to this is no, whenever an instrument routine is used by the data collector, it will turn on the instrument, perform the function, and then turn off the instrument. The delay time is necessary to let the instrument initialize when it is first turned on. The delay time is also used in the angles part of the WILD2 and 2002 drivers.

The only difference between the WILD2 and the 2002 drivers is the Angles Only routine. If you are having trouble with the Angles Only routine (e.g., ZHA in the SDA menu), try the other driver.

All Wild/Leica instruments will turn on when a signal is received on the cable, even if the baud rate and parity are wrong. It is a good way to verify that the send wire of the cable works.

If the slope distances in the raw data file are slightly different than what is shown in the display of the instrument, you need to update the instruments firmware. Older versions of Leica's firmware do not apply the prism constant to Slope Distance when the data collector is in Coarse (CRS) mode. Get the latest version of firmware from your Leica dealer or do not set Coarse mode in the collector.

Some of the instruments listed under the **TC** driver work better at 9600 baud. To try using 9600 baud and no parity, select the **TCM** driver and then press **INST** and then **SETUP** to clear the motorized flag.

The TC(S) 500 and TC800 only work in Fine mode (**INST** menu **FINE** / **CRS**).

GSI Errors

The **OLDTC** **TC** **TCM** and **TCA** drivers will sometimes report a “GSI Error” followed by a warning or error code. This code comes from the Leica instrument to indicate a particular problem. The following is a list of error codes from Leica's documentation.

Message	*Cause*	*Action*
@E103	Invalid value	On data collector, press **Pause**
@E105	Wrong sequence	On data collector, press **Pause**
@E112	Battery low	Press F5
@E114	Invalid command	On data collector, press **Pause**
@E117	Initialization error	Call Leica service
@E119	Internal temperature	Warm/cool instrument
@E121	Parity error	Try again/check parity setting on instrument
@E122	Time out	On data collector, press **Pause**
@E124	Input buffer overflow	On data collector, press **Pause**
@E139	General EDM error	Check prism, battery, etc.
@E144	V or Hz collim. error	Check calibration data
@E145	V or Hz collim. error	Check calibration data
@E150	Angle error	Call Leica service
@E151	Compensator error	Level instrument/turn off compensator/call service
@E155	EDM intensity	Call Leica service
@E156	EDM system error	Call Leica service
@E158	Instrument not level	Press F5 in instrument
@E182	Telescope position	Angle too steep
@E190	Motorization error	Call Leica service
@E191	Data error	Check record mask, Point ID
@E194	General error	Call Leica service
@E197	Calibration data fault	Call Leica service
@W100	Instrument busy	On data collector, press **Pause**
@W101	External error	On data collector, press **Pause**
@W127	Unknown command	On data collector, press **Pause**
Input buffer overflow		On data collector, press **Pause**

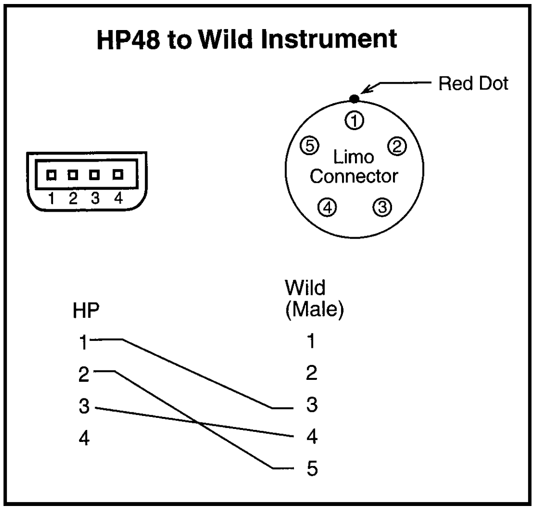


Figure B-7 HP 48 to Wild Instrument

MDL

KEYSTROKES: ↱ INST NXT NXT OTHER MDL

Models supported:

Driver	***Models***	***Settings***
MDL	Most	4800-None-8-1

Setup of Instrument

None

Comments

After pressing the key to measure on the data collector, press the trigger on the MDL to send the data to the data collector.

Nikon

KEYSTROKES: ➦ INST NXT NIKN

Models supported:

Driver	Models	Settings
NIKN	Topgun 100's, A series, C-100, D-50, DTM	4800-None-8-1
SET	DTM models set to emulate Lietz SET	1200-None-8-1

Setup of Instrument

A series - Turn on the main power while depressing the 2nd key. Tilt the scope once through the horizon. Press the 1 key until the selection option toggles to "NkRS" or "RS-232". Press the 0 key.

C-100 - Turn on the main power while depressing the RST key. Press the HOLD key until prompted for "DATA RECORDER". Press the S-H-V key until "NIKON" is selected. Press the HOLD key. Press the TRK key.

DTM 420 - Press FUNCTION 5 (Settings) 6 (System) 3 (Communication) Baud: 4800 Parity: None COM1. Use the NIKN driver on the collector.

Or, press FUNCTION 5 (Settings) 6 (Others) Baud: 4800 Data recorder: Nikon. Use the NIKN driver on the collector.

DTM 430 - Press FUNCTION 5 (Settings) 6 (Others) ENTER ENTER Baud: 4800 Parity NONE Data recorder: Nikon. Use the NIKN driver on the collector.

Or, press FUNCTION 5 (Settings) 6 (Others) ENTER ENTER Baud: 1200 Data recorder: SET. Use the SET driver on the collector.

DTM 520 - Press MENU 3 (Settings) 6 (Communication). Ext. Comm: NIKON. Baud: 4800. Length: 8. Parity NONE. Stop Bit 1.

DTM 720/750/830 - Press FUNCTION 3 (Simple Total Station). Set Baud Rate to 1200. Use the SET driver on the collector. Does not support Angles Only mode. Must have AP700, AP800 or TS application card. TDS application card does not support external data collectors.

Comments

The Nikon cable looks just like the Topcon and Lietz cables but is wired differently inside.

Problem

Setting instrument to use Vertical Angle instead of Zenith Angle results in an elevation difference showing up as the horizontal distance in the data collector.

Solution

Nikon should be set to use Zenith Angles, not Vertical Angles. Do this by pressing FUNCTION 5 (Settings) (angles) and the Up arrow to select 0.

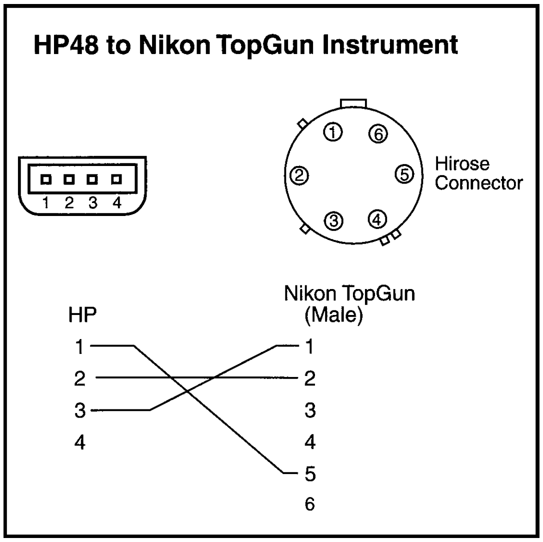


Figure B-8 HP 48 to Nikon TopGun Instrument

Pentax

KEYSTROKES: ↱ INST NXT NXT **PENT**

Models supported:

Driver	*Models*	*Settings*
PENT	PTS-III, 305, 310, PTS 10, PCS-1 some PCS-2's, 500 Series, PTS V5	1200-None-8-1
PNT2	Single shot PCS-2	1200-None-8-1
2WAY	Two-way PTS V3	1200-None-8-1

Does not support 205.

Setup of Instrument

The Pentax must be put in Measure mode by pressing the H/D/Z or AIM key.

PTS-III - There are three rows of dip switches on the side. The four dip switches farthest to the right on the bottom row control communications. They all should be set to the OFF position (push them downward).

ATS Setup - Turn on and plunge the scope. Hold down the S key and press F5 for "Remote." The serial port is now active. To cancel Remote mode, press F1 for "Quit."

PTS V5 - Set the baud rate in the Special Functions menu. To get into the Special Functions menu, hold down the double circle button while pressing the ON button.

Comments

If the PTS10 does not work, try changing the CRS / FINE toggle button.

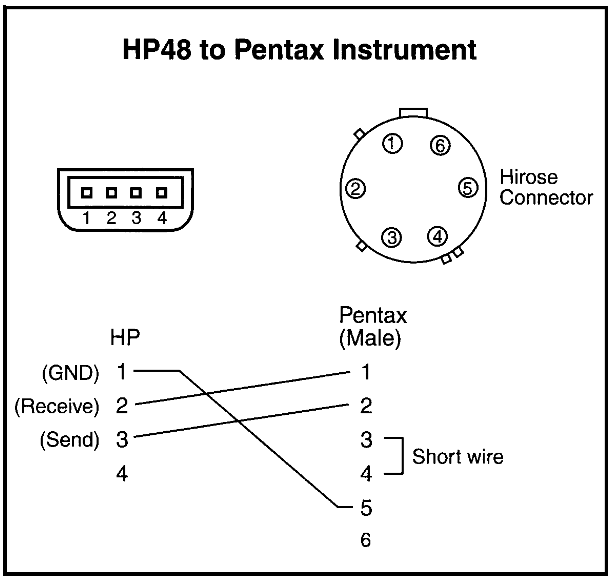


Figure B-9 HP 48 to Pentax Instrument

Sokkia/Lietz

KEYSTROKES: ↱ INST NXT LIETZ

Models supported:

Driver	*Models*	*Settings*
LIETZ	SET's: SET2, SET3, SET4, SET5, SET6, SET10	1200-None-8-1
SOKKI	SETsB: SET2B, SET3B, SET4B, SET5B	1200-None-8-1

Setup of Instrument

1. **Turn the instrument on, then pass the scope through the horizontal.**
2. **Press the [CE-CA] key.**
3. **Press** 1 **to enter the MENU mode.**
4. **Press** 2 **to select the "Config" display.**
5. **Press [+/−] until the "RS-232C format" parameter is displayed.**
6. **If the baud rate, parity, or Checksum are not set correctly, press [ENT] to change the settings.**
7. **Make sure that Checksum (CSUM) is turned off.**

When using the LIETZ driver, the instrument must be in Distance mode before taking a shot from the data collector. Press the measure button (CE-CA) on the instrument before pressing the key on the data collector.

SOKKI works with instruments using two-way communication; it does not require that you put the instrument in Distance-Measuring mode. The SOKKI driver automatically selects Fine or Coarse mode based on the CRS / FINE key in the INSTR menu.

LIETZ 4A - The yellow keys model has two-way communication.

SET10 - SOKKIA must be selected as the output format in the System menu.

Topcon

KEYSTROKES: ➦ INST NXT TOPCO

Models Supported

Driver	Models	Settings
GTS3	GTS 200's	1200-Even-7-1
GTS3	GTS3B, C; 300's	1200-Even-7-1
GTS4	GTS-4, GTS 400's	1200-Even-7-1
GTS5	GTS 500's	1200-Even-7-1
GTS6	GTS 600's	1200-Even-7-1
ET-1	ET-1	1200-Even-7-1
ET-2	ET-2	1200-Even-7-1
CTS-1	CTS-1. GTS3, ET-2	1200-Even-7-1
GMT1	GMT-100	1200-Even-7-1
800	(Robotic) GTS-800's	9600-None-8-1
APL1A	(Robotic) AP-L1A	9600-None-8-1
APL1	(Robotic) AP-L1	9600-None-8-1

Setup of Instrument

See your instrument's manual to set the baud rate and parity. If it cannot be changed, it is preset to ***SMI's*** settings.

Comments

The old-style GTS3B instrument uses a special cable built by Ingenuity that plugs into the battery port of the instrument. The only difference between the GTS3 and GTS4 drivers is the Angles Only routine.

Some Topcon instruments work better in GTS3, others in GTS4. If you get an error message using one driver, try the other.

The CTS-1 instrument must be manually put in Distance or Angles mode.

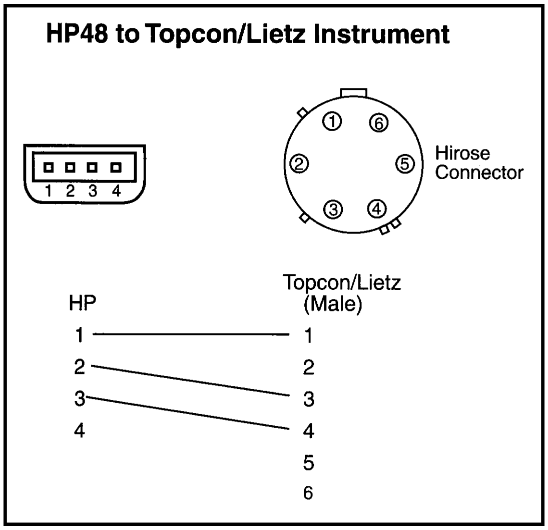


Figure B-10 HP 48 to Topcon/Lietz Instrument

Trimble

KEYSTROKES: ↱ INST NXT NXT TRIM

Models Supported

Supported Trimble Models

Driver	*Models*	*Settings*	*Card*	*Version*
TTS	Trimble 300 and 500 series	1200-None-8-1	DCE+	7.00s
3300	3300 series instrument	9600-None-8-1	DCE+	7.00s
3600	3600 series instrument	9600-None-8-1	DCE+	7.00s
5600	5600 series instrument	Variable-None-8-1	CVCR+	7.00s

Setup of the Trimble TTS 300 or 500 Series Instruments

Turn the instrument on, then pass the scope through the horizontal. Press the CE-CA key. Press 1 to enter the Menu mode. Press 2 to select the “Config” display. Press +/- until the “RS-232C format” parameter is displayed. If the baud rate, parity, or checksum are not set correctly, press ENT to change the settings. Make sure that Checksum (CSUM) is turned off.

Comments

When using the total station with ***SMI***, be sure the instrument is in Distance mode before attempting to record a shot with the ***SMI*** data collector. On the instrument, press the Measure button (CE-CA) on the instrument before pressing the key on the data collector.

Setup of the Trimble 3300

1. **Hold down the On button and press Menu.**
2. **Select "Setting Interface" from the menu and press YES.**
3. **Use the MOD key to match the following settings:**

Option	***Setting***
Leave Recording	OFF
Format	R4
Parity	NONE
Baud Rate	9600
Protocol	Xon/Xoff
Position C	11
Position P	16
Position I	1
T-O Rec On	NO
PC-DEMO	OFF

4. **Press ESC twice to get back to the angle display.**

Setup of the Trimble 3600

The Trimble 3600 can come with either a 600 CU faceplate (Geodimeter style) or an Elta faceplate (Zeiss style). When **3600** is pressed, you will be asked if you are using a 600 CU faceplate. Answer "no" if you have the Elta faceplate.

If your 3600 uses the Elta faceplate, simply plug the ***SMI*** data collector in and turn the instrument on. You are now ready to begin recording information. If you do not have ***SMI*** installed on board the Trimble 3600 instrument, please contact technical support for more information on getting the SMI software installed. The instrument may need to be shipped to have the program installed.

If using the 600 CU faceplate, it is like using the Geodimeter **G420** driver.

Setup of the Trimble 5600

Refer to *Geodimeter G600/Trimble 5600* on page 200.

Zeiss

KEYSTROKES: ➦ INST NXT **ZEISS**

Appendix B: Instrument Configuration

Models Supported

Driver	*Models*	*Settings*
ELT50	Rec Elta 50/55	9600-None-8-1
ELTAC	Elta C20/C30	9600-None-8-1
S20	(Robotic) Elta S20 direct connect	9600-None-8-1
S20R	(Robotic) Elta S20 radio (Requires Turbo 48)	19200-None-8-1
S20Q	(Robotic) S20, S10 using QL radios	9600-None-8-1
S20Q	(Robotic) Elta S20 Georadio QL	9600-None-8-1
Z46R	Z46R	1200-Odd-7-1
ELTA3	Rec Elta 3	1200-Odd-7-1
ELTA4	Rec Elta 4	1200-Odd-7-1
ELTRL	Rec Elta 15/RL	9600-None-8-1

Setup of the Zeiss ELTAC

Simply plug in the ***SMI*** data collector and turn on the instrument. You are now ready to begin recording information. If you do not have SMI installed on board the Elta C instrument, please contact technical support for more information on getting the SMI software installed. The instrument may need to be shipped to have the program installed.

Setup of Elta R50/R55

1. **Hold down the On button and press Menu.**
2. **Select “Setting Interface” from the menu and press YES.**
3. **Use the MOD key to match the following settings.**

Option	*Setting*
Leave Recording	OFF
Format	R4
Parity	NONE
Baud Rate	9600
Protocol	Xon/Xoff
Position C	11
Position P	16
Position I	1

Option	*Setting*
T-O Rec On	NO
PC-DEMO	OFF

4. **Press ESC twice to get back to the angle display.**

Setup of Elta RL

1. **Select "DATA TRANSFER" from the menu.**
2. **Select "RECORDING" from the menu.**
3. **Select "RECORDING:" until the option says "EXTERNAL (RS232-C)."**
4. **Select "PARAMETERS" from the menu.**
5. **Set the options as follows:**

Option	*Setting*
Baud Rate	9600
Stop	1
Format	REC500
Protocol	REC500
Parity	NONE
LF	YES

Shots can be taken from any menu, but angles are only visible in the Measure menu.

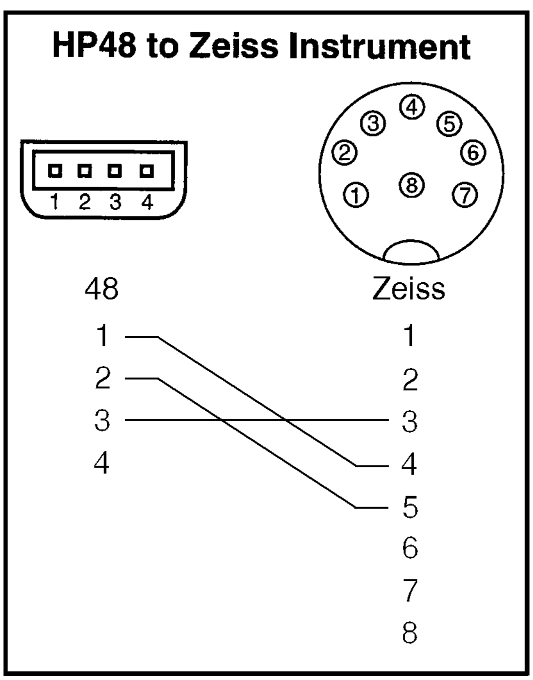


Figure B-11 HP 48 to Zeiss Instrument

Appendix B: Instrument Configuration

STATE PLANE GRID CONSTANTS

APPENDIX

C

This section provides state plane grid constants, listed by zone, as applicable, and are used in ***SMI's*** Sunshot program.

Values are for NAD27 and NAD83 data, unless noted separately.

When these constants are used, your result is State Plane Grid North.

When both constants are zero, your result is Astronomic North.

State Plane Grid Constants

State	***Zone***	***Central Longitude***	***Zone Constant***
Alabama	East	85°00'00"	0
	West	87°00'00"	0
Alaska	2	142°00'00"	0
	3	146°00'00"	0
	4	150°00'00"	0
	5	154°00'00"	0
	6	158°00'00"	0
	7	162°00'00"	0
	8	166°00'00"	0
	9	170°00'00"	0
	10	176°00'00"	0.796922
Arizona	East	110°10'00"	0
	Central	111°55'00"	0
	West	113°45'00"	0
Arkansas	North	92°00'00"	0.581899
	South	92°00'00"	0.559691
California	I	122°00'00"	0.653884
	II	122°00'00"	0.630468
	III	120°30'00"	0.612232
	IV	119°00'00"	0.596587
	V	118°00'00"	0.570012
	VI	116°15'00"	0.549518
	VII (1927)	118°20'00"	0.561243
Colorado	North	105°30'00"	0.646133
	Central	105°30'00"	0.630690
	South	105°30'00"	0.613378
Connecticut		72°45'00"	0.663059

State Plane Grid Constants

State	Zone	Central Longitude	Zone Constant
Delaware		75°25’00”	0
Florida	North	84°30’00”	0.502526
	East	81°00’00”	0
	West	82°00’00”	0
Georgia	East	82°10’00”	0
	West	84°10’00”	0
Hawaii	1	155°30’00”	0
	2	156°40’00”	0
	3	158°10’00”	0
	4	159°30’00”	0
	5	160°10’00”	0
Idaho	East	112°10’00”	0
	Central	114°00’00”	0
	West	115°45’00”	0
Illinois	East	88°20’00”	0
	West	90°10’00”	0
Indiana	East	85°40’00”	0
	West	87°05’00”	0
Iowa	North	93°30’00”	0.677745
	South	93°30’00”	0.658701
Kansas	North	98°00’00”	0
	South	98°00’00”	0
Kentucky	North	84°15’00”	0.622067
	South	85°45’00”	0.606462
Louisiana	North	92°30’00”	0.528701

State Plane Grid Constants

State	*Zone*	*Central Longitude*	*Zone Constant*
	South	91°20’00”	0.500013
	Offshore	91°20’00”	0.454007
Maine	East	68°30’00”	0
	West	70°10’00”	0
Maryland	–	77°00’00”	0.627634
Massachusetts	Mainland	71°30’00”	0.671729
	Island	70°30’00”	0.661095
Michigan (1934)	East	83°40’00”	0
	Central	85°45’00”	0
	West	88°45’00”	0
Michigan (1964)	North	87°00’00”	0.722790
	Central	84°20’00”	0.706407
	South	84°20’00”	0.680529
Michigan (1983)	Central	84°22’00”	0.706407
	South	84°22’00”	0.680529
Minnesota	North	93°06’00”	0.741220
	Central	94°15’00”	0.723388
	South	94°00’00”	0.700928
Mississippi	East	88°50’00”	0
	West	90°20’00”	0
Missouri	East	90°30’00”	0
	Central	92°30’00”	0
	West	94°30’00”	0
Montana (1927)	North	109°30’00”	0.746452
	Central	109°30’00”	0.733354

State Plane Grid Constants

State	***Zone***	***Central Longitude***	***Zone Constant***
	South	109°30'00"	0.714901
Nebraska (1927)	North	100°00'00"	0.673451
	South	99°30'00"	0.656076
Nebraska (1983)	Single Zone	100°00'00"	0.662697
Nevada	East	115°35'00"	0
	Central	116°40'00"	0
	West	118°35'00"	0
New Hampshire		71°40'00"	0
New Jersey (1927)		74°40'00"	0
New Jersey (1983)		74°30'00"	0
New Mexico	East	104°20'00"	0
	Central	106°15'00"	0
	West	107°50'00"	0
New York (1927)	East	74°20'00"	0
	Central	76°35'00"	0
	West	78°35'00"	0
	Long Island	74°00'00"	0.654082
New York (1983)	East	74°30'00"	0
North Carolina	–	79°00'00"	0.577171
North Dakota	North	100°30'00"	0.744133
	South	100°30'00"	0.729383
Ohio	North	82°30'00"	0.656950
	South	82°30'00"	0.634520
Oklahoma	North	98°00'00"	0.590147

State Plane Grid Constants

State	*Zone*	*Central Longitude*	*Zone Constant*
	South	98°00'00"	0.567617
Oregon	North	120°30'00"	0.709186
	South	120°30'00"	0.684147
Pennsylvania	North	77°45'00"	0.661540
	South	77°45'00"	0.648793
Puerto Rico		66°20'00"	0.312888
Rhode Island		71°30'00"	0
St. Croix		66°20'00"	0.312888
South Carolina (1927)	North	81°00'00"	0.564497
	South	81°00'00"	0.544652
South Carolina (1983)	Single Zone	81°00'00"	0.554399
South Dakota	North	100°00'00"	0.707738
	South	100°00'00"	0.689852
Tennessee		86°00'00"	0.585440
Texas (1927)	North	101°30'00"	0.579536
	N Central	97°30'00"	0.545394
	Central	100°20'00"	0.515059
	S Central	99°00'00"	0.489913
	South	98°30'00"	0.454007
Texas (1983)	N Central	98°30'00"	0.545394
Utah	North	111°30'00"	0.659355
	Central	111°30'00"	0.640579
	South	111°30'00"	0.612687

State Plane Grid Constants

State	Zone	Central Longitude	Zone Constant
Vermont		72°30’00”	0
Virginia	North	78°30’00”	0.624118
	South	78°30’00”	0.606925
Virgin Islands		66°20’00”	0.312888
Washington	North	120°50’00”	0.744520
	South	120°30’00”	0.726396
West Virginia	North	79°30’00”	0.637773
	South	81°00’00”	0.618195
Wisconsin	North	90°00’00”	0.721371
	Central	90°00’00”	0.705577
	South	90°00’00”	0.687103
Wyoming	East	105°10’00”	0
	E Central	107°20’00”	0
	W Central	108°45’00”	0
	West	110°05’00”	0

TROUBLESHOOTING

APPENDIX D

In this appendix:

In this appendix we have included information to help you troubleshoot some of the more common user difficulties. Before calling for technical support, look through the following suggestions. Often, the answer to a problem is simple, once you know where to look.

No matter how hard you try to prevent it, sometimes you will find yourself in a bind. In this section are a number of solutions to common problems.

General Rules to Remember

Entering Data

If you are prompted for input (as indicated by a flashing cursor on the command line), key in the desired information and press ENTER.

If you want to exit the program while you are entering data, press ON to clear the entry. Press ON again to cancel the current command. Press ON a third time to clear the data in the stack.

Alpha Entry

When you are keying in alpha data, the Alpha mode must be on. When Alpha-Entry mode is on, the greek alpha character will be shown at the top of the display.

Normally, Alpha-Entry mode will automatically be turned on when it is needed in the program. However, there are a few exceptions. One occurs when you first assign the keyboard.

Version 7 automatically assigns the keyboard when a new card is installed or when the data collector's memory has been deleted.

When you exit the ***SMI*** program, you will need to reload the ***SMI*** surveying functions by executing the K program: press α K ENTER.

✎ *Please note that reassigning keys will erase any custom key assignments or routines you may have programmed within* ***SMI****.*

Problems

1. **I just ran the K program, but my default job does not show the right defaults.**

   Existing data may be on your data collector. If you are using a RAM card, hold ON and press A and F simultaneously to clear the data collector's settings and jobs in the memory (see below for more information). The program will ask you if you want to recover data. Press NO.

   The internal memory of your data collector will now be clear. The ***Version 7*** program will reboot automatically.

   If you are not using a RAM card, you can hold ON and press the C key to reboot the software.

2. **The calculator does not seem to work with the *SMI* software.**

   Make sure you have assigned the keyboard using the K program. If, after pressing α K ENTER you only see a "K" on the display instead of the ***SMI*** program menus, check the following:

   A. **Have you installed the *SMI* program card?**

      Solution: Install the card before pressing α K ENTER.

B. **Is the card installed properly?**

Solution: The card might not be making good contact. Turn off the data collector and remove the card and reinstall it, making sure it is pressed firmly into place. Turn on the data collector and it should boot automatically.

The contacts on the card may need to be cleaned to ensure a good contact. Take the ***Version 7*** card out and use a pencil eraser and lightly rub the gold contacts on the back. Then reinsert the card and it should boot automatically.

If, after you press [α], K [ENTER], the data collector's display simply shows the letter K, you may need to reset the card. If the display shows any other character, K has been reassigned. Remove the card and hold [ON], and press [A] and [F] simultaneously to clear the data collector's settings (see below for more information). Then reinsert the card and it should boot automatically.

C. **If nothing works, the card may have been damaged or lost its programming; contact *SMI* or your dealer for a replacement. For additional help, call *SMI* technical support.**

3. **You are experiencing trouble with the calculator or the program.**

During the learning process, you will sometimes press a wrong key. Do not worry – you cannot erase the program from the program and in the data collector. However, you can do some strange things to the calculator!

If the calculator starts acting unpredictably, follow this checklist of the suggested remedies. These are listed in order of least to most drastic.

A. **Press [ON] two or three times.**

This does one or more of the following: clears the current entry, cancels the program, clears the stack, and/or brings up another stack display.

B. **Check the display and make sure `SMI` is on top of the screen. If it is not, press [α], K, [ENTER]. `SMI` should appear at the top.**

C. **Hold down [ON] and press the "C" key.**

This is a type of "soft boot" (similar to CTRL-ALT-DELETE on a PC) that often will get the calculator out of a slow mode. This will simply reboot the ***SMI*** software.

D. **Hold down [ON] and press the "D" key.**

This will cause a line to appear down the center and each side of the display. Now hold down [ON] and press the "C" key (see C above).

E. **Hold down [ON] and press the "E" key.**

This is a self test and takes a little time. When the self test starts repeating, hold down [ON] and press the "C" key (see C above).

4. **The calculator is "frozen" or the display seems locked up.**

Occasionally, the HP 48 will lock up. The possibility of this happening averages about once every six months for various reasons. However, many have reported using the HP 48 for two years without a problem. Generally, the reason for a lockup is static electricity due to carpet or transmission power lines. A blue screen is often due to too much heat in the summer sun. Other possible causes of lockups include extreme heat or cold, static charge, pressing several keys at one time, or very low batteries.

Symptoms and solutions:

- Blue screen, cannot turn off.
- `Try to Recover Memory` message appears.

- ➥ The hourglass is stuck for a long period of time.
- ➥ Calculator is locked up and beeps when any key is pressed.

If the first solution does not work, continue down the list for more possible fixes. It is OK to leave the program card and the RAM card in the data collector during the following procedures.

A. Press ON and C at the same time (this is a soft boot and should reboot the calculator).

B. Take the top right rubber boot off the back of the HP 48. Using a paper clip or something small, push the Reset button down.

This should turn the calculator off.

C. Take out one battery and immediately put it back in. This should turn the calculator off. When the calculator turns on, press Alpha α, K, ENTER to get back into the *SMI* program.

IF ALL ELSE FAILS:

I. Take the battery cover off. Reverse the polarity of two of the three batteries. (Yes, put two of the three batteries in backwards.)

II. Click the ON key two or three times.

III. Place the batteries in correctly.

IV. Press ON.

When the HP 48 displays "TRY TO RECOVER MEMORY", press NO (the F key). On SMI's ***Version 7*** cards, the ***SMI*** program automatically initializes. On older version cards, press α, K, ENTER.

As you can see, the solutions are the same in several different examples of lockups. Hopefully, these examples will help in the event that your calculator locks up.

5. **Trouble naming a job.**

   The HP 48 uses 2100 named functions; ***SMI*** adds another 600. So, it is possible that, at some point, you will find that a name you want to use may already be taken. If this happens, the display will give you a prompt: NAME OF PROGRAM. If you get this message, press NEW and give the job a slightly different name.

   You may also try using some lower case characters; to type a lower case letter, press ↰ and the letter. It will appear as lower case.

6. **The calculator seems suddenly (or unusually) slow.**

   The problem may be that your memory is close to full. Check your memory using the VIEW function (see *View* on page 377); this will tell you how much space you have available for storage of points. If the memory is full, backup older jobs to your PC or delete unwanted jobs.

7. **The HP 48 batteries need replacement.**

   The HP 48 requires three AAA batteries. Make sure you replace the batteries within one minute to preserve data/jobs that are stored in the HP 48's internal memory. After one minute with the batteries out of the calculator, data will be erased.

✔ ***Do not press ON while you are changing batteries. This will erase the HP 48's internal memory (and your data not on a RAM card).***

✔ ***Do not reverse the polarity (+ and -) of the batteries. This will erase the HP 48's internal memory (and your data not on a RAM card).***

8. **Lost memory.**

   What's happened to my memory?

   It is not unusual to get a memory loss on the HP 48. In fact, a static discharge in the field or adverse operating conditions (such as heat, humidity, dust, etc.) may occasionally cause the HP 48 to lose memory. As a result, it is desirable to back up your field data daily to an office PC.

   However, to better protect your data in the field, it is recommended that you use a RAM card. If you use a RAM card with the HP 48, ***SMI*** software will automatically back up each shot as soon as it is taken.

   When you use a RAM card, your data is more secure than when it is stored in the HP 48 alone. In fact, you can deliberately clear the data on the HP 48; your jobs will remain safe on the RAM card.

   The RAM card uses an internal battery to maintain its data independent of the HP 48. It is recommended that you replace its battery every 10-12 months. You may want to write on the RAM card the date the battery was replaced so that you do not find yourself with a dead RAM card.

9. **Distance error occurs when staking points.**

   This generally will occur if you were working in one job (with a specific range of coordinates) and then switched to a different job (with different coordinates).

   Unless you tell it otherwise, the program assumes that you are still working from the coordinates of the first job, and the last point that you occupied in that job. Therefore, it will reflect distances and angles accordingly.

   To prevent such distance errors, simply reoccupy the point your instrument is on and enter the backsight number in the new job before you begin staking points.

   Note that there may be times when you will want to incorporate multiple jobs and data during a project. ***SMI*** software gives you that flexibility and control; you can occupy a point in one job, backsight a point in another job, and actually begin staking in a third job.

10. **Cannot store notes with my job (*ACE* or above).**

    Make sure that the NOTES key is turned on (the N flag should appear at the top of the display). If it does not, turn it on using the Change menu.

11. **I have an * before my distances.**

    Solution:

    An * indicates that a scale factor is being applied to the distance. If this was unintentional, press CHANGE NXT ADJST and SCALE or ↰ SCALE (on the multiplication key). Set the scale factor to 1 and the distances should then be correctly displayed.

Error Messages

➥ "Invalid card data"

The HP 48 periodically checks the RAM card to verify that data has not been corrupted (due to low battery, for example). When this error is displayed, reinitialize your RAM card.

Turn alpha on and type `PINIT` ENTER. When port initialization is finished, the display will clear.

- ➥ "Invalid I/O PAR"

  "XMIT Failure"

  Either of these may happen when you are trying to transfer data to the PC. It may mean your HP 48 batteries are too weak to initialize the communications port. Replace your batteries.

  If the error repeats, you may have a bad port. Check your port and cables using the diagnostics in ***SMI*** to PC Test.

- ➥ "Low Battery"

  If your HP 48 displays this message when you are trying to transfer data to the PC, this means your HP 48 batteries are too weak to initialize the communications port (even though they have sufficient power to adequately operate your surveying software). Replace your batteries immediately.

  Make sure you follow the proper procedures to change the battery (see step number 7 on page 416).

- ➥ "Invalid checksum"

  Some brands of PC serial ports will not work with the ***SMI Transfer*** program. If this is the case, use the Kermit programs as an alternative.

- ➥ "Insufficient Memory"

  There is not enough internal memory to perform the last function. This is not related to how much memory is on the RAM card. If your jobs are on a RAM card instead of internal memory, clearing the internal memory can help. Chain and cut sheet files are temporarily saved in internal memory while being used. Insufficient memory can be a problem when they get very large.

Cable Trouble

If you are experiencing problems or receiving error messages, it would not be surprising if the problem lies within your cable. Check the following:

If the pins on your data collector are slightly misaligned, they will not properly connect with your TFR cable. The four pins on your HP 48's serial port should be clean, parallel, and equidistant. If one looks out of line, gently move it back into place and reconnect your cable.

An internal problem in your cable is a little more difficult to see. However, following is a test routine you can run to verify that the HP 48 is sending (and/or receiving) data correctly through the cable.

Bent pins: A pin pushed out of place in your HP 48 serial port or cable will disrupt the signal.

IO Loop-Back Test

PRODUCT: `SCE+`

KEYSTROKES: [α], `type IO`, [ENTER]

The HP 48 calculator has a built-in serial loop-back test that can be run to determine if the calculator serial interface is working properly. ***SMI*** has also added a serial loop-back test that can be run using the same premise for testing. This check was added primarily to verify that the serial interface on both the HP 48 and the ***Titan*** were in good repair.

Procedure

1. **Connect the *SMI* data collector to the transfer serial cable.**
2. **On the other end of the transfer serial cable, locate the Send and Receive pins. On a PC cable, these are pins 2 and 3. See *Instrument Configuration*, which begins on page 383, for instrument cable diagrams.**

   On a PC cable, these pins should be marked with tiny numerals. When looking at the face of the cable reading the numerals, there is a row of five holes on top and a row of four holes on the bottom. Pin 1 is usually the first pin on the top right, with pins 2 and 3 adjacent to it moving across the top to the left.
3. **Take a paper clip and bend it into a U-shape. Use the paper clip to connect the Send and Receive pins or holes.**
4. **Turn the *SMI* data collector on.**
5. **Press [α], type `IO` (for input-output), and press [ENTER].**
6. **You should hear a rapid beeping sound coming from the *SMI* data collector. If you remove the paper clip and the beeps continue, but at a slower rate (about one beep per second), then the data collector/cable passes the test. If the rate of the beeps is the same whether or not the clip is in the pins, you may have a problem with either the cable or the port connection on the data collector. Press [CANCEL] or ESC (*Titan*) to cancel the test.**
7. **If the cable test fails, the problem could be in the hard case or the data collector. You can eliminate the cable as a possibility by removing the cable and repeating the test on the pins of the hard case or the pins of the data collector.**

RAM Card Troubleshooting

What to Do if the Calculator says "low battery p(2)"

Most RAM Cards

If you have RAM card with a removable battery, simply change the RAM card battery. It is a 3v-button battery that you can find in any camera shop. The model of the battery is CR2016. These RAM cards are distinguished by having a switch at the top of the card.

Rechargeable RAM Cards

The rechargeable RAM card will draw power occasionally from the calculator's batteries. A low battery indication for the RAM card will happen when the calculator is not used for long periods, only used occasionally, or because the batteries in the HP 48 are weak.

If the batteries in your HP 48 are over two weeks old, or you are not sure, replace the AAA batteries in the HP 48. The batteries in the HP 48 need to be new or almost new. Weak batteries can run the calculator, but will not charge the RAM card battery.

Changing the batteries in the HP 48 every month is a good idea for several reasons. First, this ensures that the batteries will be strong in the HP 48. Instability is many times more likely if the calculator does not get enough power. Second, the battery in the RAM card requires the batteries to be strong to charge properly. Third, it is an opportunity to clear the memory in the HP 48. An HP 48 that has its memory cleared after battery changes will operate much more reliably than one that does not.

Perform These Steps to Charge Your RAM Card Battery

1. **Back up all data to your PC.**
2. **Exit SMI:**
   - A. **Press [↰] [α].**
   - B. **TDS users need to exit the program.**
3. **(Optional) Turn off the beep by pressing the following keystrokes: [↱]** I; D; **press K seven times, C; K; C; F; F.**

   This will turn off flags 57 and 56.
4. **Go into Set Alarm ([↱],** 4; **Q; [ENTER]).**
5. **Set the time for five minutes after the time it shows (e.g., if it shows 11:25, set it for 11:30).**
6. **Arrow down to repeat (Q; Q).**
7. **Set it to repeat every four minutes (**4; **[ENTER]; [α]; M; [α]; F).**
8. **After you let this run overnight or the weekend, stop the alarm ([↱],** 4; **[ENTER]; C; F).**

After the alarm is set, the calculator will keep itself on to constantly charge the RAM card battery. Let the calculator run overnight. If it still says “`low battery p(2)`”, then call SMI for a replacement. Before you leave for the weekend, set the four-minute alarm to more fully recharge the battery.

RAM Card Battery Needs Replacement

The RAM card battery should be replaced every 10-12 months, since this internal battery is needed to maintain data independent of the HP 48. It uses a 3-volt camera battery, type CR2016.

The RAM card runs on the HP 48 battery only while the HP 48 is on. A RAM card cannot retain data if you remove a RAM card battery while the HP 48 is off, or while the RAM card is not installed in the calculator.

To replace the battery, turn on the HP 48.

✎ *It should remain on during this procedure to protect the data stored on the RAM card.*

Turn over the HP 48 and remove the plastic cover over the plug-in card ports (on the display end of the HP 48). You can leave your program card in place.

Place your index finger in the recess just above the RAM card. This prevents the card from slipping out of the HP 48 when you remove the RAM card’s battery holder. Insert the thumbnail of your free hand into the nail grip in the back plastic at the left side of the end of the RAM card and pull the battery holder out of the card.

✎ *RAM cards use a battery (photocell, style CR2016) to preserve stored data. This battery has an effective life of up to 12 months, so should be replaced annually. If you plan to remove the RAM card from the HP 48 to change the battery, first download job data from the card to your HP 48 or a PC, since all data on the RAM card will be erased.*

Remove the old battery from the plastic battery holder. Install a fresh battery (CR2016), making sure you observe the proper polarity; the + side should face the front of the RAM card. Position the battery and plastic housing into the RAM card until it snaps back into place.

✔ ***Mark the RAM card with the date you installed the battery. Be sure to install a fresh battery within a year’s time.***

When you replace the RAM card battery, you may occasionally get an “invalid card data” message when you first use the RAM card. See *Error Messages* on page 417 for the remedy.

The RAM Card Will Not "Write" – Will Not Accept Data

First, make sure a fresh battery is properly installed in your RAM card.

Second, make sure the "read/write" switch is set to "read *and* write." The switch is a thin black toggle located on the top of the RAM card. Position the switch toward the center of the RAM card so that it lines up with the double-arrow symbol on the back of the card. This is the "read and write" position.

If the switch is set toward the outside of the RAM card, aligned with the single arrow, it is in a "read only" position. In this setting, it will allow you to read data from the RAM card, but no data may be stored on the card.

General Communications Problems

This section should be tried first if you have just started using new or different hardware (computer, cable(s), and/or data collector), but are somewhat familiar with ***SMI*** or have used it before with a different computer.

SMI Transfer uses a serial port on your computer to transfer job files. Serial ports are male ports usually on the back of the computer. Older computers use one 9-pin and one 25-pin port. Newer computers use two 9-pin ports. Laptops usually have just one 9-pin serial port. Parallel ports (female 25-pin connectors on the computer) are not used with the ***SMI Transfer*** program. As a rule of thumb, "if it fits it should work."

Here is a checklist of things to verify when having communications problems:

- Make sure everything is wired properly. If the data collector is used with a total station and it collects data properly, this indicates that there should not be a problem with the pins in the calculator or hard case (if applicable).
- If you have a Version 6 card on the HP 48, make sure the data collector is set on WIRE instead of IR. Select JOB then XFER. Make sure the menu is set to WIRE instead of IR. The wire option transfers data using the transfer cable. IR, or infrared, attempts to transfer data using the IR port on the top of the data collector.
- If you try using a different data collector with the same computer and the transfer works, you have determined that the computer serial port is good and the transfer works properly. Pressing the α ENTER keys on the HP 48 restores the default settings.
- On the HP 48 (unless you have a Turbo HP 48), the baud rate is hard coded to 9600. For PC transfers or Hard Case-to-Hard Case transfers, use WIRE. Use IR for infrared (wireless) HP 48-to-HP 48 transfers.
- Check to see if the serial cable is connected to the wrong serial port. If it is, verify the port setting on the Setup tab in the ***SMI Transfer*** program.
- Your data collector requires a certain amount of charge to generate a signal that can be recognized through the serial cable by your PC. If your batteries are weak, they may still be strong enough to run your data collector, while not having the power needed to signal your PC.
- Verify all communication settings. If your data collector has options to set the communication parameters, they must match with the ***SMI Transfer*** program on the Setup tab.

Recommended Baud Rates

Data Collector	***Baud Rate***
SMI HP 48GX	9600 (hard coded)
SMI Turbo 48GX marked with orange label on front	19200 (hard coded)
SMI Titan	9600-115200
Trimble/TDS HP 48GX	9600
Trimble/TDS Ranger	9600-115200
Other data collector	Varies*

✎ **Check the settings on the collector and verify they are set the same (baud 9600, data bits 8, no parity). Refer to your data collector's documentation for further assistance.*

- ➥ Check to see if you have a serial or PS/2 mouse. A serial mouse needs a dedicated serial (COM) port to operate. If you have a serial mouse, you cannot boot your computer with a serial mouse (or digitizer) plugged in, and then swap cables or use a switch box to transfer data with your data collector. This generally worked in a DOS environment. Windows, however, "captures" the device on start up and reserves that port setting for that device until the machine is rebooted. Keyboard and touchpad controls normally should not cause a conflict. However, there have been instances where the computer needs to be reconfigured to get the serial port to work.
- ➥ The serial port can be tested by turning off the computer, plugging in a serial mouse (disconnect other mice), and booting up the computer. If the mouse works, you know that the port is functioning properly. If it does not work, consult the computer manufacturer or a hardware technician.
- ➥ If you have an internal or external modem, verify your modem settings. To check, click on Start → Settings → Control Panels → Modems. Check the COM port and interrupt request setting (IRQ). It is common for an internal modem to be preconfigured to use COM 3. By default, COM 3 uses the same interrupt as COM 1, so you may need to either reconfigure the modem to a different IRQ or change the modem to a different COM port setting (2 or 4 is good if you are attempting to transfer to COM 1 or vice versa). When making COM port and IRQ changes, be sure to avoid a conflict with yet a different device, card, or board. If you have several devices, do some checking of the settings that already exist for these devices.
- ➥ Verify the BIOS settings on your computer to see if the port is enabled or to see if there may be an interrupt request conflict (IRQ). You can view your BIOS settings by pressing a keystroke while your machine is beginning to start up. One most machines, this may be the F1, F2, F8, or Delete key. Check your computer's documentation for more information.
- ➥ Remove any recently installed devices (e.g., camera, modem, PDA, digitizer, or even sound/video cards, etc.). This may require you to physically remove the device/card from the inside of the PC. Restart your machine and retry the transfer.
- ➥ Low batteries on the collector are a problem if only a portion of the file transfers.
- ➥ Swap cables if you have recently replaced cables.
- ➥ Ideally, internal modems use virtual ports (using the resources, but not using a physical port on the back of the computer) 3 or 4 on the computer. Some manufacturers assign the modem to use the resources of ports 1 or 2, thus rendering a physical port unusable. This may or may not be changeable. Contact the computer manufacturer to determine if it is changeable. (e.g., if the modem is assigned to COM 2, the HP 48 cannot transfer on COM 2).

- Switchboxes are not recommended, but they typically are used for shaping a plotter and the HP 48. They add more cabling to the system, thus leaving it open to more connector/cabling problems. If you are having difficulty transferring, bypass the switchbox until the problem is resolved. Be aware that the device drivers of the non-HP 48 device may adversely affect the ***SMI Transfer*** program.
- If you have a USB port, buy a USB to serial adapter through ***SMI***. Typically, a USB port is included in computers made in 1998 or later. If you are not sure whether you have a USB port, refer to the computer manual or manufacturer.
- A local computer vendor may be able to install an additional COM port in your computer.

If you become frustrated, please contact technical support. As with any problem, you must identify exactly where the problem is realized before you can solve it.

Support technicians provide fast, friendly answers to your product questions. You can call, fax, or e-mail your questions to our technicians regarding product questions. The fax service is available 24 hours a day, five days a week at (563) 556-5321. E-mail questions to our technicians using support@smi.com. When calling for technical support, please use our toll free number at (800) 234-0123.

Windows-Specific Settings

Windows 95, Windows 98, or Windows ME Operating Systems

✎ *For any changes to take effect, you should restart your computer after making the change.*

- Remove and reinstall your COM port with the default settings. To do so, click on Start → Settings → Control Panel → System → Device Manager. Toggle on the View Devices by Connection option. Expand the Plug and Play BIOS option to reveal the desired COM port. Highlight the desired COM port and click on the Remove button. Reboot the computer and retry the transfer. Without Plug and Play you can still manually remove the device, reinstall the device through Control Panel → Add New Hardware, and restart your computer.
- Add a line to your computer's autoexec.bat file. You can edit this file by clicking Start → Find → Files or Folders. Type `autoexec.bat` in the Name edit field and set Look in to your C:\ drive. When it displays, highlight the file and select File → Edit from the Find menu. Add this line to the bottom of the file:

  ```
  mode com1: baud=96 parity=n data=8 stop=1 retry=p
  ```

  or

  ```
  mode com1:96,n,8,1,p.
  ```

  Restart your machine and retry the transfer.

Windows NT, Windows 2000 or Windows XP Operating Systems

✎ *For any changes to take effect, you should restart your computer after making the change.*

- Verify the serial device has been started. To check, click on Start → Settings → Control Panel → Devices. Scroll down to the device named Serial and start the device if the status shows it has not already been started.
- Verify that there is a COM port added to your list of ports. Make sure the port that you are adding is for the serial port that you want to transfer data through.

To add a port, click on Start → Settings → Control Panel → Ports. The default settings for a COM port are found in the table below.

Default Settings for COM Port

Settings	***Value***
Baud Rate	9600
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

Advanced Settings for COM Ports

Advanced Settings	***COM Port 1***	***COM Port 2***	***COM Port 3***	***COM Port 4***
Base I/O Port Address	3f8	2f8	3e8	2e8
Interrupt Request Line (IRQ)	4	3	4	3
FIFO Enabled	ON	ON	ON	ON

SMI Version 7 User Guide Glossary

Glossary of Terms

This section defines the terms used in this manual as they relate to surveying and the use of your program card.

Acreage

The area of an enclosed polygon. One acre equals 43560 square feet or 4840 square yards.

Alphanumeric

Letters and numbers combined, such as ABC123, JOB2, or R24.

Angle Right

The clockwise angle from a backsight point to a foresight point.

Angle Adjustment

The adjustment of the lines of a traverse so that the direction of the closing line is the same as the beginning line.

ASIN

Arc sine. A trigonometry function which determines one of the acute angles of a right triangle when the ratio of the opposite side divided by the hypotenuse is known.

Assigning keys

The act of changing the use or function of keys. A new program or function can be assigned to almost any key on the data collector (KASN in the CUSTOM menu).

Astronomic Azimuth

The clockwise angle to a line from the geographic azimuth north pole (or, if using south azimuth, to the geographic south pole).

Axis of the scope

The line through which the vertical and horizontal crosshairs pass.

Azimuth surveyors

Surveyors who base their field angle directions on angle from north, as opposed to Angle Right surveyors, who base their field angles on angle right from the backsight point.

Back point

The point used as a reference to measure the angles to new points.

Backslope

Positive slope from the bottom of the ditch. Expressed as a ratio to one. Also called the cut slope.

Backup

Allows the user to save a copy of a job so that, in the event that the current job becomes damaged or corrupted, the backup job may be used.

Bearing-Bearing

A term used to describe the intersection of two lines from two points, based on the bearings or directions from those points.

Bearing-Distance

A term used in intersections for computing the intersection based on one point and a distance plus another point and a bearing or direction.

Normally, there are two solutions to bearing-distance intersections. This is what is used when intersecting a line with a curve (where one point is the radius point or curve center and the distance is the radius of the curve); the other point has a bearing or direction from it, which passes through the curve. If the bearing does not pass through the curve, there is no possible solution.

Baseline

An established line used as a reference for a construction job.

Benchmark

An established point with a known or assumed elevation.

Card

A program module approximately the size of a credit card, containing software programs or memory, and used in the data collector.

Catch Point

In a cut area, this is the point where the backslope from the ditch is projected up and intersects with the existing ground surface. In a fill area, this is the point where the slope from the shoulder of the road (ditch slope) will meet the ground surface.

Chain

Chain defines a set of data containing horizontal, vertical, and template control that is used in conjunction with a construction job. In some cases, it is also defined as a unit of measure, one chain equaling 66 feet.

Closure

The direction and distance of error, or the ratio of the distance of error to the distance of the traverse.

Codes

Information used to define points while collecting data, so that when this information is used by a computer program or plotter, lines and features are drawn automatically.

COGO

See *Coordinate Geometry* (below).

Command line

The bottom line of the data collector display, on which data is entered into the data collector.

Pressing any number or letter will automatically display the command line; the “stack” is scrolled upward. When **ENTER** is pressed, the command line disappears and the data just entered is displayed on level 1 of the stack. Any data that was on level 1 is moved to level 2, and so on.

The cursor flashes when the command line is active.

Compass rule

The most widely used method for adjusting a traverse. The adjustment of each point is proportional to the ratio of the distance traversed to the total perimeter. The total adjustment is the total closure error.

Coordinate Geometry

(COGO) The use of coordinates, often stored by point number, to perform various computations, such as inverse, traverse, curve data, and staking. Charlie L. Miller, owner of Elm Software, coined the term COGO – short for coordinate geometry. Mr. Miller is known as the father of COGO.

Coordinates

Points defined by a north and east distance from a zero reference point. An elevation or a point description may also be included with the coordinates, and are stored by point number.

Copy

To duplicate a set of points or a job.

Cross-section

A plotted view of distances and elevations across a baseline or road centerline.

Curve, horizontal

Also called a simple curve with a center point or curve center and non-changing radius. This is normally in the horizontal plane.

Curve, spiral

A curve which begins with an infinite radius, and where the radius is constantly changing as you move along the curve until you get to a simple curve.

Typically, spiral curves consist of a spiral to simple curve section, a simple curve, and a simple to spiral section. The place where the spiral starts is called the tangent to spiral (TS) point. The place where the spiral curve meets the simple curve is called the spiral to curve (SC). The place where the simple curve meets the spiral is called the curve to spiral (CS).

The spiral to tangent (ST) is where the spiral curve meets the forward tangent. The spiral length back (SLB) is the length of the spiral from the TS to the SC. The spiral length ahead (SLA) is the length of the spiral from the CS to the ST. Normally, the SLB and the SLA have the same length.

Curve, vertical

A parabola used to define the vertical position of a road at various stations of the road in a transition from two slopes.

Data collection

The process of manually or electronically collecting data from an instrument and storing that data in the memory of the data collector or other electronic devices.

Default

The "factory" program settings which are established automatically when the software is initialized.

Delta

The central angle, also the deflection angle. It is based on the two tangents at the point of intersection (PI).

Directory

A location in the PC or data collector where a group of files and/or other directories may be stored.

Display

The monitor or screen of the data collector, on which data or requests for data are shown.

Distance-Distance

This is used to refer to intersections when using specific distances from points of reference.

Ditch

The point on the template where the ditch slope from the shoulder intersects the backslope.

Ditch bottom width

A ***Construction Five*** program which allows the user to specify the flat ditch bottom width. If this value is zero, the ditch is a V ditch.

Ditchslope

The negative slope from the shoulder through the ditch bottom. Expressed as a ratio to one. Also called the fill slope.

Downloading

Transferring data to a reference computer. Many use this term to describe transferring data to a PC; others use it to refer to data being transferred to the data collector.

Electronic entry

Automatic transfer of data from an electronic total station via cable to the data collector.

Electronic Instrument

There are two basic types of electronic instrument: manual electronic, where data is read and written in a field book; and electronic total station, where data may be entered into a field book or fed electronically to a storage device such as the data collector.

Elevation

The vertical distance from sea level, or from an assumed reference elevation.

Enter

The key on the data collector (and on a PC) used to execute a function or accept data. Also used in this manual to describe the process of putting data on the command line of the data collector so that it may be used in a function or calculation.

Ephemeris

A set of tables containing data that allows the computation of Astronomic North from the sun or stars. A built-in ephemeris is contained in the ***SMI*** software for the data collector, so the computation of Astronomic North is automatic; therefore, ephemeral data need not be looked up in tables.

Extension

A descriptor or “flag” used to put files into categories in a directory in the PC. If a file name is called JONES.ASC, the three characters after the period (.ASC) make up the extension.

The extension .ASC is sometimes used to identify ASCII files, indicating that the file is a standard DOS file.

Extensions are automatic when naming jobs on the data collector. The .48M extension is used when there is no memory card. The .CRD extension is used when a RAM card is in the data collector.

Fine (and coarse)

These are mode settings on some instruments, indicating whether it will use fine or coarse EDM distance. This setting may be selected from the data collector (***DCE*** and above) using the menu.

Flat ditch bottom width

See *Ditch bottom width* on page 428.

Foresight point

This is a forward point, side shot, or traverse, where the angles and distance are entered, the forward point data is computed, and the coordinates (and elevation and description, if available on your card) are stored.

Free Stationing

Accurately locating the instrument from two or more points.

Function

An operation on the data collector, typically executed by pressing a key. The data collector includes hundreds of HP and ***SMI*** functions, including: add, subtract, divide, SIN, traverse, side shot, and store coordinates.

Graphics display

The data collector can display graphics, in addition to stack and alphanumeric displays. Refer to the screen plot function (SPLOT) to learn how to plot a graphics display of a job.

Greek characters

These characters often are used to represent scientific or mathematical functions. The alpha character (under the **ENTER** key) is an example of a Greek character.

To access Greek characters, turn on alpha, then press ↱ and an alpha character, such as the letter A.

Greenwich

Also called the Greenwich Meridian. This is the line running north-south through Greenwich, England where the international zero longitude divides east from west. Time zones and longitude start at this point.

When taking sunshots, the time used must be Greenwich time and not local time.

Hectare

A unit of area in the metric system equal to 10000 square meters.

Hinge method

A method of determining the intersection point for a predetermined area where a point on one side of a boundary line is held constant while a point is moved along the other side of the boundary along a line.

Horizontal circle

The horizontal angle on an instrument is sometimes called a horizontal circle reading, since this is the reading from the horizontal circle of the instrument.

Horizontal control

North and east coordinates are stored by point numbers, sometimes called horizontal control. In ***Construction Five***, horizontal control points and a beginning station number are used in HCCL to define a baseline or the centerline of a road.

Hypotenuse

The longest side of a right triangle.

Infrared

Communication method for sending data via infrared light signals to a printer or another data collector; this does not require a cable.

A more common communications method is to use a serial cable or RS232C communication. The HP 48 can communicate and transfer data using either method.

Interface

A term used to describe a medium, or pathway, used to facilitate communication between one device (such as the data collector) and another (such as a PC, printer, or plotter).

Serial or RS232C is the most common interface.

Internal memory

The memory built into the data collector, used for storage of data and/or custom programs.

All ***SMI*** programs can use the data collector’s internal memory for point storage (see *Memory* on page 431).

Intersection

The computation of a point where two lines (or a line and a curve, or two curves) cross.

Inversing

The computation of a direction and distance between two points or two sets of coordinates.

Job

A file containing coordinates and other data stored as point numbers. These files are stored and accessed in the data collector by job name.

Latitude

The angular distance in degrees, minutes, and seconds north or south from the equator, with the radius point at the geographic center of the earth.

Letters

The characters in the alphabet.

Longitude

The angular distance in degrees, minutes, and seconds east or west from the Greenwich Meridian, with the radius point at the geographic center of the earth.

Manual entry

The keying of information by hand into the data collector or another data storage device.

Mean backsight

The Computation Resulting When The zenith angle and Slope Distance are measured to the backsight in the direct and reverse positions, and the Zenith Angles are meaned.

A new elevation is computed for the occupied point and averaged with the old elevation currently stored at the occupied point.

Mean reverse reciprocals

The computation resulting from when Zenith Angles are meaned in the direct and reverse positions from both ends of a line and the mean elevation is computed for the new position.

Memory

A location, either internally in the data collector or on an optional RAM card, where data may be stored.

Modes

A place in the data collector where the type of format for numbers can be changed. For example, the mode may be set to standard, scientific, or fixed-point format, and the fixed point length may be set for any number between 0 and 10.

Multiple angles

The turning of more than one angle to increase the accuracy of a survey, or to help detect angle errors. ***SMI*** cards allow the use of one or more types of multiple angles, including: SHOTS, and TRIG.

Note

A data option available on ***ACE*** cards and above, in which descriptions of points may be included with the coordinates and stored at a point number.

Occupied point

The assumption that the data collector is positioned over a specific point, similar to the way an instrument occupies a point. Computations are then performed from the occupied point as the reference point.

Offset

A program that stores points at a specific distance from a series of points, such as break points in the center of a road. Points also can be stored at an offset from a line or curve.

Overlay functions

Executable program steps designed to carry out specific tasks, and accessible by pressing the corresponding key (as identified on the overlay).

Overwrite

To store a point (and its data) over another existing point. The former data will be replaced by the new data.

Perpendicular Offset

The shortest distance from a point to a line. This is measured at a 90° angle from the line.

Perimeter

The distance around a boundary.

Point

Typically a number that has a stored north and east coordinate (to define its location) and, sometimes, an elevation and/or note or description.

Point traverse

Traversing with point numbers that already are stored in a job.

Polar

A type of coordinate based on an angle and a distance.

Poles

A unit of measure sometimes used in old deeds. One pole is equal to 16.5 feet.

Precision

The ratio of the distance traveled to the distance of error. For example, if a traverse is 10000’ long and the error is .5’, the precision is “1 in 20000” (or simply “20000”).

Program cards

A card, approximately the size of a credit card, on which programs are stored. Program cards are placed only in the first slot (Port 1) of the HP 48.

Random points

A designated series of points (not necessarily consecutive) used for performing functions that require only certain point numbers. For example, a Random Point Traverse may use only a certain set of points as defined in the Random Points file. These random points may be used to perform functions such as graphic display area adjustment.

Raw data

The data exactly as it comes from an instrument, along with other essential information required for the regeneration of coordinates.

Rectangular Coordinates

North and east coordinates which surveyors normally use to define points.

Register

A location where data is stored in a calculator.

Resection

Often referred to as "free stationing"; this is a method to determine position. Free stationing involves setting up at a random position and shooting two points to determine your position.

Some use a distance-distance intersection as a form of resection. ***SMI*** programs use true "free stationing," as it is much more accurate for determining position. ***SMI's*** new positioning program is called 2PFS (Two Point Free Station) and is in the **SETUP** menu.

Roadwork

A term used to describe field survey work dealing with slope staking, boundary staking, stations, offsets, bluetop staking, collecting cross sections, collecting topographic points, field inspection work, and almost any other field survey work associated with road or highway construction.

Rotate

To turn a set of points a specific number of degrees, minutes, and seconds around a specific point; this actually changes the coordinates of the points.

RPL

The programming language used in the HP 48 (Reverse Polish Lisp).

RPN

An earlier programming language used in the HP41CX (Reverse Polish Notation).

RS232 Interface

The most common medium used for the transfer of data; also called serial interface.

Scale factor

A number used to determine the ratio at which a set of points is rescaled, such that the distances between the points are changed but remain proportionate to each other.

Screen plotting

To show a drawing on the data collector's display which represents a set of lines defined by points stored in a Random Points file.

Separate distance angle options

With an electronic total station, it is sometimes desirable to add or subtract a distance, move a point right or left of the prism a specific distance (that may not be able to be seen with the scope), or measure a distance to one point and an angle to another point.

In SMI's ***DCE*** and above cards, an SDA function (found in the setup menu) allows any of the above options.

Serial port

A port located at the back of a PC which allows communication with the data collector and other devices. It is important to select the correct port in any PC software designed to communicate with the data collector.

Shift

Two Shift keys are found on the data collector; these allow access to additional functions from the keyboard.

One key may have a distinct function assigned to it, with a second function executed using SHIFT LT (left) before pressing the key, and a third function executed using SHIFT RT (right). These functions are indicated on the data collector and the ***SMI*** overlay using the color that corresponds with the Shift key.

Shot

A function key used in staking and in ***Construction Five*** with an instrument selected; Shot takes a reading with the electronic total station.

In Manual Entry mode, Shot prompts the user to enter the appropriate data that would be gathered electronically.

Shots

A function allowing multiple angles (horizontal and vertical) and/or distances to be meaned. These angles may be checked, with the worst angles displayed (and eliminated, if desired).

SIN

This key is used to get the sine, which In a right triangle, is the ratio of the opposite side divided by the hypotenuse. To get the sine of an angle in degrees, minutes, and seconds use SIN.

Slide method

A method for computing a predetermined area, in which one side (or line of specific direction) is slid until the resulting boundary contains the desired area.

Slope

The vertical rise (+) or fall (-), expressed as a ratio to (or percentage of) horizontal distance. For example, a 3% slope is a 3' rise per 100 feet of horizontal distance.

(A -3% slope would be a 3' fall per 100 feet.) 3:1 indicates a horizontal distance of 3 feet for each foot of rise or fall.

Slope distance

The distance along the slope from the instrument to the prism.

Soft keys

The keys (A-F) on the data collector which access the functions in the soft key menu at the bottom of the display.

Stack

The temporary register displayed on the data collector and directly accessible by pressing ENTER or a function.

Stake

A program that facilitates the staking of points in the field by point number.

Subgrade

The drop in elevation from the road surface.

Sunshots

Determining the direction of a line from the sun.

Template data

The designed or planned cross-section of a road.

Temporary random points file

This is a nonpermanent file created by the ***SMI*** program used to store random points where the Random Points file is needed only until another temporary file is entered. SMI's ***SCE*** and above survey cards allow you to store multiple Random Points files.

Tolerances

Error limits set for angles, distances, and coordinates.

Topographic

A map of the surface, showing elevations.

Transformations

The act of sliding, rotating, and/or scaling coordinates and changing elevations.

Translate

To move a set of coordinates a specific direction and distance horizontally.

Traverse

To move from point to point around a boundary, computing new coordinates as you go.

TRIG

(As defined by SMI - used in Trig Leveling.) Allows the meaning of Zenith Angles (direct and reverse) using a distance, and storing coordinates at a point with an elevation based on meaned Zenith Angles.

Trig leveling

Computing elevations by Zenith Angle and Slope Distance.

Two-point resection

This is used to find a new set of coordinates for the instrument by taking readings on two known points. See *Free Stationing* on page 429.

Vertical control

Used in **Construction Five** to define the vertical alignment of the road centerline or the baseline. Normally used in construction with a construction project.

Zenith angle

The vertical circle reading where 90° or 270° is level.

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