

**SOKKIA**

**SETX**

Total Station



SDR SOFTWARE REFERENCE MANUAL




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# Welcome

Thank you for purchasing SETX.

- Please read the Software Usage License Agreement contained at the back of the manual before using this software.
- Please read this manual carefully before using the SETX in Program mode.
- Data saved in the SETX can be sent to a connected host computer. Command operations from a host computer can also be performed. For details, refer to Interfacing with the SOKKIA SDR Electronic Field Book and Command Explanations manuals.
- Some of the diagrams and screen displays shown in this manual are simplified for easier understanding.
- Sokkia continually conducts research and development in order to make its products easier to use and enhance their precision. The specifications and general appearance of the instrument may be altered without prior notification.

## How to Read this Manual

- The SETX comes equipped with 3 manuals for operation information. Manuals 1, and 3 below are electronic manuals provided on a CD-ROM in PDF format (  ). Adobe Reader is necessary in order to view these documents. The latest version of Acrobat Reader can be downloaded from the Adobe homepage.
1. SDR Software Reference Manual (SETX)  : explains advanced measurement operations using the SETX in Program mode, and methods for managing measured data.
  2. Operator's Manual: Explains basic operation and functions of the total station.
  3. SFX Dial-Up Program Explanations (SETX)  : Explains how to send and receive data using the SFX function.
- For information on key operation and using the SETX screen, see “5. BASIC OPERATION” of the Operator's Manual for your total station.

## Notes Regarding Manual Style

- Except where stated, “SETX” means SET1X/2X/3X/5X in this manual.
- The text, items, and tabs displayed on the total station can be modified by the user. Those used in this manual are the factory settings. For more information, see “20. CHANGING THE SETTINGS” of the Operator's Manual for your total station.

## Documentation Conventions

The following conventions, typefaces and icons are used in this manual:

- Main Menu** .....Indicates field identifiers, menu options, unit names, variables, and functions.
- [...] - [...]** .....A menu bar separation. Follows a menu selection, and is shown in boldface in the format **Menu bar item/Menu item**, as in this example: **[Edit] - [Insert]**.
- Prompt** .....Represents screen prompts and other information displayed on the screen.

- {KEY}** .....Indicates a keyboard key that causes an immediate action.  
Examples: **{1}**, **{F1}**, **{ESC}**, **{Y}**, **{N}**. If you must press multiple keys to initiate an action, the combination will be shown with a plus sign between the keystrokes; for example, **{FUNC CTRL} + {←}**.
- [Softkey]** .....Indicates a softkey on the display. Examples: **[New]**, **[Del]**, **[Read]**.
- TEXT** .....Represents user-typed text, numeric or special character input (always followed by one of the action keys above).
- Print** .....Represents reports or output to a printer.

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**NOTE** A note indicates that adjoining text explains previous text.

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**TIP** A tip gives shortcuts and useful advice for working with your product.

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Indicates important information or warning information concerning adjoining text.

## Terms

In this manual, the following terms are used:

- Field** .....The units of data that make up a record in a data file.
- Edit field** .....A special type of field where you are to type text. The cursor will begin to blink when it is located in an edit field. An edit field looks like this: **Filename: [ ]**
- Control**.....The first level of choices in a dialog box.

## Obtaining Technical Support

When contacting Sokkia Customer Service, please make sure you have the following information: your **software version number** and **an accurate description of the problem**. For Sokkia Customer Service contact details, see the final page of this manual.

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## Software Usage License Agreement

# Chapter 1

## Introduction

### In this chapter

- Communication setup
- Operating modes
- System messages

The SETX is an advanced total station from Sokkia that offers an integrated solution by providing SDR functionality within the total station.

The SDR functionality increases the efficiency of your total station for:

- Traversing
- Topographic surveys
- Setting out

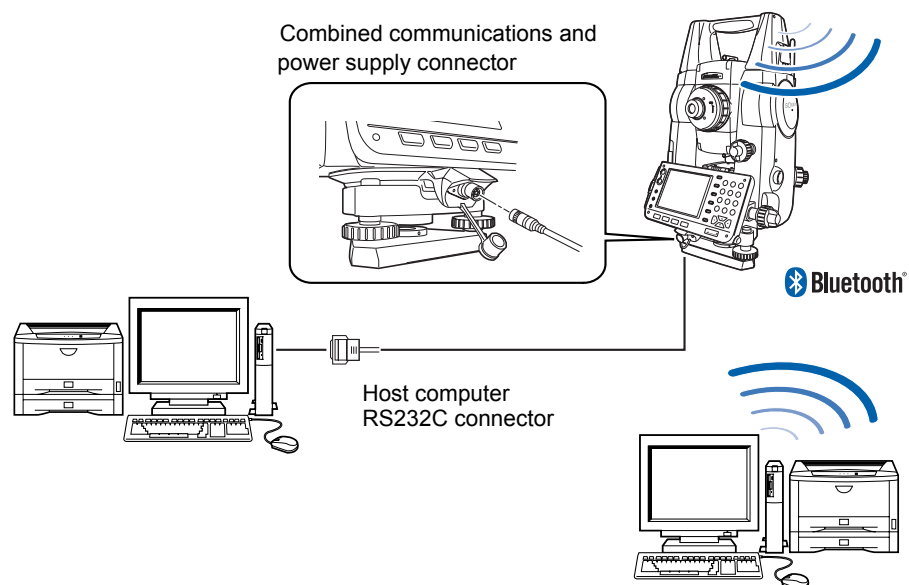
The SETX is also a convenient link to Sokkia's office-based plotting and design software.

With SETX instruments, you can define horizontal and vertical road alignments, or load the alignments from your computer. You can then set out the road by station and offset, including catch points. Sort out your points by azimuth to minimize set out time.

The SETX supports tangents, circular arcs, and spiral curves in the horizontal definition, and straight grades and parabolic curves in the vertical. The SETX also supports building faces in non-vertical planes.

## 1.1 Communication Setup

Observation data, after being obtained from Basic mode and stored in Program mode, can then be output to a host computer or other external instruments via an RS232C cable or wireless technology for further processing.



**NOTE** Interface cables differ depending on the external instrument being used. Contact your Sokkia agent for further information.

## 1.2 Understanding the Operating Modes

The SETX operates in two modes, which you can quickly and easily switch between as needed:

**Basic mode** .....Accesses total station functionality. This is the default mode. To switch to this mode when in Program mode, press **{PROGRAM}**. For Basic mode functions see the Operator’s Manual for your total station.

**Program mode** .....Accesses the SDR functionality. To switch to this mode, press **{PROGRAM}**.

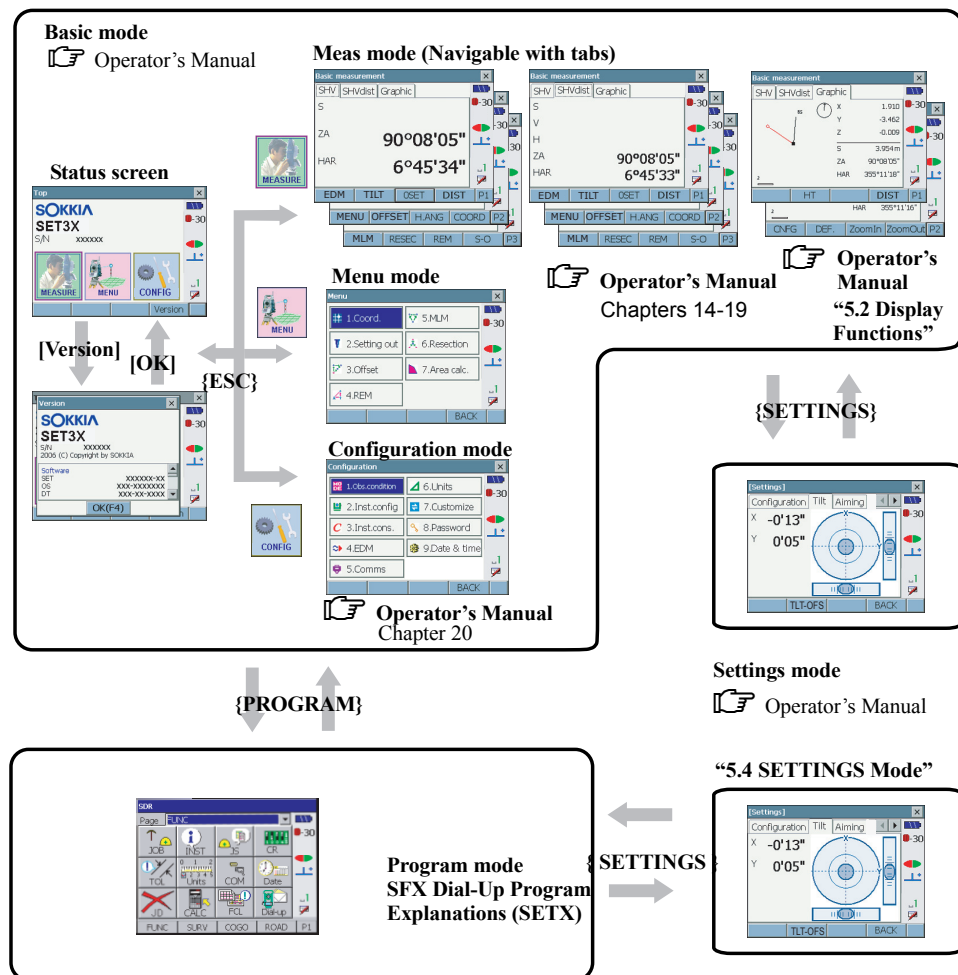


Figure 1: Mode structure

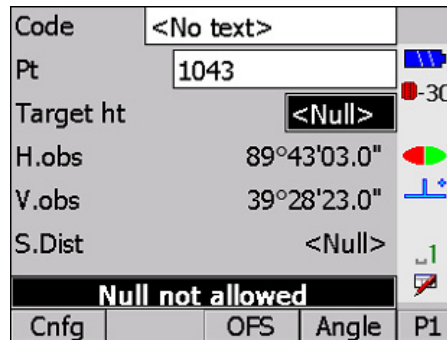
Switching between modes is not possible during distance measurement or while the motor is in operation.

For measurement programs in Program mode, see Chapter 3, **Understanding the SDR Menu Structure**.

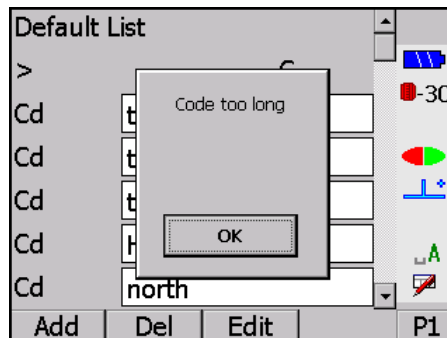
### 1.3 Understanding System Messages

Whenever the SETX cannot continue its normal operation, it displays a warning message.

Two types of system messages exist. The first type displays a message on one line of the screen (just above the softkeys or on the top line), while the rest of the screen remains intact. The message remains until you press any key. For example:



The second type of error message is a pop-up window in the center of the screen:

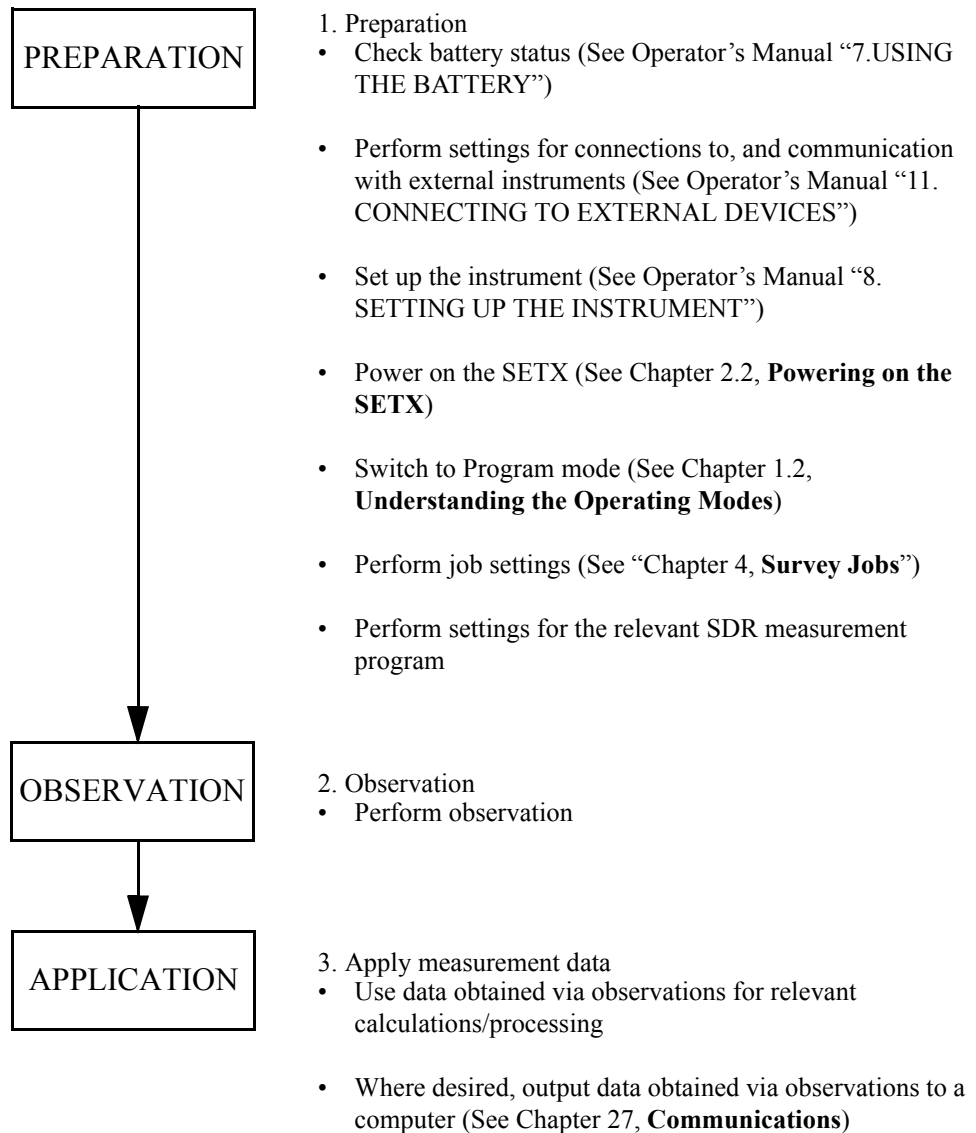


See Appendix A, **System Messages** for a full list of system messages and descriptions.

## In this chapter

- Operation procedure
- Power on


## 2.1 Operation Procedure



## 2.2 Powering on the SETX

Press {⏻} to power on the SETX. The SETX automatically performs self-check.

Press {⏻} + {⚙️} to power off the SETX.

-  In the event that the SETX fails to power on even when a battery is mounted, or the power fails shortly after the instrument is powered on, remaining battery power is insufficient for operation. Replace with charged battery as soon as possible. Leaving a fully-discharged battery mounted in the instrument will cause the backup lithium battery to discharge.
- The battery mark in the status panel will flash to indicate that the mounted battery requires charging. Terminate operation as soon as possible, power off the SETX, and charge the battery.
- To save power, power to the SETX is automatically cut off if it is not operated for a certain period of time.
- The screen for adjusting the touch panel will be displayed after the launch window when using the SETX or for the first time, or when a reset has been performed. For adjusting the touch panel, see “Chapter 10. POWER ON/OFF” of the Operator’s Manual for your total station.

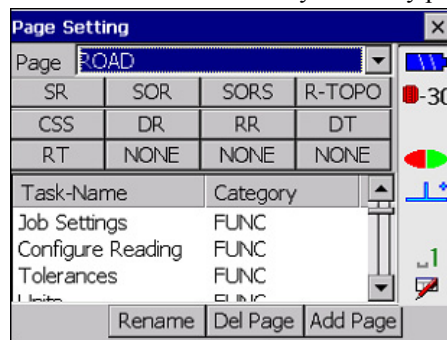
# Chapter 3

## Understanding the SDR Menu Structure

### In this chapter

- Menu structure and options
- Shortcut keys
- Entering notes
- Graphical view
- Options for the *Functions* menu

A menu provides a list of SETX actions or selections. You access the menus with the drop-down list box at the top of the SDR-Level 5 page or via the Menu softkey. You can return to the selected Program mode menu from almost any screen by pressing {ESC} repeatedly.



The SETX has four main menus:

- FUNC** .....(**Functions**) Used to set up or start survey jobs; also controls all communications between the SETX and any other devices like a PC (see Page 3-3).
- SURV** .....(**Survey**) Accesses programs frequently used in the field for data collection (see Page 3-16).
- COGO** .....(**Coordinate Geometry**) Performs coordinate geometry calculations and setting out field work (see Page 3-16).
- ROAD** .....(**Roading**) Contains programs for road survey, definition, and set out (see Page 3-17).

Each menu lists several options that are organized according to specific tasks. The options available on an SETX are shown in Table 1.

**Table 1: SETX Program mode menu structure**

Func	Surv	Cogo	Road
Job	Topography	Set out coords	Select road
Instrument	Traverse adjustment	Set out line	Set out road
Job settings	Resection	Set out arc	Set out road surface
Configure reading	Set collection	Resection	Road topo
Tolerances	Set review	Inverse	Cross-Section Survey
Units	Building face survey	Areas	Define road
Communications	Collimation	Intersections	Review road
Date and time	Remote elevation	Point projection	Define template
Job delete	Keyboard input	Taping from baseline	Review template
Calculator		Transformation	
Feature code list		Keyboard input	
Dial-up			

### 3.1 Navigating the Program Mode menus and Accessing Menu Options

The four Program mode menus are listed in the drop-down list at the top of the page. Select a menu from this list either by using the touch panel functionality or  $\{\blacktriangle\}/\{\blacktriangledown\}/\{\blacktriangleleft\}/\{\blacktriangleright\} + \{\blackleftarrow\}$  when the cursor is located on the drop-down list. Each menu is also represented by a softkey at the bottom of the softkey page 1.

There are 2 methods for activating menu options.

1. Both menus and menu options can be selected by using the touch-panel functionality.
2.  $\{\text{TAB}\}$  shifts the cursor to and from the menu drop-down list and through the menu option icons from top-left to bottom-right. Press  $\{\blackleftarrow\}$  to activate the selection menu option.

The title of the selected menu option will be displayed both in the screen title bar and the white caption bar on the icon itself.

Softkey pages can be added/deleted on the launcher page by pressing  $\{\text{Menu}\}$  in page 0 and using  $\{\text{Del Page}\}/\{\text{Add Page}\}$ . Menu options can be allocated to added pages according to user preferences.

### 3.2 Shortcut Keys

The following shortcut keys provide quick access to useful functions during measurement.

Table 3-1: Shortcut keys

Key operation	Function
$\{\text{READ}\}$ trigger key (on right side)	Initiates measurement/confirms input or selection
$\{\text{FUNC CTRL}\} + \{0\}$	Accesses the SDR database (see Chapter 5, <b>Viewing Survey Data</b> )
$\{\text{FUNC CTRL}\} + \{.\}$	Accesses the note input screen (see Chapter 3.3, <b>Entering Notes</b> )
$\{\text{FUNC CTRL}\} + \{+/-\}$	Accesses <Plan View> (see Chapter 3.4, <b>Using the Graphical View</b> )
$\{\text{FUNC CTRL}\} + \{4\}$	Accesses the calculator function (see Chapter 3.5.10, <b>Calculator</b> ).
$\{\text{FUNC CTRL}\} + \{6\}$	Accesses the <Take Reading> screen for basic measurement. (Same function as $\{\text{READ}\}$ key)

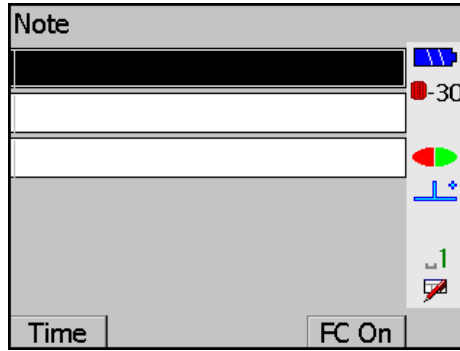
### 3.3 Entering Notes

Notes are used to enter additional information about an observation. A note can consist of three lines of 20 characters or a 60-character maximum. The note record is stored, printed, and transmitted as a continuous 60-character string, but is split on 20-character boundaries on the screen.

Notes can be entered into the database at any time by pressing  $\{\text{FUNC CTRL}\} + \{.\}$ .



An example of a note in screen display is shown below:



[TIME] may be pressed to store the current time and date. [FC ON]/[FC OFF] is used to turn on or off feature codes.

You will not see [FC ON]/[FC OFF] if the **Code list active** option is set to **No** on the **Configure Reading** screen (see Chapter 3.5.4, **Configure reading**).

If you want to insert a feature code into a note, press [FC ON]. When you enter a note, the SETX will open the feature code library (or stack) if it recognizes a word in the currently selected stack. If your word is in the feature code stack, select it by scrolling to it rather than manually entering it. For additional information on feature codes, see (see Chapter 7, **Feature Codes and Attributes**).

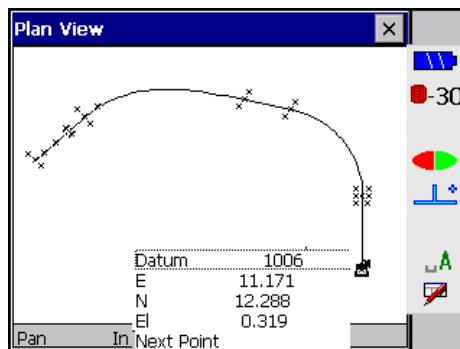
Press {←} to store the note in the database, press {ESC} to discard it.

### 3.4 Using the Graphical View

To assist the user SDR Level 5 provides a graphical view of all collected points, stations, and positions contained in the current database. Thus allowing the user a visual aid in which to determine if the site location has been collected satisfactorily. This view can be accessed at any time by pressing {FUNC CTRL} + {+/-}.

Point name (Datum), coordinates (E, N), and elevation (El) for measurement points can be ascertained by tapping points on the touch panel. Tapping “Next Point” will shift to the information for the next measurement point.

All observations are depicted with a cross (×), keyboard input positions a square (□), and all stations with a triangle (△).



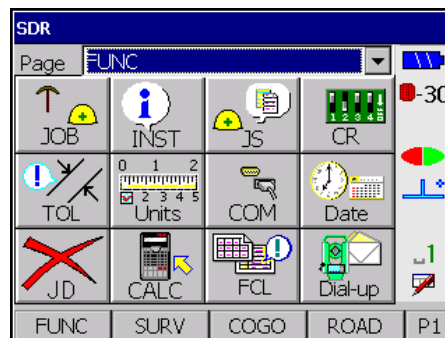
The functions below can be activated by tapping the relevant display or pressing the relevant function key.

**Table 3-2: Plan View Functions**

Display	Function key	Function
“Pan” (“Select” displayed)	F1	When “Pan” is selected (“Select” displayed), tapping an area on the touch panel with the stylus pen will center the screen on the selected area.
“Select” (“Pan” displayed)	F1	When “Select” is selected (“Pan” displayed), tapping a point on the touch panel with the stylus pen will display information for that point.
“In”	F2	Zooms in.
“Out”	F3	Zooms out.
“To Fit”	F4	Returns to the original orientation display.

### 3.5 FUNC Menu

The **Functions** menu is used to set up or start survey jobs. The **Functions** menu screens are shown below:



The **Functions** menu contains the following options:

- Job**.....Create or select a survey job (see Page 3-5)
- Instrument**.....Specify your instrument or total station (see Page 3-5)
- Job settings**.....Review or change job specifications (see Page 3-6)
- Configure reading**.....Specify the number, type and manner of field readings (see Page 3-6)
- Tolerances**.....Specify the desired measurement precision (see Page 3-9)
- Units**.....Specify the units of measurement (see Page 3-10)
- Date and Time**.....Check or set the time of day and date (see Page 3-12)
- Job delete**.....Remove jobs, roads, and templates (files) from the SETX (see Page 3-13)
- Calculator**.....Provides an RPN calculator function.
- Feature code list**.....Manage one or more lists of feature codes (see Page 3-15)
- Communications**.....Transfer data between the SETX memory and a PC (see Page 3-12)

**Dial-up** ..... Transfer data using SFX function (see SFX Dial-Up Program Explanations (SETX))

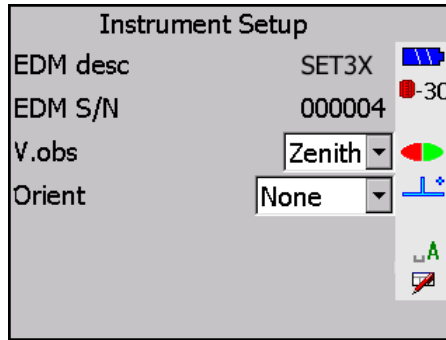
### 3.5.1 Job

The **Job** option is used to perform the following tasks, which are further discussed in Chapter 4, **Survey Jobs**:

- Select an unfinished job from a list
- Start a new job
- Rename a job
- Display the statistics of a job
- Mark a job as a control job

### 3.5.2 Instrument

The instrument screen displays information about the instrument and gives you access to various parameters.



The **Instrument Setup** fields display the following information:

- EDM desc** ..... (*information only*) The type of EDM, which transmits in the instrument record.
- EDM S/N** ..... (*information only*) The six-digit numeric field for the EDM serial number, which transmits in the instrument record.
- V.obs** ..... The vertical observation selector field displays if the instrument has more than one way of measuring its vertical angle. **Zenith** - angles are measured with the upward vertical representing 0°, and **Horiz** - angles are measured upwards from horizontal representing 0°.
- Orient** ..... Controls the setting of the horizontal circle at the time of a backsight reading. **Zero** automatically sets the horizontal to zero; averaged **F1/F2** values are not allowed, **Azimuth** automatically sets the computed azimuth; averaged **F1/F2** values are not allowed, and **None** makes no change.

### 3.5.3 Job settings

The **Job Setting** option is discussed in Chapter 4, **Survey Jobs**.

### 3.5.4 Configure reading

The **Configure reading** screen controls aspects of observation measurement and recording. For an explanation of any icons you might see in this screen, see the Operator's Manual for your total station.

**Auto pt num** ..... If you do not enter a point designator, this is the next designator that SETX automatically suggests. Once a point designator has been suggested and accepted, the SETX automatically adds an increment to determine the next value. For example, point 1000 is followed by 1001, and PIPE8 is followed by PIPE9 and then PIPF0. HELLO is followed by HELLP. The sequence continues until HELLZ, which is followed by HELMA.

**Topo view stored** ..... Stored observation records can be viewed in several forms. This field controls in which view observations are initially displayed using the topography program. Options are as follows:

**Table 4: Observation Record Views**

View	Description
<b>OBS</b>	Raw observation view
<b>MC</b>	Measured and corrected view
<b>RED</b>	Reduced view
<b>POS</b>	Position view

**NOTE** Data is always stored internally in raw form. You can change the current view any time using the data view as described in Chapter 5, **Viewing Survey Data**. **Topo view stored** defines the initial view when the record is stored in the database. Also see Chapter 6, **Coordinate Search Logic**. For information on the options for outputting data, see Section 27.2, *Specifying the output format of observations*, Page 27-3.

**Combine F1/F2** ..... When this field is set to **Yes**, the **Topography** program prompts you for two observations, one from each face of the instrument. The two readings are then combined to produce an averaged observation record.

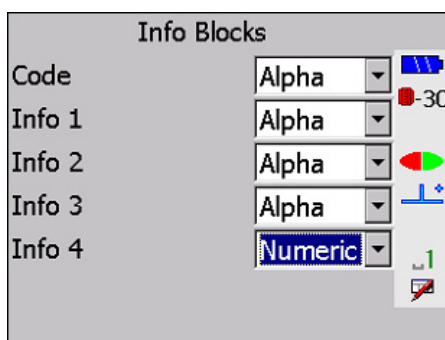
- # dist rdgs** ..... This field specifies the number of distance readings you will take for each point. Values from 1 to 9 are allowed. If 0 is used, an angles-only reading is taken.
- Code list active** ..... When this field is set to **Yes**, any code field will use the feature code list for quick entry of codes as described in Chapter 7, **Feature Codes and Attributes**. When this field is set to **No**, use normal entry of alphanumeric data in the code field. See *Code fields on?*, Page 3-8 for variations.
- Info blocks** ..... This field will split your note records into specific fields that contain different types of data. For more information, see *Info blocks*, Page 3-7.
- Code fields** ..... This field determines whether codes (on observations or point records) are split into sub-fields. For more information, see *Code fields on?*, Page 3-8.
- Recip Calc** ..... This field specifies how the SETX performs reciprocal vertical calculations. For more information, see *Recip calc*, Page 3-8.

**3.5.4.1 Info blocks**

This feature provides compatibility with Wild’s Info Block style of data entry. It should not be confused with the Attribute definition capability of the SETX’s feature code list, which is more powerful. Use this field to split your note records into specific fields that contain different types of data (information blocks).

Specify the number of extra fields that you want to fill in. If this number is zero, then a note is one continuous alphanumeric string up to 60 characters long. If the number of info blocks is more than zero, then entry of notes is done as a number of fields. The first field is called the codes, and subsequent fields are called “Info 1,” “Info 2” etc., up to the specified number of information blocks. The maximum number of blocks is five.

When you enter a non-zero number of information blocks, the following type of screen appears. Select whether the field should be numerical or alphanumeric by using the {◀} or {▶} key.



Press {◀} when you have chosen **Alpha** or **Numeric** for each field.

For example, if you specified four info blocks, a note entry might appear as:

Code	TREE	
Info 1	OAK	30
Info 2	WHITE	
Info 3	GIRTH	
Time		

The code and each info block are allocated eight characters each and are combined in a single note record. The above example would generate a note record with the text:

Tree            Oak            White Girth            3.0

### 3.5.4.2 Code fields on?

This feature provides compatibility with the Zeiss style of code entry. This field determines whether codes (on observations or point records) are split into sub-fields. The number specifies the total number of sub-fields. The maximum is seven. When you specify a number of code fields greater than one, you can specify the size of each field:

Code Fields		
Field 1	3	30
Field 2	2	
Field 3	1	

The SETX suggests possible default values for the sizes of the fields. The total size of all the sub-fields must be less than or equal to 16; this number includes a space between each sub-field.

No buffer exists to stop characters in one sub-field from overflowing into the next sub-field. Here is an example of field code entry with three fields:

Key in Azimuth		
Cd	GORE Dle	30
To pt	2	
From	1	
Azimuth	<Null>	

**NOTE** Generally, if you are using code fields, disable feature code lists.

### 3.5.4.3 Recip calc

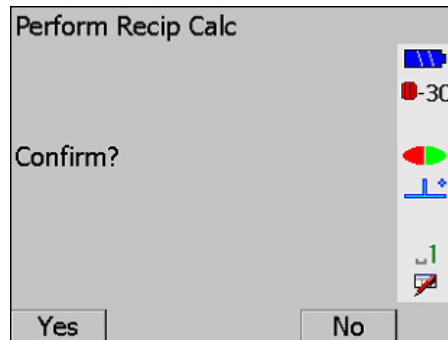
The *Recip Calc* field specifies if and/or how the SETX performs reciprocal vertical calculations. The options are as follows:

**Always** .....The SDR will search the survey database to determine whether the observation you are about to make is one for which a reciprocal calculation is appropriate.

For example, earlier in your survey, you observed station #2 from station #1. You are now set up over station #2 and are about to backsight to station #1.

In this case, the SETX will automatically perform the reciprocal calculation refining the elevation of station #2 and add note records to the database indicating a reciprocal calculation was performed.

**Prompted** .....The SETX will display the following screen before performing a reciprocal calculation:



**Never** .....You will receive no prompt and reciprocal calculations will **not** be performed.

### 3.5.5 Tolerances

The SETX checks observations for consistency within specified tolerances. These tolerances are used at several places in the software:

- When observations are made to a point using both faces of the instrument, the two readings are compared after the collimation correction is applied. This comparison happens in topography when the **Combine F1/F2** configuration option is **On**. It also occurs during set collection if observations are being made on both faces. If the observations differ from the average by more than the specified tolerance, in the distances, vertical or horizontal angles, the SETX will notify you.
- During set collection, each observation to a point is compared with the other observations to the same point. If the observation differs from the average by more than the specified tolerance, in distances or in vertical or horizontal angles, the SETX will notify you.
- When reviewing sets of data, any observations that are out of tolerance will be marked with an asterisk.
- When you observe an existing point in topography, the SETX will show you the difference between the expected observation and your actual observation. If this difference is out of tolerance, it will be indicated with an asterisk.
- When the SETX performs a resection using a least squares adjustment, the weighting of the observations is derived from the tolerances. For this purpose, the tolerance is assumed to be the value of three standard deviations ( $3\sigma$ ).

### 3.5.5.1 Tolerance fields

The tolerance screens are used to specify the tolerances applied to observations. The tolerance screen is shown below.

**Tol H.obs**.....This field specifies the horizontal observation tolerance as an angle field. A tolerance of zero is not allowed.

**Tol V.obs** .....This field specifies the vertical observation tolerance as an angle field. A tolerance of zero is not allowed.

**EDM tol (mm)**.....EDM fixed tolerance in millimetres specifies the EDM error that is independent of the length of line measured.

---

**NOTE** This field is always in millimetres, even if the current distance units are feet.

---

**EDM tol (ppm)**.....EDM tolerance in parts per million specifies the EDM error that is proportional to the length of line measured. The EDM tolerance is the sum of the *EDM tol* (mm) field, plus this field times the length of the line, divided by one million. A tolerance set to zero tells the SETX not to check EDM tolerances.

### 3.5.6 Units

The SETX can use different measurement units in different work environments. Units can be changed at any time without invalidating stored data. For example, if a coordinate in the SETX has an elevation of 100.000 meters, it would automatically change to 328.084 feet when the units are changed.

After selecting **Units** from the *Functions* menu, the following settings are available:

**Angle**.....Angle units apply to all horizontal and vertical angle measurements and azimuths. Units can be degrees, quadrant bearings, gons, or mils.



The SETX assumes horizontal angles and azimuths are always measured turning to the right. Selecting quadrant bearing units only affects the display of bearings (30° displays as N30°E); the underlying units are still degrees.

The conversion factors are 90° = 100 gons and 90° = 1,600 mils.

**Dist** .....Distance units can be meters, (International) feet, or US feet. The unit chosen applies to all distances, lengths, and coordinates.

The conversion factor used is *1 International foot = 1.000002 US feet = 0.3048 meters.*

For distances in land surveying, the difference between the International foot and the U.S. Survey foot is less significant than the error inherent in EDM instruments. However, this factor should be taken into account in certain situations, such as using state plane coordinate system values.

**Coord** .....Coordinate units do not refer to the coordinate values, but to the order in which they are displayed. Options are:

**Table 5: Coordinate Unit Display**

Coordinate Unit	Description
N-E-Elv	North, East, Elevation
E-N-Elv	East, North, Elevation
S-W-Elv	South, West, Elevation
W-S-Elv	West, South, Elevation

**Other grades** .....This grade unit will be applied to all crossfall occurrences including the definition of the actual templates in ROADING (with the exception of the sideslope grades as discussed below). Options are:

Grade Unit	Example
Ratio	1:10
Percent	10%

**Sideslope grade** .....The sideslope is the crossfall which joins the edge of a roading template and the existing terrain at a catch point. It can be set independently of other grades with this unit. The options are the same as for *Other grades*.

**Sta...ing** .....This field controls how stationing values are displayed. The options are **10+00**, **1+000** and **1000**.

**Decimals shown** .....This field controls how many decimal places are shown. The options are **2**, **3**, and **4**. The number will be rounded at that decimal place.

**NOTE** The units used in Program mode for temperature and atmospheric pressure will be the same as those set in Basic mode.

### 3.5.7 Communications

The **Communications** item controls all communications between the SETX memory and other equipment, such as a host computer or a printer. Use **Communications** to print reports of data or to send and receive data to and from your office computer. It is also possible with the SETX to print data to file in a specified data format. The first screen shown when **Communications** is selected asks you to select a data format.

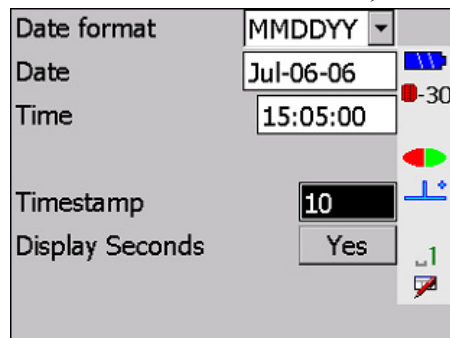


You can select from **SDR**, **Printed**, **Delimited Text**, **Plotted**, **Cut sheet**, **ICS**, **SDMS Output**, or **MOSS**. For more information, see Chapter 27, **Communications**.

### 3.5.8 Setting the time and date

Time and date are maintained automatically by the SETX. Current time and date are displayed on the start-up screen and on the date and time screen.

After selecting **Date and Time** from the **Functions** menu, this screen appears:



**Date format** ..... This field controls date entry in the **Date** field. The options are DDMMYY, MMDDYY, and YYMMDD.

**Date** ..... The **Date** field shows the current date. Change it by entering a new date, in the form *ddmmyy* or *mmddy*, depending on the **Date format** field setting.

**Time** ..... The **Time** field shows the current time. You can change it by entering a new time in the form *hhmmss* where *hh* is hours (in 24-hour form), *mm* is minutes, and *ss* is seconds. The SETX generates automatic timestamp records as described below.

**Timestamp** ..... Timestamp is an automatic record of the time stored with data.

This field specifies the number of minutes between automatic timestamps. Whenever data is stored, the SETX checks to see whether the specified length of time has elapsed since the last timestamp record. If it has, a new timestamp record is entered automatically.

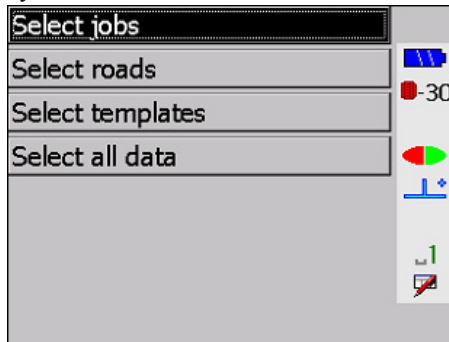
If the timestamp interval is set to zero, the SETX will not generate timestamps.

Timestamps can be inserted into the database by pressing [TIME] when entering a note.

**Display seconds**.....The Display seconds option allows you activate/deactivate the seconds (ss) section of the timestamp.

### 3.5.9 Job delete

Use the **Job delete** item to delete jobs, roads, templates, or all data from the SETX. The following screen is displayed when **Job delete** is selected.

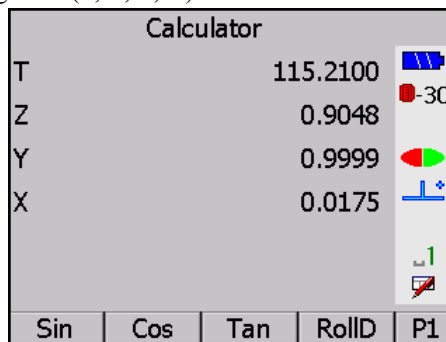


For more information, see Section 4.7, *Deleting a Job*, Page 4-6.

### 3.5.10 Calculator

SDR Level 5 provides a Reverse Polish Notation (RPN) calculator. This calculator can be activated by pressing {FUNC CTRL} + {4} or selecting **Calculator** from the *Functions* menu.

The calculator has 4 registers (T, Z, Y, X)..



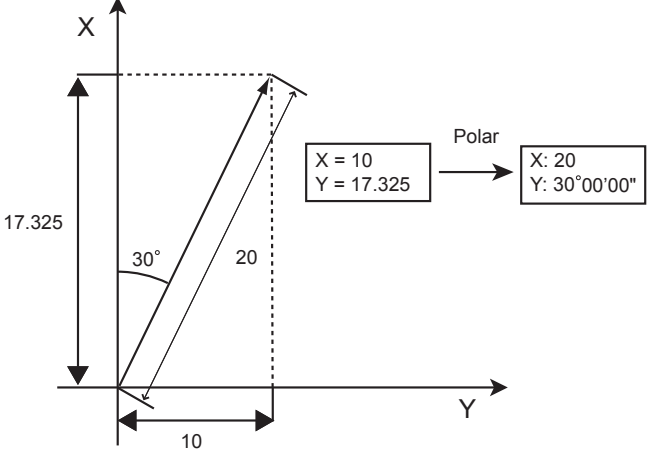
#### Calculator softkey list

Use the right arrow key to shift the softkey page by 3 pages.:

**Table 6: Calculator softkeys**

Softkey	Function
[Sin]	Finds sine value for X value.
[Cos]	Finds cosine value for X value
[Tan]	Finds tan value for X value.
[RollD]	Rolls the stack down.
[ASin]	Finds sine angle for X value.
[ACos]	Finds cosine angle for X value.
[ATan]	Finds tan angle for X value.

Table 6: Calculator softkeys

Softkey	Function
[Roll]	Rolls the stack up.
[ClrM]	Clears all memories.
[°"]	Informs the calculator that the input value is in “degrees-minutes-seconds” (DMS) format, not just a decimal number.
[°"/.]	Switches a DMS format value to a decimal number.
[Σ +] / [Σ -]	Operate on sigma memories.
[Σ RCL]	Recalls a sigma memory.
[Rect]	Converts entered azimuths and distances to rectangular ordinates.
[RclPt] / [StoPt]	Moves northings and eastings between the current JOB and calculator.
[Σ CLR]	Clears sigma memories.
[Polar]	Converts X and Y coordinate values to polar coordinate values. 
[√]	Finds square root of X value.
[+/-]	Switches X value from a positive to a negative value and vice versa.
[X-Y]	Switches the values in the X and Y registers.
[LastX]	Retrieves the last input value into the X register.
[Sqr]	Finds square of X value.
[1/X]	Finds inverse of X value.
[PI]	Inputs pi value in X field.
[ClrM]	Clears all memories.
[Store]	Stores a number or angle.
[Rcl]	Recalls a number or angle.

**General operation**

Any field in SDR Level 5 that requires a numeric entry may be populated from the calculator by selecting {FUNC CTRL} + {←}. The value in the X register will be used to populate the field the cursor was in when the calculator was launched.

RPN allows equations to be entered algebraically. For example to enter the equation  $2*(3+2)$  the user would key in the following 2 Enter 3 Enter 2 + \*.

### Angle operation

When keying in a degree-minutes-seconds (DMS) angle value, pressing [°"] will inform the calculator that this value is in DMS format not decimal format. Pressing [°"/.] has the reverse effect. If the number in the X register is in angle format and the entry field is in numeric, no value is used to populate the original field.

If the X register holds a decimal number and the data entry field is an angle field, the calculator will assume the number is in decimal degrees (DD.ddddd), convert it to DD.MMSS format, and return it to the data entry field.

If the X register has a number in DMS format, and the data entry field is an angle field, the number will be written to the data entry as DD.MMSS.

### Calculator memory

There are six user memories numbered 1 to 6. Numbers and angles can be stored by pressing [Store]. To add, subtract, multiply, or divide with a memory, press [Store], enter the +, -, ×, or ÷ symbol using the input panel (see the Operator's Manual for your total station), then enter the memory number. To recall a memory, press [Rcl] and enter the memory number.

Memories 5 and 6 are the sigma memories. If they are non-zero, they are displayed on the bottom two lines. The sigma keys ([Σ +]/[Σ -], [Σ RCL], [Σ CLR]) described below operate on both of these memories at once. The [Σ CLR] softkey clears both sigma memories. [ClrM] clears all memories including the sigma memories.

### Accessing the current JOB with the calculator

The [RclPt]/[StoPt] softkeys allow you to move northings and eastings between the current JOB and the calculator stack. After pressing [RclPt] you are prompted for a point number. If the point number does not exist you may key in the coordinates. The northing corresponds to the Y register, and the easting to the X register. After pressing [StoPt] you are prompted for the code, point number, and elevation before the point is stored in the JOB.

## 3.5.11 Feature code list

See Chapter 7, **Feature Codes and Attributes** for details on the specification and use of feature codes and attributes.

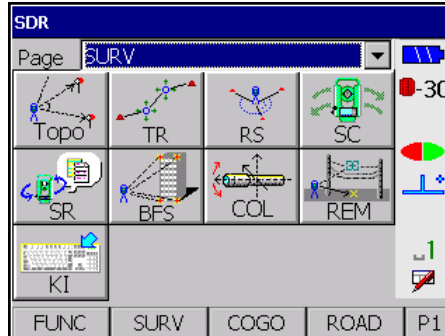
## 3.5.12 Dial up

See SFX Dial-Up Program Explanations (SETX) for details of data communication using SFX dial-up technology.

### 3.6 Survey menu

The **Survey** menu contains the programs most frequently used in the field for data collection. The **COGO** menu also is used for field work.

The **Survey** menu contains the following options, which are described in the chapters indicated.

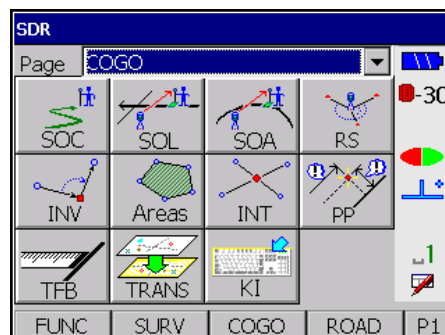


- **Topography** (Chapter 8, **Topography Observations**)
- **Traverse Adjustment** (Chapter 9, **Traverse Adjustment**)
- **Resection** (Chapter 10, **Resection**)
- **Set Collection** (Chapter 11, **Set Collection**)
- **Set Review** (Chapter 11, **Set Collection**)
- **Building Face Survey** (Chapter 12, **Building Face Survey**)
- **Collimation** (Chapter 13, **Collimation Errors**)
- **Remote Elevation** (Chapter 14, **Remote Elevation**)
- **Keyboard input** (Chapter 15, **Keyboard Input**)

### 3.7 COGO menu

The **COGO** menu contains programs used frequently in the field for coordinate geometry calculations and setting out field work. The **Survey** menu can also be used for field work.

The **COGO** menu contains the following options, which are described in the chapters indicated.



- **Set Out Coords** (Chapter 16, **Set Out Design Coordinates**)
- **Set Out Line** (Chapter 17, **Set Out Line**)
- **Set Out Arc** (Chapter 18, **Set Out Arc**)
- **Resection** (Chapter 10, **Resection**)
- **Inverse** (Chapter 19, **Inverse**)
- **Areas** (Chapter 20, **Area Calculation and Subdivision**)
- **Intersections** (Chapter 21, **Intersections**)

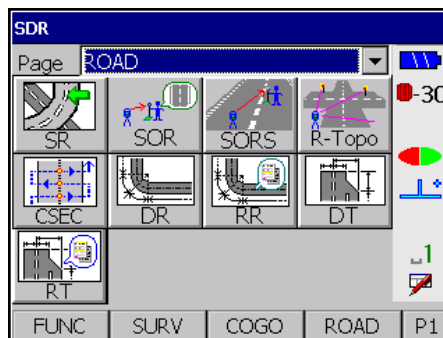
- **Point Projection** (Chapter 22, **Point Projections**)
- **Taping from the Baseline** (Chapter 23, **Taping from Baseline**)
- **Transformation** (Chapter 24, **Transformations**)
- **Keyboard Input** (Chapter 15, **Keyboard Input**)

**Resection** and **Keyboard input** are in this menu, as well as in the **Survey** menu, since these options are useful in both.

### 3.8 Roding menu

The **Roding** menu contains programs used in the surveying, definition, and setting out of roads.

The **Roding** menu contains the following options, which are described in the chapters indicated:



- **Select Road** (Chapter 25, **Roding**)
- **Set Out Road** (Chapter 25, **Roding**)
- **Set Out Road Surface** (Chapter 25, **Roding**)
- **Road Topo** (Chapter 25, **Roding**)
- **Cross-Section Survey** (Chapter 26, **Cross-Section Survey**)
- **Define road** (Chapter 25, **Roding**)
- **Review road** (Chapter 25, **Roding**)
- **Define template** (Chapter 25, **Roding**)
- **Review template** (Chapter 25, **Roding**)

# Chapter 4

## Survey Jobs

### In this chapter

- Creating a new job
- Selecting an existing job
- Viewing job statistics
- Changing a job name
- Designating a control job
- Verifying the name of a job
- Deleting a job
- Modifying job settings

The SETX works on one survey job (file) at a time, unless a second job has been designated as a control job. This way, points can have identical names as long as they are in different job files.

Some settings, notably instrument settings, are remembered from job to job, so it is unnecessary to set them for each new job.

### 4.1 Creating a New Job

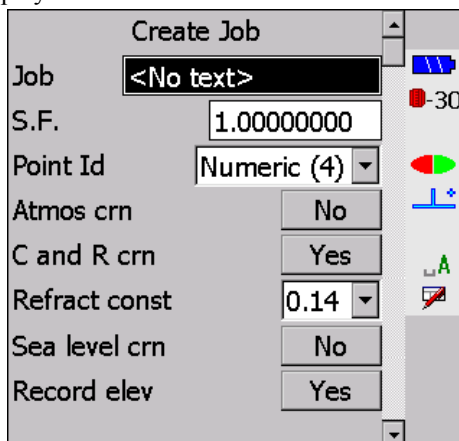
You can create as many jobs as required.

1. Select the **Job** option from the **Functions** menu (see Section 3.4, *Using the Graphical View*, Page 3-3). The **Select Job** screen displays.



**NOTE** If no jobs are available in the SETX, the **Create Job** screen appears when you select **Job** from the **Functions** menu.

2. Press [New] to display the **Create Job** screen.





3. Enter information in the following fields:

**NOTE** Most values may be changed with **Job settings** on the **Functions** menu. For more information, see Section 4.7, *Job settings*.

**Job**.....This field holds the name of a new job. Enter a name with any combination of letters and numbers, up to 16 characters long.

**S.F.**.....(*Cannot be changed later*) This field holds the **Scale Factor** of the job. This is a plane scale factor, so if your job is using a transverse mercator projection you will need to calculate a suitable scale factor for your work area.

The scale factor is applied whenever observations are reduced to generate coordinates. It is also applied in reverse to generate set out measurements.

**Point ID** .....(*Cannot be changed later*) This field specifies the length and type of point names in the job. The two options are as follows:

**Table 7: Point ID Field Length**

Field	Length	Description
<b>Numeric</b>	4	Point names contain four digits; compatible with the SDR20 series of data collectors.
<b>Alpha</b>	14	Point names may contain 14 characters, both letters and digits.

**NOTE** If you choose to use alphanumeric point names, verify that your office software will process them correctly. (The output formats differ from the SDR2x formats.) The Sokkia software modules prior to version 4.02 do not support the alphanumeric point names. Sokkia software versions 4.02 and above support this new format.

**Atmos crn** .....If atmospheric correction is set to **Yes**, the SETX applies an atmospheric correction to observations based on the current temperature, pressure and humidity values. Calculation details are given in Section 29.2.2, *Pressure and temperature correction*, Page 29-3.

**C and R crn** .....If curvature and refraction correction are set to **Yes**, the SETX applies a correction to allow for the curvature of the earth and refraction of the EDM beam through the atmosphere. Calculation details are given in Section 29.3.1, *Curvature and refraction correction*, Page 29-5.

**Refract const** .....(*Available only when C and R crn is set to Yes*) The refraction constant is the coefficient of refraction used in the calculation of curvature and refraction correction. It is a selector field with the options 0.14 and 0.20.

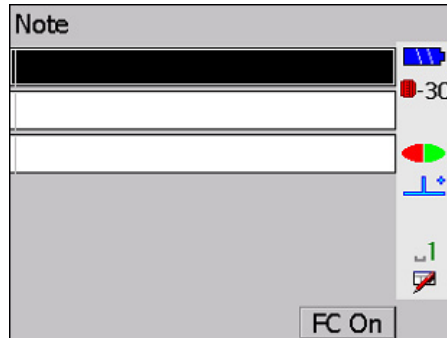
**Sea level crn** .....If sea level correction is set to **Yes**, the SETX reduces a horizontal distance at the elevation of the instrument station to the corresponding (shorter) sea level chord when generating coordinates. Calculation details are given in Section 29.3.2, *Sea level correction*, Page 29-5.

**Record elev** .....(*Cannot be changed later*) The SETX generally expects that points are in three-dimensional space. However, if you want to assume that all or some points lie in a plane, set the **Record elev** to **No**. Points will be assigned the same (indeterminate) elevation.

**NOTE** When **Record elev** is set to **No**, corrected records are given a vertical angle of 90°. This forces all subsequent calculations to take place in two-dimensional (horizontal) space.

- Once you have set these job parameters, press {FUNC CTRL} and {←}.

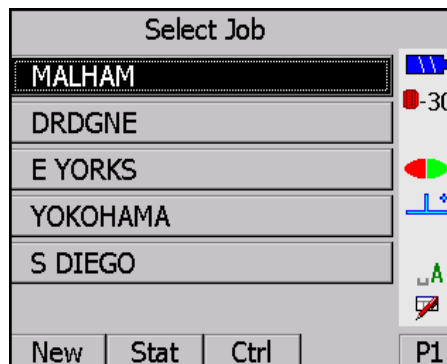
The **Note** screen displays. You can then enter an unlimited number of job notes. Press {←} when finished entering notes.



## 4.2 Opening an Existing Job

You can access an existing survey job with the following steps.






- Select **Job** from the **Functions** menu. The **Select Job** screen displays.



- Tap the name of the job you want or select using {▲}/ {▼} and then press {←}.
- Press {ESC} or {←} to return to job selection.
- Press {←}. The selected job will become the current job.

### 4.3 Accessing Job Statistics

[Stat] displays the job statistics for the job selected on the *Select job* screen. A typical statistics screen is shown below:

Job Statistics		
ID	MALHAM	 -30
Job size (k)	42	
Recs used	362	
Date	Jul-06-06	
Time	23:34:54	
Point count	74	






- ID** .....Displays and allows modification of the job name
- Job size (k)**.....Displays the size of the job, in kilobytes, that the job currently occupies in memory.
- Recs used** .....Displays the approximate number of records (point positions, observations, notes, etc.) currently stored in the job.
- Date and Time** .....Displays the date and time that the job was last accessed. The date and time will **not** necessarily relate to the last time data was saved in the job. For example, selecting a job as the current job accesses the job files and updates the date and time.
- Point count** .....Displays the number of points currently stored. A new job will have a point count of 0.

Press {←} or {ESC} to return the *Select job* screen.

### 4.4 Renaming a Job

You can change the name of an existing job with the following steps.

1. Highlight the name of the job on the *Select Job* screen and press [Stat]. This will present you with a screen similar to the following.

Job Statistics		
ID	MALHAM	 -30
Job size (k)	42	
Recs used	362	
Date	Jul-06-06	
Time	23:34:54	
Point count	74	

2. The *ID* field displays the current name for the job. You can edit this field to enter the new name for the job.
3. Press {←} to complete the entry and change the job name. You will then be returned to the *Select Job* screen with the new job name displayed.

## 4.5 Specifying a Control Job

Often, when you are working within a job, you want to use points that already are present in another job. **[Ctrl]** allows you to “tag” a job to act as the “control” job. Once you have done this, if you specify a point name that does not exist in the job you are currently working on, the SETX also will search through the control job to see if a point with the specified name exists within it. If the point exists in the control job, the point details will automatically be copied into the current job ready for use within the job. If the specified point does not exist in either the current or control job, the standard **Search failed** message will be displayed, and you will be given the opportunity to enter the point details.

Only one job can be tagged as a control job at any one time.

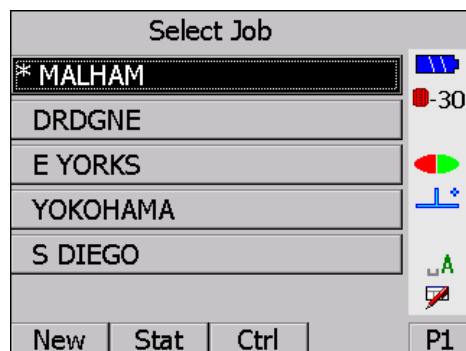
Control jobs will usually work even if the current job and control job have different point ID types. The SETX searches for the best point name match. For example, “12” in an alphanumeric point job matches “0012” in a numeric point job and vice versa.

A note is always stored if a new point is copied from a control job.

An optimal way to use this control job facility is to create a special control job. Store all the control point coordinates you most often use and give them unique point names. You can then tag this job as the control job and it will provide the control point coordinates that you can use in other jobs.

### Steps to determine a control job

1. Select **Job** from the *Functions* menu. The *Select Job* screen appears.



2. Use **{▲}**/**{▼}** to highlight the name of the job you want, and then press **{←}**.
3. Press **[Ctrl]**. An asterisk (\*) will be displayed to the left of the job name to indicate that it has been selected as the control job. To deselect the job as a control, press **[Ctrl]** again.

**NOTE** If another job was already tagged as the control job, then it will automatically lose this status in favor of the newly-selected control job. If you press **[Ctrl]** on the currently-tagged control job, it will de-select the job.

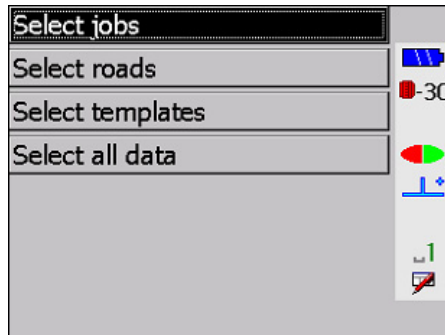
## 4.6 Verifying the Current Job

Job details for the current job such as job name and free records remaining are displayed immediately after selecting an option from one of the four Program mode menus.

## 4.7 Deleting a Job

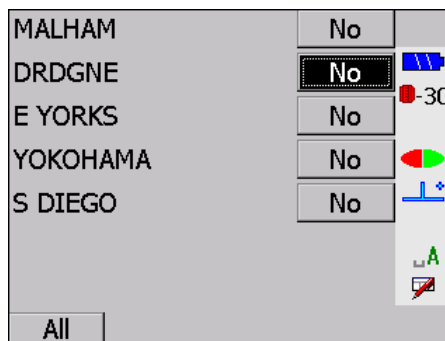
Once you have transmitted a job to your office computer (or printed it out on a printer), you can remove it from memory.

1. Select **Job Delete** from the *Functions* menu.

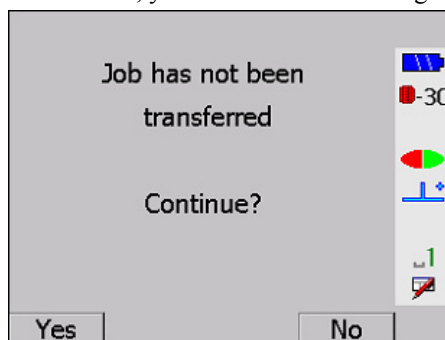


This screen is used for the deletion of roads and templates, as well as survey jobs, so you need to select what you are removing (this may vary, depending on your configuration).

2. Highlight *Select jobs* and press {←}. The SETX will display the list of jobs with a **No** following the name.



3. Place the cursor on the jobs you want to delete, and use the arrow keys to toggle settings from **No** to **Yes**; or select [**All**] to select all jobs for deletion.
4. If a job has not been transferred, you will see the following message:



Select [**Yes**] to continue, or [**No**] to return to the *Job Delete* screen.

5. Press {←} to delete the job(s).

## 4.8 Modifying Job Settings

You can review the choices you made when you created a job. Select **Job setting** from the **Functions** menu to display the **Job settings** screen:

Job Settings	
Job	MALHAM
Atmos crn	No
C and R crn	Yes
Refract const	0.14
Sea level crn	No
Record elev	Yes
S.F.	1.00000000
Point Id	Alpha (14)

The **Job settings** screen lets you change some of the options on the **Create job** screen. You cannot change the point ID type, scale factor or records elevation choices that you selected at creation time. Changes made on the **Job settings** screen do not affect data that has already been collected. These changes affect only subsequent data points.

If anything on this screen is changed, a NOTE JS will be saved on the database. This note contains a four-digit sequence.

Table 8: NOTE JS Sequence

Digit in Sequence	Represents	Entry options
First	Atmospheric Corrections	0 = Off 1 = On
Second	Curvature and Refraction Correction	0 = Off 1 = On
Third	Sea Level Corrections	0 = Off 0 = On

This note record is primarily used by a software package (for example, Sokkia software). It will not indicate to you anything other than when job settings were changed.

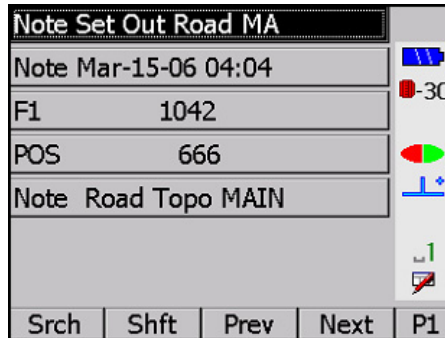
# Chapter 5

# Viewing Survey Data

### In this chapter

- Viewing stored data
- Searching for data
- Editing notes and codes
- Observation views

Stored SETX data can be viewed at any time by pressing {FUNC CTRL} + {0}. You see the following screen:

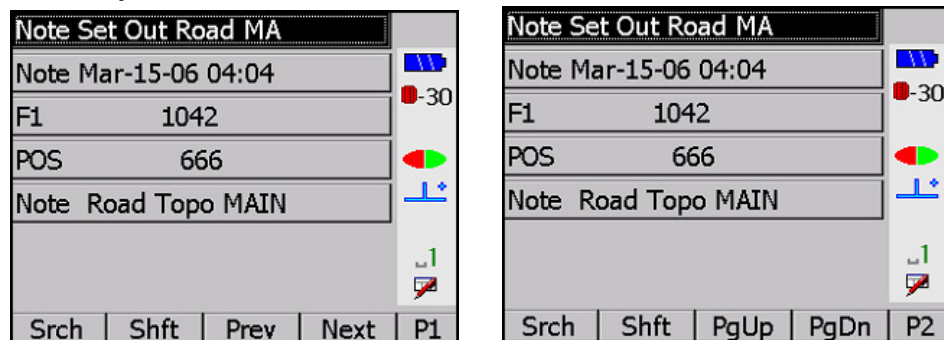


Each line corresponds to one record in the SDR database. New records are added to the end of the database so record order is chronological. The only exception is NOTE records, which can be added anywhere in the database when viewing recorded data. The note is entered immediately before the record currently highlighted.

Information displayed for each record includes record type, the derivation code (indicates which part of the program generated the record), and the first data field of the record.

## 5.1 Reviewing the Database

From the initial database review screen, you can view a list of the records corresponding to the current job.



When this screen is first accessed, the highlight bar is on the last record. {▲} and {▼} move the highlight bar forward or backward one record at a time. Several softkeys also are available to help you navigate in review mode:

[Srch] .....Allows you to search backward or forward for a particular point name or code.

[Shft] .....Toggles the last two softkeys from [Prev] and [Next] to [PgUp] and [PgDn]

**[Prev]** .....Moves you to the previous occurrence of the record type you have currently highlighted. For example, if a station (STN) record is highlighted, pressing **[Prev]** moves the highlight bar to the next station in the database.

**[Next]** .....Moves you to the previous (or next) occurrence of the record type you have currently highlighted.

**[PgUp]**.....Move up a full screen

**[PgDn]**.....Move down a full screen

To exit from the database, press **{ESC}**. The last screen accessed before entering the database will display.

## 5.2 Performing a Survey Data Search

You can search the database for records containing a particular point or code or both. Press **[Srch]** and this screen displays:

Enter the point name in the **Pt** field and/or the code in the **Code** field. Press **{←}** or **[Prev]** to search backward or **[Next]** to search forward. The first matching record is highlighted. You now can open that record or repeat the steps to continue your search.

If both a point name and a code are entered, SETX first looks for point names matches. If none are found, then it searches for code matches.

If no matches are found, the following message displays:

### Searching for coordinates

If you want to find out what coordinates the SETX will use for a particular point name, specify the point name for a new station setup. You can do this by entering the Topography program, (see Chapter 8, **Topography Observations** for more information).







Enter the point name in the **Stn** field. The SETX then displays the point coordinates if it knows them or can calculate them.



### 5.3 Opening a Record for Viewing

You can open any record displayed in the database list.

1. Select the record whose fields you want to view.
2. Tap the record or press **{▶}** or **{◀}** to open it.

Road pos	SS	
Pt	1040	
Sta..ing	<Null>	 -30
Offset	<Null>	
N	0.278	
E	2.217	
EI	-0.073	
<b>Edit</b>		







3. Press **[Edit]** to edit notes and codes.
4. The **{▲}**/**{▼}** keys open the next adjacent record in the indicated direction.
5. To return to the database list, press **{ESC}**, **{◀}** or **{◀}**. Exit out of review mode by pressing **{ESC}** or **{FUNC CTRL} + {◀}** from the database list.

### 5.4 Editing Notes and Codes

Most of the information stored in the database records cannot be edited. However, you can modify codes or notes, with the exception of program-generated notes, such as Traverse closure information.

#### Steps for editing records







1. Open the record to be edited.

OBS	F1	
Stn	1003	
Pt	1002	 -30
H.obs	113°50'18"	
V.obs	94°23'14"	
S.Dist	2.839	
Cd	<No text>	
<b>Edit</b>	<b>MC</b>	<b>Red</b> <b>Pos</b>

2. Press **[Edit]**.
3. Make your modifications to the code or note.
4. Press **{FUNC CTRL} + {◀}** when you are finished or **{ESC}** to exit edit mode. Press **{◀}**, **{ESC}** or **{◀}** to return to the database list.

## 5.5 Reviewing Observation Records







When you open an observation record (OBS), this screen displays:

OBS		F1	
Stn	1003		
Pt	1002		 -30
H.obs	113°50'18"		
V.obs	94°23'14"		
S.Dist	2.839		 a
Cd	<No text>		
Edit		MC	Pos







The data shown in an OBS screen has the prism constant and atmospheric corrections applied (if applicable). No other corrections, such as instrument/target height, curvature and refraction are applied.

The three softkeys at the bottom of the screen, refer to different views you can see of this observation. The initial view measurement is the view specified in the *Topo view stored* field in the **Configure reading** option under the **Functions** menu. So when you take an observation and then review it, you will not necessarily see the raw data.






**[MC]**.....(measured and corrected) The **MC** view shows the observation adjusted for orientation, collimation, instrument height, target height, prism constant (if applied by the SETX), atmospheric corrections, and curvature and refraction corrections.

OBS		MC	
Stn	1003		
Pt	1002		 -30
Azimuth	88°13'15"		
V.ang	94°23'14"		
S.Dist	2.839		 1
Cd	<No text>		
Save		Obs	Pos

**[Red]** .....(reduced) The **Red** view shows you the observation reduced to its horizontal and vertical components with the sea level correction and scale factors applied where applicable.

RED		TP	
Stn	1003		
Pt	1002		 -30
Azimuth	88°13'15"		
H.dist	2.831		
V.Dist	-0.217		 a
Cd	<No text>		
Save		Obs	MC
			Pos

**[Pos]** .....(position) The **Pos** view shows the observation coordinates relative to the station from which it was observed:

POS	TP	
Pt	1002	
N	12.102	 -30
E	15.278	
EI	-0.234	
Cd	<No text>	

Save   Obs   MC   Red

These views are illustrated in Figure 2.

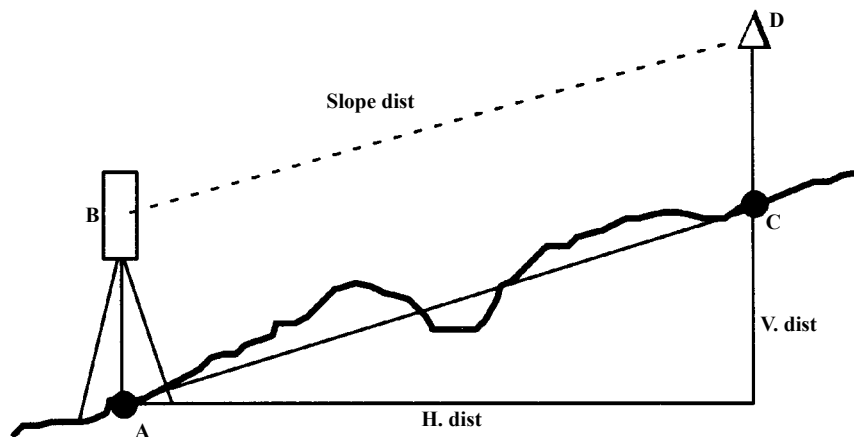


Figure 2: Various observation views

The **RAW OBS** view is the vector from B to D. The **MC** view is the vector from A to C. The **Red** view is H.dist and V.dist. The **Pos** view is position C. The illustration does not show the horizontal observation (angle), which is part of the raw view, or the azimuth, which is part of the **MC** and reduced views.

Store the data in any of the views. When you look at the record again, it will be the view you selected. When you press one of the softkeys, such as **[Red]**, the softkey changes to **[Save]**. If you press it again, that view will be saved. (**[Save]** is not displayed, confirming that the record is saved in **Red** view.)

**NOTE** Actual stored data does not change: the raw data is always retained. Only the method of data presentation changes.

Once you have saved a particular view, the SETX treats the observation as a record of that type for all other purposes. For example, if you save an observation in **Pos** view, it is subsequently treated by the SETX as a position record. Of course, you can change the view back to **RAW OBS** at any time.

**NOTE** The SETX does not permit you to view a backsight observation as anything other than an **OBS**. This avoids problems caused by recoordinates a backsight point.

When you transfer job data, you can transfer observation records in more than one view. The default action is to transmit in the current view. Use **[Optns]** on the **Data Format** screen to select views before transmission. The **Data Format** screen is displayed by selecting **Communications** in the **Functions** menu.

For example, you can choose to output your observations in both **RAW OBS** and **POS** view. Your printout or transmission contains two lines for each record, one showing the raw data and one showing the coordinated data. Because this calculation is done at transmission time, it requires no memory for storage. For more information, see Chapter 27, **Communications**.

---

**NOTE** The ability to store observations in **RAW OBS** view or **Pos** view has useful implications when combined with the SETX's search rules for calculating coordinates. For example, you can store your observation to override or ignore particular observations after they have been sorted (see Chapter 6, **Coordinate Search Logic**, for details). If you feel an observation is especially accurate, store it in **Pos** view. The SETX uses this observation view to calculate coordinates.

---

## In this chapter

- Coordinate search rules for total station instruments
- Application of total station coordinate search rules

A **Pos** view record is, most typically, an observation (**OBS**) in position (**Pos**) view. However, **MC** and **Red** records can also be stored in **Pos** view. These three types of **Pos** view records (**OBS** in **Pos** view, **MC** in **Pos** view, and **Red** in **Pos** view) are equal in precedence to true **POS** (or **STN**) records in the coordinate search rules.

When the SETX program searches for the coordinates of a point, it always uses the latest information, except that **POS** and **Pos** view records are used before more recent **OBS** records.

The SETX searches for the latest coordinates of the station point to calculate the target's coordinates from the observation.

Coordinates are one of the following:

- Station record (STN)
- Position record (POS)

Coordinates can be calculated from one of the following:

- An observation record (OBS) stored in **Pos** view
- An observation record stored in raw or reduced view
- A reduced record (RED)

See Chapter 28, **SDR Database**, for information on the records stored in the SETX SDR database.

## 6.1 Understanding the Search Rules

When searching for the coordinates of a point, the SETX uses the following rules.

### **Rule 1: Observations in Pos view are treated as a POS record.**

For search purposes, any **OBS**, **MC**, or **RED** record in **Pos** view is treated the same as a true **POS** record.

### **Rule 2: The SETX uses POS, STN, and Pos view records before using OBS records even if the OBS record is more recent.**

The SETX will look for any **POS** records, **STN** records, or **Pos** view records, starting at the end of the current job (most recent records), and going backward in time. The first **POS**, **STN**, or **Pos** view record found is used to determine the coordinates.

If the SETX finds a **POS** or **STN** record, the coordinates are immediately available from that record. If however, the SETX finds a **Pos** view record, it must reduce that record to coordinates. For more information, see Chapter 28, **SDR Database**.

**Rule 3: If there are no applicable POS, STN, or Pos view records, the SETX will use the most recent OBS, MC or RED record. The record's view is no longer significant.**

The SETX will look for any **OBS, MC or RED** records, starting at the end of the current job and going backwards in chronological order. If the SETX finds an **OBS, MC, or RED** record in its search, it will reduce it to coordinates (see Chapter 28, **SDR Database**).

**Rule 4: If no such record can be found, the search fails.**

If the SETX cannot find any **POS, STN, Pos view, OBS, MC, or RED** records for the point in question, the search fails and the SETX assigns Null coordinates. An aborted set may leave **OBS** records on the database, but these **OBS** records are ignored in database searching.

**Rule 5: Coordinate searching is iterative.**

Finding the coordinates of the point may necessitate finding the coordinates of several other points. This process will continue until a fixed position for some point (a **POS** or **STN** records, not a **Pos** view record) is found.

The number of iterations that the SETX can perform are limited. The search fails if the SETX has no coordinate more than 25 points before it can coordinate the original point in question.

## 6.2 Applying Coordinate Search Rules

The intelligent SETX search rules will give you some useful results. Once you understand the search rules, you will probably think of even more ways to use the SETX to solve surveying problems:

### Example 1

When setting up on a new station, just enter the point name. The SETX finds the coordinates automatically and calculates them if there is just an observation to the point.

### Example 2

When a traverse is adjusted, all the sideshots are automatically adjusted (assuming they were stored in **Pos** view). This is true because the traverse program stores updated coordinates for each station on the route. When the sideshots are output, the search for the station point finds the adjusted coordinates, and the calculation produces adjusted sideshot coordinates.

### Example 3

Cadastral surveyors may key in one starting coordinate and then a sequence of azimuths and distances as marked on a plan. In the field, any one of those points may be used as a station or reference point. The SETX's iterative search (Rule 5) automatically calculates the desired coordinates.

### Example 4

If topography is done from a station, and the coordinates of that station are subsequently improved (perhaps by averaging or keyboard input of a new position records), then the coordinates of the topo points will be updated appropriately during comms output or when displayed in review.

**Example 5**

When observing an existing point, the **Store POS** option stores the observation in **Pos** view, whereas the **Store OBS** option stores it in **OBS** view. The searching rules ensure that a previous **POS** record (or observation in **Pos** view) will be ignored or used as desired.

**Example 6**

If you change a **Pos** view observation back to **OBS** view, an earlier **Pos** view observation to that point will be used in preference for calculating the coordinates. This gives you some control over what data is used, which is useful if a mistake occurs.

It is possible that sometimes the SETX will output coordinates different from those you expected. After checking for obvious survey errors, check that the coordinate search rules have not had an unexpected effect. If you did some topography from a resected station, and later re-entered the station point with a corrected elevation, the SETX will use the later station information to calculate the corrected coordinates of all the topo points during comms output. The observations don't have to be edited in the office.

**STN** and **POS** records provide fixed coordinates, which do not change like observations in **Pos** view. In the above example, if you set up a new station on one of the topographical points, the new station coordinates would not be updated when the old station coordinates are re-entered.

**TIP**

---

If you use **{FUNC CTRL} + {0}** to search for a point, you see the most recent record defining it. To see the coordinates of a point that the SETX will use for calculation, go to **Keyboard Input** and enter the desired point's number and name. The coordinate value appear as defaults. You can then press **{ESC}** to exit without storing a new record.

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# Chapter 7

## Feature Codes and Attributes

### In this chapter

- Defining a feature code list
- Adding feature codes to a feature code list
- Selecting feature codes
- Attribute definition and entry

Feature coding is the method of describing each point observed with an alphanumeric code. These codes are then processed to generate a site plan. With the SETX, you can quickly select feature codes from a list. You can add, modify, or delete codes from the list and maintain multiple lists of feature codes. This feature is convenient if you are using lengthy, repetitive descriptions.

Use the **Feature Code List** option in the *Functions* menu to define your feature codes. Then, whenever you are entering a code field, just type the first letter or two of the feature code you want. The feature code selection screen will pop up. Select the code you want, then press {←}.

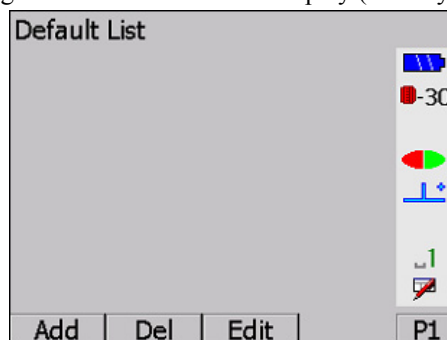
Each feature code may also have user-defined attributes. The attributes can be used to collect several pieces of information about each point. Attributes are output as Notes and as AutoCAD attributes in DXF plotted output when a file is converted using your PC's serial communications program (refer to the documentation for your computer's serial communications for information on how to use program).

The definition of each feature code also determines whether plotted output will draw linework between points with that code.

### 7.1 Managing Feature Code Lists

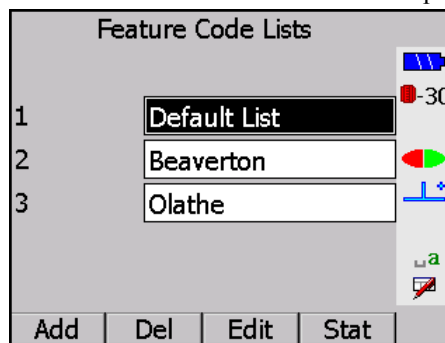
The SETX can access multiple lists of feature codes. Each list can be user-defined to provide a specialized set of features codes in a specific order, or the feature code list can be alpha-sorted. Initially, the SETX accesses a Default List, which is empty — allowing you to designate the feature codes you would need most.

To access the lists, select **Feature code list** from the *Functions* menu. The currently selected list and its designated feature codes will display (initially, the Default List).





Access the second page of softkeys and press **[Lists]** to access the management functions for lists. All the feature code lists available in the SETX are displayed.



The management functions include the following:

- Selecting a list
- Adding a new feature code list (**[Add]**)
- Deleting the highlighted feature code list (**[Del]**)
- Changing the name of the feature code list (**[Edit]**)
- Checking the statistics of the feature code list (**[Stat]**)

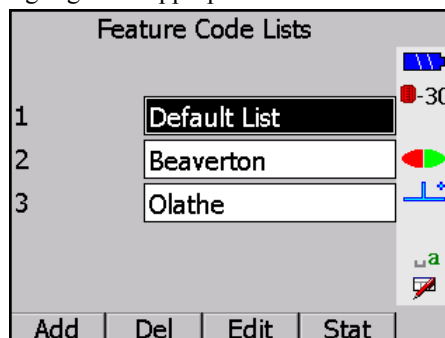
### 7.1.1 Selecting a feature code list

You can select the feature code list to be used in the current job by highlighting the appropriate list and pressing **{←}**. Once the list is selected, you can modify its contents (see Section 7.2, *Managing Feature Codes in a List*, Page 7-5).

1. Choose **Feature code list** from the **Functions** menu.
2. Access the second page of softkeys and press **[Lists]** to access the management functions for lists.



3. In the **Lists** screen, highlight the appropriate feature code list.

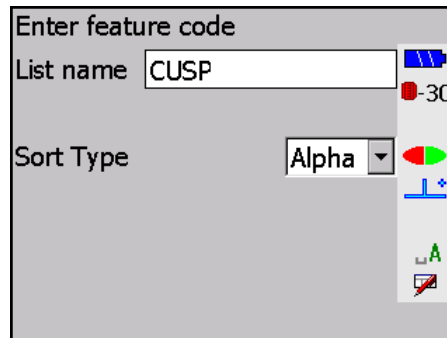


4. Press **{←}** to select.

### 7.1.2 Adding a feature code list

You can add several feature codes lists (limited only by available memory).

1. Choose **Feature code list** from the *Functions* menu.
2. Access the second page of softkeys and press [**Lists**] to access the management functions for lists. See Section 7.1.1, *Selecting a feature code list*, Page 7-2.
3. In the *Lists* screen, press [**Add**].
4. Enter the name of the new feature code list in the *List name* field and press {←}.



5. Select a sorting option for feature codes in the list in the *Sort Type* field. The *Sort Type* field provides two sorting options:

**Alpha** .....As feature codes are entered in the list, they are automatically sorted alphanumerically. The Default List is sorted alphanumerically.

**User**.....The user-defined sorting option should be used if you repeatedly will use particular feature codes in the same order, for example a road cross-section with user-sorted feature codes of curb, gutter, center line and curb. As you enter points, the feature code list will always be one code away from the next observation. Additionally, the feature code lists starts from the beginning when it gets to the end.

---

**NOTE** The sort option cannot be changed after a feature code list has been created.

---

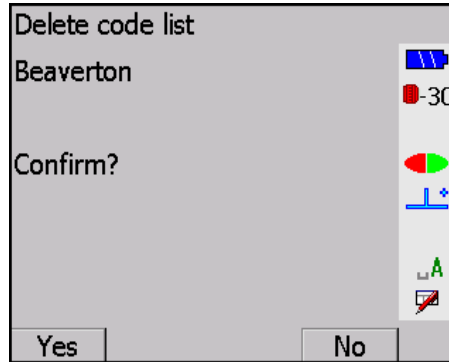
6. Press {←} to accept the list.

### 7.1.3 Deleting a feature code list

You can delete a feature code list.

1. Choose **Feature code list** from the *Functions* menu.
2. Access the second page of softkeys and press [**Lists**] to access the management functions for lists. See Section 7.1.1, *Selecting a feature code list*, Page 7-2.
3. In the *Lists* screen, highlight the feature code list to be deleted.
4. Press [**Del**].

5. A confirmation message displays:

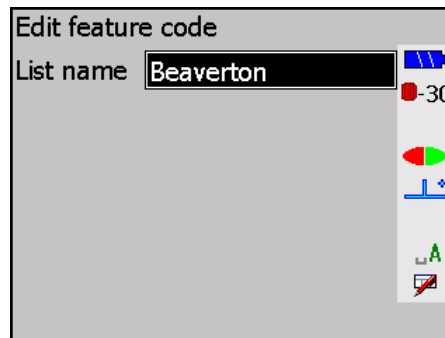


6. Select **[Yes]** to delete or **[No]** to cancel the operation.

### 7.1.4 Renaming a feature code list

You can rename any feature code list.

1. Choose **Feature code list** from the **Functions** menu.
2. Access the second page of softkeys and press **[Lists]** to access the management functions for lists. See Section 7.1.1, *Selecting a feature code list*, Page 7-2.
3. In the **Lists** screen, highlight the feature codes list whose name will change.
4. Press **[Edit]**.



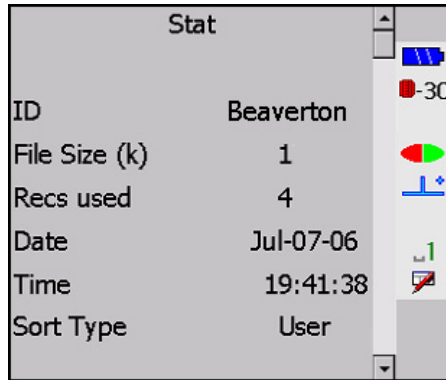
5. Enter a new name and press **{←}**.

### 7.1.5 Reviewing the statistics for a feature code list

You can view the statistics of a feature code list to review the file size, the number of associated records and the creation date and time.

1. Choose **Feature code list** from the **Functions** menu.
2. Access the second page of softkeys and press **[Lists]** to access the management functions for lists. See Section 7.1.1, *Selecting a feature code list*, Page 7-2.
3. In the **Lists** screen, highlight the appropriate list.

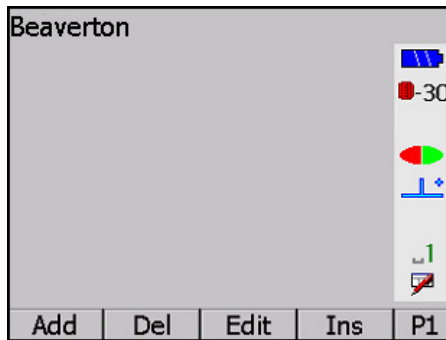
4. Press **[Stat]**.



5. Press **{ESC}** to exit the *Stat* screen.

## 7.2 Managing Feature Codes in a List

A newly created *Feature code list* contains no feature codes. You must add them one at a time. When you finish defining a feature code list, your SETX screen will appear with the list name displayed at the top:



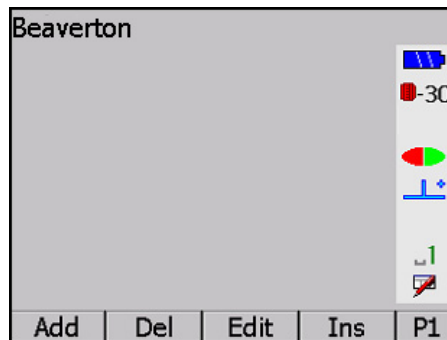
Feature code management functions are accessed with the following softkeys:

- [Add]** .....Adds feature codes to the end of the list
- [Del]** .....Deletes the feature code currently highlighted
- [Edit]** .....Accesses a screen in which the feature code properties can be edited
- [Ins]** .....(available on user-sorted lists only) Inserts a feature code before the currently highlighted code
- [Lists]** .....(second page of softkeys) Displays a list of all feature code lists residing in the SETX (see Section 7.1, *Managing Feature Code Lists*, Page 7-1)

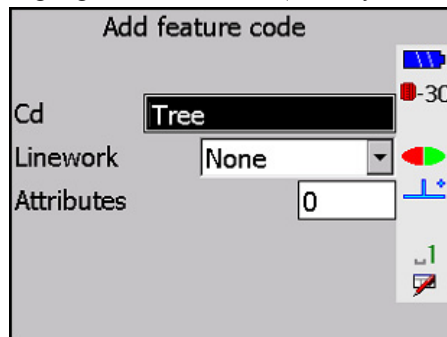
### 7.2.1 Adding feature codes

You can add several feature codes to any list (limited only by available memory).

1. Choose **Feature code list** from the *Functions* menu.



2. Press **[Add]** to add a code to the end of the list, or press **[Ins]** to add a code to the list before the currently highlighted feature code (*user-defined lists only*):



3. Enter the information in the following fields:

**Cd**.....Assigns the feature code name

**Linework** .....Determines whether points with this code are joined together as linework. Select one of the following options.

**None** - no linework associated with this code

**Join** - draw a line from the last previous identical code

**Start Code** - create a line from the associated point to the next identical code

**End** - end the line of current code

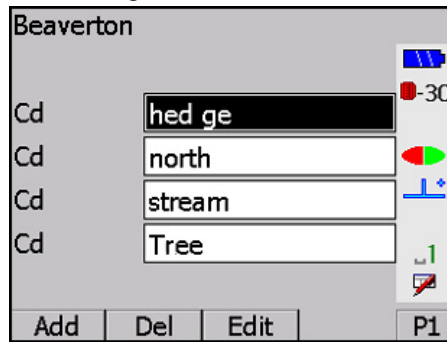
**Close code**- draw a line from current point to the identical code with a Start code

**Start curve fit** - begin a three point curve fit beginning with this point

**End curve fit** - the ending point of curve fit

**Attributes** .....Determines user-defined attributes. For more information, see Section 7.4, *Defining Attributes*, Page 7-10.

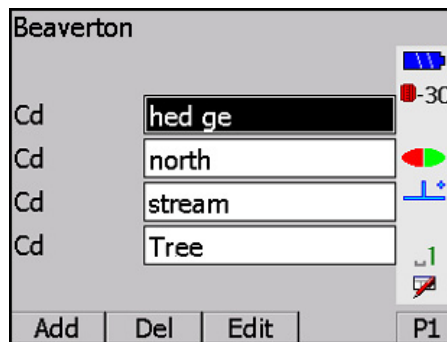
4. Press {←} when the feature code definition is correct. The SETX will display a screen similar to the following:



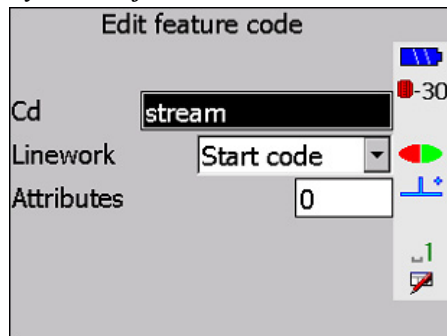
## 7.2.2 Editing feature codes

Individual feature codes can be edited.

1. Choose **Feature code list** from the *Functions* menu.



2. Highlight the feature code to be edited.
3. Press [Edit] to display the *Edit feature code* screen.

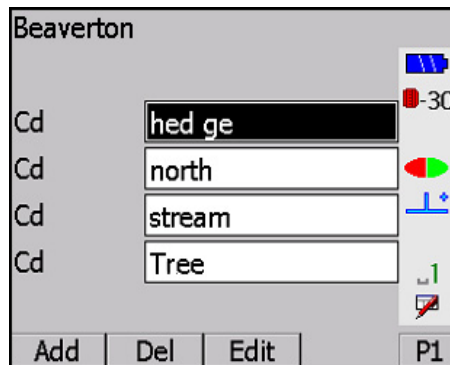


4. Modify the necessary fields.
5. Press {←} when the feature code definition is correct.

### 7.2.3 Deleting feature codes

You can delete feature codes from a list.

1. Choose **Feature code list** from the *Functions* menu.



2. Highlight the feature code to be deleted.
3. Press [Del].

### 7.3 Using Feature Codes

The feature code list is always accessible when editing any *Cd* field if the **Code list** option is set to **Yes**. It will also be accessible for *Note* fields, in this case, if the **Feature code insert** option is turned **On** in the *Note* screen. (Press [FC ON] to turn this option **On**. If [FC OFF] is displayed, this option is already **On**.)

In the following example you will see two different feature code lists that contain the same codes: tree, stream, tax, road, rim, tp, turn, curb, and center.

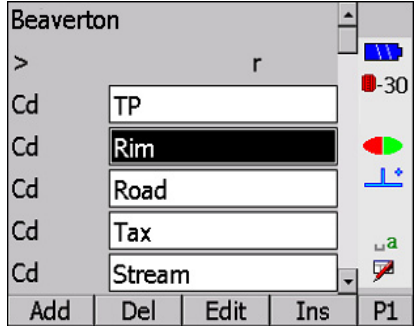
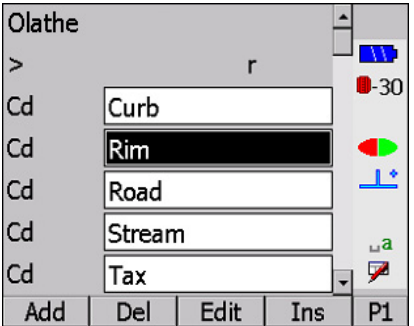
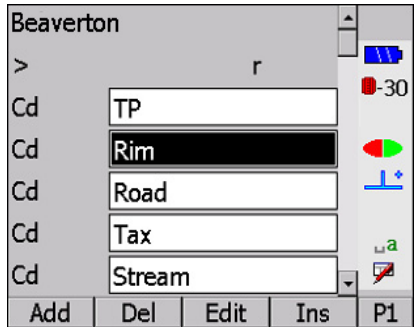
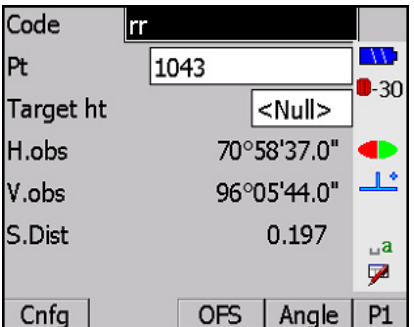
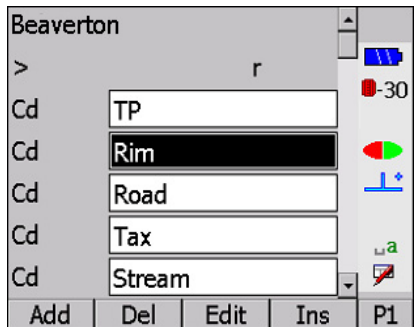
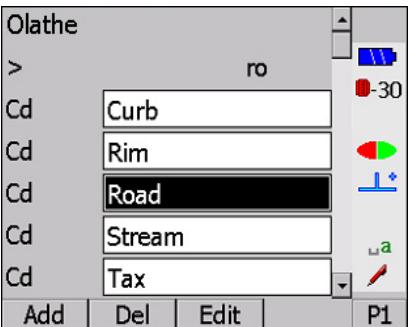
**Beaverton** .....User-sorted in the order in which the codes were just listed

**Olathe** .....Alpha sorted

1. Make sure the **Code List Active** option is set to **Yes**. This option is listed under **Configure Reading** in the *Functions* menu.
2. Access a code field or a note.

- When typing in a code field or a note, the SETX searches for feature codes in the current list in the following manners. User-sorted lists access feature codes one letter at a time; while alpha-sorted lists can access letter combinations.

**Table 9: User-Sorted List vs. Alpha-Sorted List**

Enter	User-sorted list	Alpha-sorted list
R (one letter)	 <p>The first feature code beginning with that letter is highlighted.</p>	 <p>The first feature code beginning with that letter is highlighted.</p>
RR (two identical letters)	 <p>SETX searches for the next feature code in the list which begins with that same letter.</p>	 <p>SETX searches for the next feature code that begin with those two letters. If no matches are found, the input screen from which the feature code list was accessed appears.</p>
RO (two different letters)	 <p>When the first feature code beginning with that letter is highlighted, use the arrow keys to highlight the desired code. Alternatively tap the touch screen.</p>	 <p>SETX searches for the next feature code that has those two letters at the beginning.</p>

- When the appropriate feature code is highlighted, press **{←}** and the code will be entered into the code field or note in which you are working.



## 7.4 Defining Attributes

Attributes are optionally defined as part of the feature code definition. Each feature code can have up to five attributes, each of which can have a user-defined name and a type of Alpha or Numeric.

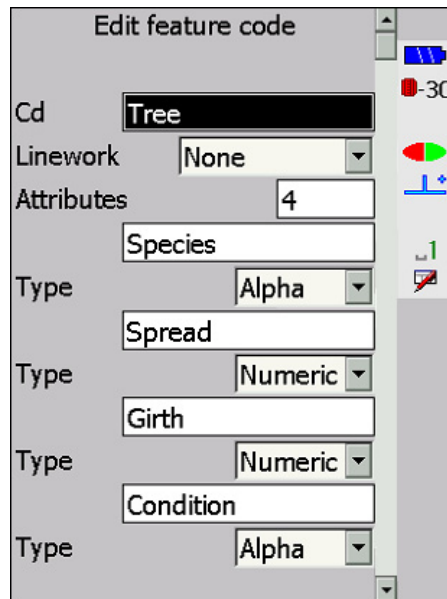
1. When you add or edit a feature code, the following screen is displayed:

The screenshot shows the 'Edit feature code' dialog box. The 'Cd' field contains the text 'Tree'. The 'Linework' field is a dropdown menu set to 'None'. The 'Attributes' field is a text box containing the number '0'. On the right side, there is a toolbar with icons for undo (blue arrow), redo (red arrow), and a pencil (red pencil). There are also some status indicators like a red '-30' and a green/red indicator.

2. Enter in the *Attributes* field the number of attributes required for this code. Setting the number to 0 means you will not be prompted for attributes when the feature code is used. The screen changes to display the same number of *Info* fields as the number of attributes specified.
3. Select each *Info* field and change the name to the attribute required — the names entered here are the prompts that will display on the screen when a point is assigned this feature code.

The screenshot shows the 'Edit feature code' dialog box after the 'Attributes' field has been set to '4'. The 'Cd' field still contains 'Tree' and 'Linework' is 'None'. Below the 'Attributes' field, there are four 'Info' fields. Each 'Info' field has a text box containing the name (Info 1, Info 2, Info 3, Info 4) and a 'Type' dropdown menu set to 'Alpha'. The toolbar on the right is visible, showing the undo, redo, and pencil icons.

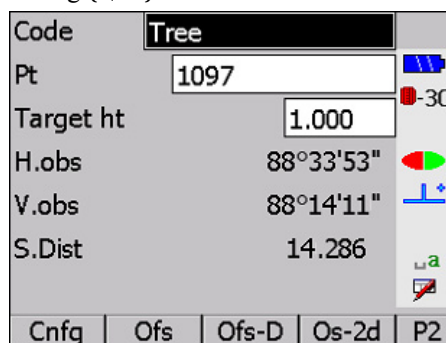
- Assign each attribute a type (**Alpha** or **Numeric**) using the {←} or {→} keys in the **Type** field. Alpha type attributes may be up to 16 characters long. Numeric type attributes up to 10 digits long, limited to ±9999999, and display up to three decimal places.



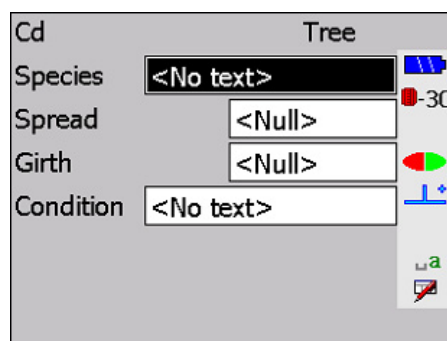
- Press {←} to accept this definition, and then define any other feature codes desired.

## 7.5 Entering Attributes

Attributes values are entered when taking observations with applicable feature codes. Enter the feature code name in the usual way, by typing the first and second letter of the feature code, and then pressing {←}.



When the instrument reading is completed, press {←} or the {READ} key as usual to store the reading. The following screen is shown to allow entry of the attributes for the TREE feature code:



Once the appropriate attributes have been entered for the point, press {←} and all the attributes are stored in separate Note records after the observation. These Note records have a derivation code of AT (Attribute).

These notes can be printed, or the comms output format file can be modified using an appropriate program to produce a file suitable for direct input into a GIS or other asset management system.

Alternatively, your PC's serial communications program can be used to create a DXF file that contains the attribute information for each point. This DXF file can be used for direct input into AutoCAD or GIS systems that read DXF format files, or it can again be modified by an appropriate conversion program.

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**NOTE** For more information, refer to the documentation for the PC's serial communications program.

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# Chapter 8

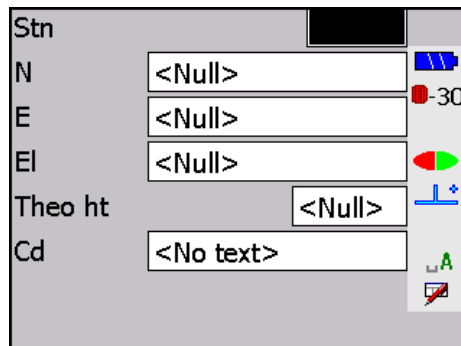
# Topography Observations

### In this chapter

- Station setup
- Backsight observation
- Deriving station elevation
- Using the SETX to measure observations (applies to topography, setting out, set collection - any observations)
- Averaging multiple observations

## 8.1 Setting up a Station

Before performing surveying tasks such as topography observations, your instrument needs information about your instrument location and backsight. You provide this information by establishing a station and performing a backsight observation. If you have not previously set up an instrument station and attempted to take a reading, the following screen displays:



Enter instrument setup and station coordinate information in the following fields:

- Stn** .....Specifies the station point name. If you enter a name known to the SETX, it fills in the coordinate fields with the point's coordinates; otherwise it sets the coordinate fields to Null (unknown).
- N, E, El**.....Show the point's coordinates. You may change any or all of these values.
- Theo ht**.....The instrument height - the instrument's height above the ground point. Refer to the Operator's Manual for your total station to determine the instrument height mark.
- Cd**.....(for descriptive purposes only) A 16-character alphanumeric field. It may be left blank.

Press {←} to accept and store the station setup.

## 8.2 Observing a Backsight

Once you have entered station details, you should enter a backsight.

1. Enter the backsight point name in the *BS pt* field:

2. If the point is unknown, the SETX displays this menu.

3. You can choose to enter either the backsight coordinates (*Key in POS*) or the azimuth from the current station point to the backsight point (*Key in azimuth*). These two methods are described in Chapter 15, **Keyboard Input**. The following screens enable you to enter azimuth values and/or coordinates:

4. Once the backsight data is entered, this screen displays for measurement of the backsight observation:

5. Press the **{READ}** key to initiate an instrument measurement to the backsight point. Enter a target height and press **{FUNC CTRL} + {←}** when the measurement is complete. Details about the instrument measurements are described in Section 8.3, *Initiating the Observation*, Page 8-4.
6. Once the backsight observation is made, the SETX generates a back-bearing record (**BKB**) that orients subsequent observations until another back-bearing record is stored.

The backsight observation is always in the **OBS** view, even if the **CNFG** option says to store it in **POS** view. You may, however, change the backsight observation to a **POS**, **RED**, or **MC** view by pressing **{FUNC CTRL} + {.** and using the edit options. For more information on views and searching through the database, see Section 5.5, *Reviewing Observation Records*, Page 5-4, and Chapter 28, **SDR Database**, for more information about observation views.

If you change the backsight observation to a POS view, it overrides any previous information about the backsight point (such as, OBS, MC [measured and corrected observation] or KI POS [keyboard entry position]). Any subsequent calculations using backsight coordinates will find the backsight observation and calculate the coordinates of the backsight point. Every observation has some error; this error will be reflected in the coordinates and will continue to grow in subsequent calculations.

### 8.2.1 Avoiding backsight

Backsight setup can be avoided. Press **{←}** when the **BS pt** field is blank to eliminate backsight setup. A confirmation prompt follows.

Press **[YES]** and then continue taking topographical observations. Horizontal angles stored are treated as azimuths with no orientation correction applied. This option is in effect until the next station is entered.

### 8.2.2 Averaging multiple backsights

Multiple backsights are supported by the topography program. When more than one known point or azimuth is observed, the resultant back-bearing corrections for each observation are averaged to generate a single back-bearing record. This back-bearing record orients subsequent observations.

The method for observing multiple backsights is described in Chapter 8.5, **Averaging Multiple Observations**.

To use multiple backsights other than in topography (for example, when setting out), first use topography to measure the multiple backsights and generate the averaged back-bearing record. Exit topography and start the setting out program, confirming the existing orientation.

#### Technical note

The back-bearing record contains two fields: the calculated azimuth to a known point and the corresponding horizontal observation from the instrument to that point. The difference between these two values is used as the correction for subsequent horizontal observations to convert them to azimuths when reduced.

In the case of multiple backsights, the SETX generates a back-bearing record with the point number of the most recently observed backsight and calculates a horizontal observation to go in the record.

**NOTE** This horizontal observation is not a value that has originated from the SETX. It is a calculated value derived from averaging the back-bearing records. A correction reflecting the average correction derived from the individual backsights results.

If the **Orient** field in Instrument Setup is set to azimuth or zero, this information is transmitted to the instrument after *the first backsight observation only*.

A new back-bearing record is generated for each backsight observed. These records are internally weighted, so that observations to a third backsight point will be correctly averaged with the previous two backsight observations.

### 8.2.3 Using a backsight to derive station elevation

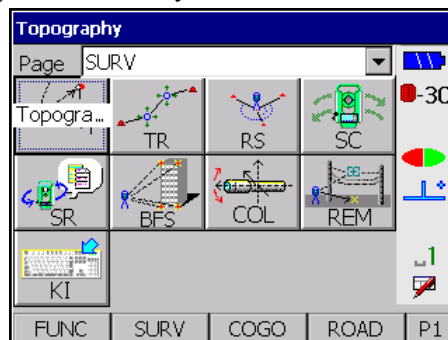
If you set up the SETX on a station point with an unknown (null) elevation, it calculates an elevation for your station when you observe a backsight point with a known elevation.

The backsight observation requires a slope distance measurement so that the elevation difference between the instrument and backsight target can be calculated.

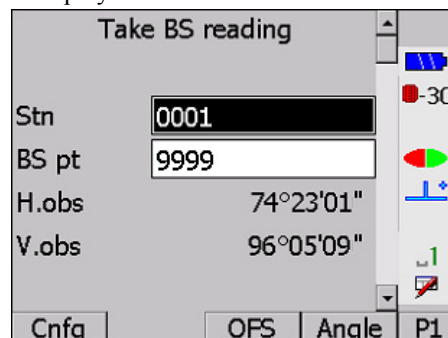
## 8.3 Initiating the Observation

To initiate an observation follow these steps:

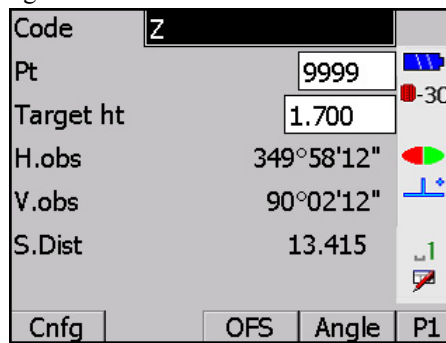
1. Be sure your SETX instrument settings are in the proper mode for operation.
2. Select **Topography** from the **Survey** menu.



3. The following screen displays:



- Initiate a reading by pressing the **{READ}** key. The SETX starts measuring and displays the following screen:



- Enter values for the first three fields while the SETX is measuring distance. The SETX enters data for *H.obs*, *V.obs*, and *S.Dist* fields.

Table 10: Read Screen Fields

Field	Description
Code	The <b>Code</b> field is a 16-character field that describes the point being observed. If the <b>Code lists active</b> option in the <b>Configuration</b> menu is set to <b>Yes</b> , feature codes can be selected from this field. (See Chapter 7, <b>Feature Codes and Attributes</b> .) This is a quick and efficient method of entering feature codes from a pre-defined list.
Pt	The <b>Point</b> name field is the name of the point being observed. Initially, this contains the next automatic point name allocated by the SETX.
Target Ht	<b>Enter the target height</b>

- Store the observation by pressing **{FUNC CTRL} + {←}**. The SETX displays **Input accepted** and returns to the *Take Reading* screen.

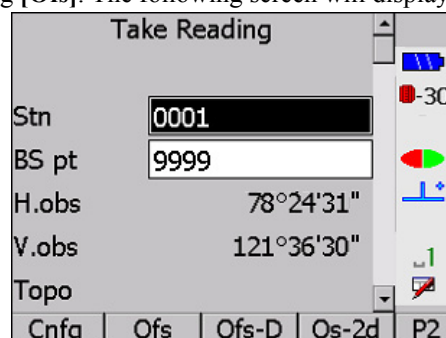
**TIP** As a shortcut, press the **{READ}** key to store the observation and initiate another reading.

Alternative actions can be performed with the following softkeys.

- Use **[Ofs]** to access offset measurements (see the following section).
- Use **[Angle]** to initiate an angles-only (theodolite mode) reading.
- Use **[Cnfg]** to access the *Configure Reading* screen (see Section 3.5.4, *Configure reading*, Page 3-6.)

## 8.4 Taking Offset Observations

Three types of offset are available for topographical (and other) observations. These types are accessed by pressing **[Ofs]**. The following screen will display:





- [Ofs] .....Angle offset, where the horizontal angle is measured separately from the vertical angle and the distance.
- [Ofs-D] .....Single-distance offset with direction.
- [Ofs-2d] .....Two-distance offset, where two prisms are mounted on a rod and observed.

Pressing the appropriate softkey will initiate the offset reading. These offset types are explained in the following sections.

### 8.4.1 Angle offset observations

The angle offset observation is made with two readings. The first reading observes the vertical angle and distance and is observed on the prism. To take the second reading, the surveyor rotates the instrument until the target is in sight. The surveyor then observes the horizontal offset angle. The SETX combines both readings into a single angle offset observation record.

- From the *Take reading* screen, press [Ofs] to view the offset softkeys.

Take Reading	
Stn	0001
BS pt	9999
H.obs	78°24'31"
V.obs	121°36'30"
Topo	
Cnfg   Ofs   Ofs-D   Os-2d   P2	

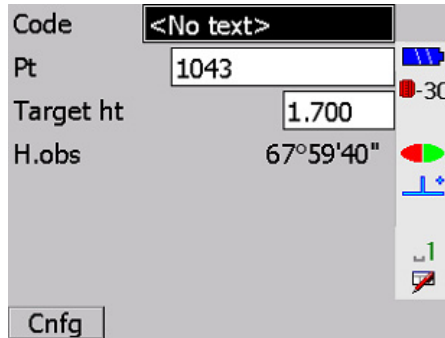
- Aim the instrument to locate the prism and press [Ofs]. The first reading will be initiated.

Code	<No text>
Pt	1043
Target ht	1.700
V.obs	121°36'30"
S.Dist	13.415
Cnfg	

- Press {FUNC CTRL} + {←} to accept the first reading. You are now ready to take the second reading.

Take 2nd o/s read	
Stn	0001
BS pt	9999
H.obs	67°59'33"
V.obs	93°23'20"
Topo	
Cnfg	

4. Rotate the instrument until the target point is lined up in the instrument's sight. Press the {READ} key to take the second reading.
5. The SETX takes the second reading and displays the following screen:

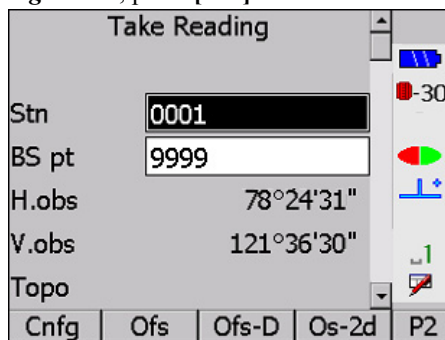


6. Enter a code in the **Code** field and press {FUNC CTRL} + {←} to accept the entire reading. The SETX will return to the *Take reading* screen.

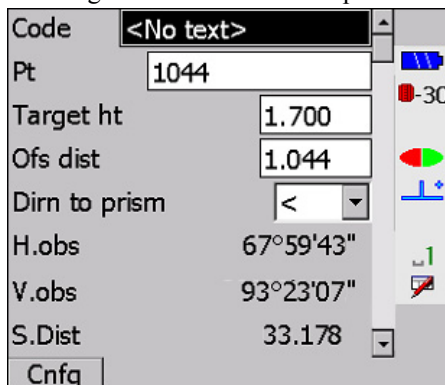
### 8.4.2 Single-distance offset

The single-distance offset is made by observing a prism that is at a known distance from the target point. The direction from the prism to the target is normal to, or along the line of sight from, the instrument to the prism (see Figure 3, Page 8-9).

1. From the *Take reading* screen, press [Ofs] to view the offset softkeys.



2. Initiate the single-distance offset observation by pressing [Ofs-D]; the surveying instrument measures the angles and distance to the prism.



3. Enter selections for the following fields:

**Code** .....An associated code.

**Pt** .....The point ID.

**Target Ht** .....The target height.

**Ofs dist**.....The distance to the prism from the target point. This field will default to the value of the last-entered distance. You can enter a different offset distance or let the default value stand.

**Dirn to prism** .....The direction *to the prism from the target point* as viewed by the instrument operator. Assign direction to the prism by using {◀} or {▶} to scroll through possible directions. Interpret the arrow direction from the perspective of the instrument operator as follows:

**Table 11: Arrows for Direction to Prism**

Arrow	Description
Right	Prism is to the right of the target point
Down	Prism is in front of the target point
Up	Prism is behind the target point
Left	Prism is to the left of the target point

**H.obs** .....(*information only*) The horizontal observation angle.

**V.obs** .....(*information only*) The vertical observation angle.

**S.Distance** .....(*information only*) The slope distance.

- Once the fields and the measurement are complete, press {FUNC CTRL} + {◀}.
- The SETX calculates the horizontal and vertical angles and slope distance to the target point, then it stores them in an observation record. The offset from the prism to the target point is assumed to be horizontal. A NOTE OS record (example shown below) is generated that shows the original measurements and the offset distance and direction used in the calculation. See Figure 4, Page 8-9.

```
NOTE OS          100.00 90-00'00"  23-00'00" OS 3.000 Dirn <
OBS F1 0005-1002 S.Distance 100.045  V.obs 90-00'00"  H.obs
24-43'06"
POS TP          North 90.878      East41.835      Elev 0.000
Code 0
```

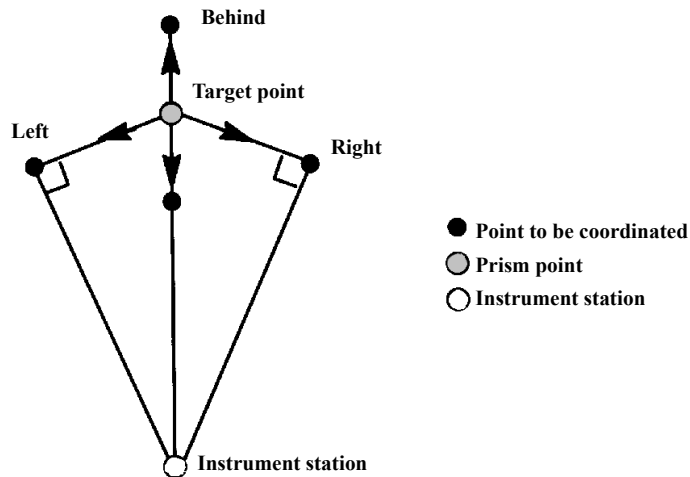


Figure 3: Direction to the prism from the target point

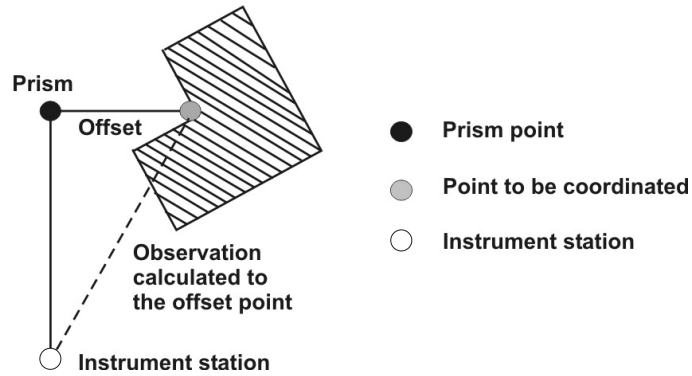


Figure 4: Horizontal/vertical angles and slope distance calculation

### 8.4.3 Two-distance offset observation

The two-distance offset observation is made by using a rod that has two prisms attached. The rod extends a known distance past the end of each prism. Both prisms are observed, and the SETX calculates the vector between them. The vector is then extrapolated the specified distance to find the target point’s coordinates.

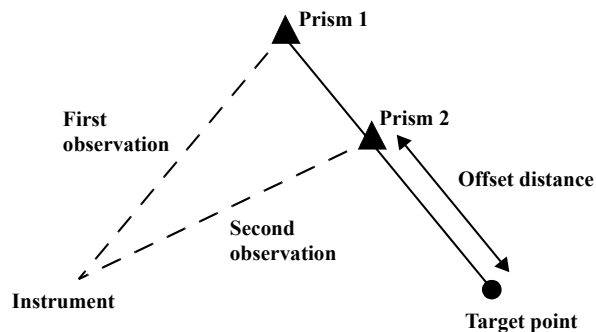


Figure 5: Two-distance offset

1. Sight on the first prism (furthest from the target point).

2. From the *Take reading* screen, press [Ofs] to view the offset softkeys.

Take Reading	
Stn	0001
BS pt	9999
H.obs	78°24'31"
V.obs	121°36'30"
Topo	
Cnfg   Ofs   Ofs-D   Os-2d   P2	

3. Press [Ofs-2d] to initiate the two-distance offset observation.

Code	<No text>
Pt	1041
Ofs dist	1.100
H.obs	67°59'34"
V.obs	93°24'00"
S.Distance	11.684
Cnfg	


4. Enter an offset distance and a code. Press {FUNC CTRL} + {←} to accept the first reading. You are now ready to take the second reading.

Take 2nd o/s read	
Stn	0001
BS pt	9999
H.obs	66°50'18"
V.obs	94°27'59"
Topo	
Cnfg	

5. Sight on the second prism and press the {READ} key. The SETX reads the distance and direction to the second prism and displays the following screen.

Code	<No text>
Pt	1044
Ofs dist	1.100
H.obs	58°57'23"
V.obs	94°27'44"
S.Distance	14.484
Cnfg	






6. Press **{FUNC CTRL} + {←}** to accept the entire observation. The SETX calculates the positions of the two prisms, extrapolates the vector between them for the offset distance, and then calculates the observation that a prism directly on the target would have made. This calculated observation is stored in the appropriate view.

-  The target height (which is not displayed) is implicitly set to zero.

An alternative way of using the two-distance offset is to use one prism on a pole, sliding the prism toward the target for the second reading.

## 8.5 Averaging Multiple Observations

When you use the topography program to observe a previously observed point or a point already known to the SETX, you are shown the difference between the observation and the observation expected by SETX based on its data. For example, you may see a screen like the following, where an asterisk (\*) indicates a value that exceeds the tolerances specified in the *Tolerance* menu.

Existing	0002	
Action	Store Pos	
$\Delta$ HDist*	-2.057	
$\Delta$ Azmth*	163°24'10"	
$\Delta$ Vang	0°00'01"	
Pt-Pt HDist	2.409	

Please refer to Figure 6 for more information about the values listed on the screen. The  $\Delta$ *SDist* field shows the difference in slope distance AB and the distance AB'. The  $\Delta$ *Azmth* field shows the difference between the azimuth from A to B and the azimuth to the observed point B'. The  $\Delta$ *Vang* field (not illustrated) shows the difference between the expected and observed vertical angles. The *Pt-Pt SDist* field (not illustrated) displays the slope distance between B and B'.

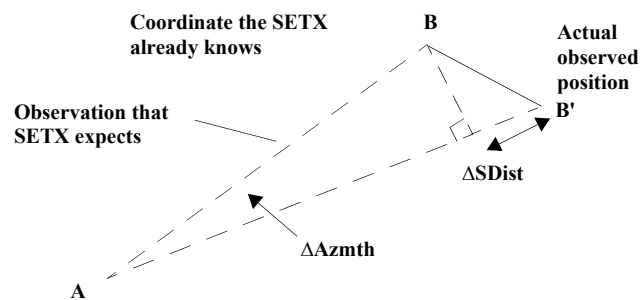







Figure 6: Comparing previous data and current observation

After your observation follow these steps:

1. Select the desired option in the *Action* field by pressing {◀} or {▶}.

Existing	0002	
Action	Average BS	
$\Delta$ HDist*	-2.057	
$\Delta$ Azmth*	163°24'10"	
$\Delta$ Vang	0°00'01"	
Pt-Pt HDist	2.409	

The available options are as follows and are described in the following sections. (Some of these options may not be available if they are not relevant.)

- Store Pos
  - Store Obs
  - Store Note
  - Rename
  - Average
  - Average BS
2. Press {FUNC CTRL} + {←} to continue or press {ESC} to ignore the observation.

### 8.5.1 Store Pos

Store POS stores the observation in **POS** view, effectively overwriting any previous coordinates of the target point.

### 8.5.2 Store Obs

Store OBS stores the observation in **OBS** view, which will NOT overwrite a previous coordinate if it exists in POS view. If the point previously exists in **OBS** view only, then this option will effectively overwrite the coordinates of the target point (see Chapter 6, **Coordinate Search Logic**). An application of this option could be to use an observation within a traverse without overwriting a previous POS view of the coordinate.

### 8.5.3 Store Note

Check only stores the observation entirely within NOTE records for later reference. The notes show the difference in slope distance, northing, easting, and elevation between the expected and actual observations.

### 8.5.4 Rename

Rename enters a different target point name for the observation you just made. The SETX checks to see if the newly entered point name is also known. If it is, a new screen displays.

### 8.5.5 Average

Average takes the new observation and averages it with the existing data. The average is generated in a variety of ways:

- A new observation is averaged with an existing observation resulting in an averaged record. A Face 1 observation (F1) is averaged with another F1 observation to produce an averaged Face 1 record.

```

OBS F1 0005-1006  S.Dist 200.000  V.obs 90-00'00"  H.obs
200-00'00"
                                Code OFFSET B
POS TP 1006      North -187.939  East  -68.404      Elev 0.000
                                Code OFFSET B
NOTE TP
Action Average  Pt-Pt SDist -0.010
OBS F1 0005-1006  S.Dist 199.990  V.obs 90-00'00"  H.obs
200-00'05"
                                Code OFFSET B
POS TP 1006      North -187.927  East  -68.405      Elev 0.000
                                Code OFFSET B
OBS F1 0005-1006  S.Dist 199.995  V.obs 90-00'00"  H.obs
200-00'03"
                                Code OFFSET B
POS TP 1006      North -187.933  East  -68.405      Elev 0.000
                                Code OFFSET B

```



- A face 2 (F2) observation is averaged with another F2 observation to generate and averaged Face 2 record. If the target height changes, or if a Face 1 record is averaged with a Face to record, an averaged MC observation is generated.

```

OBS F1 0005-1008 S.Dist 300.000 V.obs 90-00'00" H.obs
300-00'00"
Code OFFSET D
POS TP 1006 North 150.000 East -259.808 Elev -2.000
Code OFFSET D
NOTE TL V.obs tol. error:pt: 1008 0'02'52"
NOTE TL H.obs tol. error:pt: 1008 179-59'55"
NOTE TP Action Average Pt-Pt SDist 0.002
TARGET Target ht 2.250
OBS F2 0005-1006 S.Dist 300.000 V.obs 270-00'00" H.obs
300-00'05"
Code OFFSET D
POS TP 1008 North -150.0006 East 259.804 Elev -2.250
Code OFFSET D
OBS MC 0005-1006 S.Dist 300.008 V.ang 90-24'31" Azmth
210-00'02"
Code OFFSET D
POS TP 1008 North -259.806 East -150.003 Elev -2.125
Code OFFSET D

```

- If a station or a position record of target point coordinates exists, or if the coordinates have been internally calculated from another station to the target point, these coordinates are averaged with the new observation coordinates. A new position record results.

```

OBS F1 0005-1005 S.Dist 200.000 V.obs 90-00'00" H.obs
300-00'00"
Code 0
POS TP 1005 North -187.939 East -68.404 Elev 0.000
Code 0
NOTE TP Action Average Pt-Pt SDist -0.010
OBS F1 0005-1005 S.Dist 199.990 V.obs 90-00'00" H.obs
200-00'05"
Code 0
POS TP 1005 North -187.927 East -58.405 Elev 0.000
Code 0
POS TP 1005 North -187.933 East -68.405 Elev 0.000
Code 0

```

If the existing data for the target point is the result of an average calculation, the SETX correctly weighs the values for subsequent averaging.

### 8.5.6 Average BS

Average BS creates a more accurate back-bearing record for orientation adjustments. To use this option, follow these steps:

1. Sight on a point with known coordinates in the SDR database. (This point may be the same point as the first backsight you observed, or it can be a different known point.)
2. Select Average BS and the SETX calculates a new orientation correction based on the newly observed point. This correction is averaged with the existing correction. (A BKB record is generated with the first-observed backsight.)

This procedure can be repeated for any number of backsights (or multiple observation to the same backsight point or multiple observation to multiple backsight points). The SETX handles the weighting for average calculations automatically where more than two orientation corrections are averaged.

**NOTE** If you are taking Face 2 observations and you average an observation as a backsight, you will not be prompted for a second face reading.

---



# Chapter 9

# Traverse Adjustment

## In this chapter

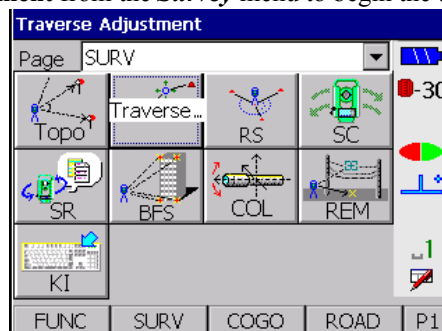
- Explanation of the traverse calculation
- Methods of traverse adjustment
- Procedures for selecting adjustment options
- The traverse adjustment routine

The traverse adjustment program allows you to specify a sequence of stations through which a traverse may be calculated and optionally adjusted.

Before running the traverse adjustment program, make observations from each station using either set collection or topography. The observations do *not* have to be made in the same order as the traverse route.

## 9.1 Calculating the Traverse

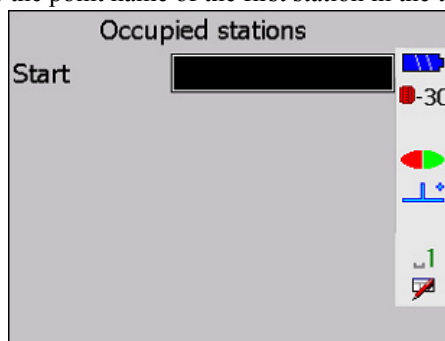
Select **Traverse adjustment** from the *Survey* menu to begin the traverse adjustment.



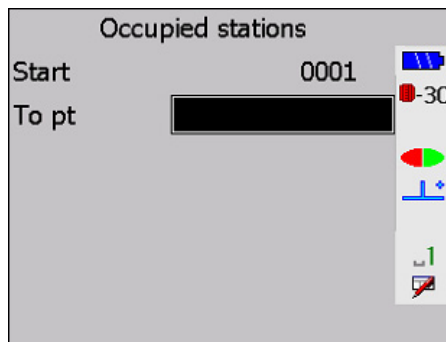
If you press {ESC} to exit this program at any time, you will be asked to confirm.

### 9.1.1 Starting point

The SETX first asks for the point name of the first station in the traverse:



Enter the point name of the first station. The SETX looks at the observations from that station and presents the route of the traverse as far as it can determine:

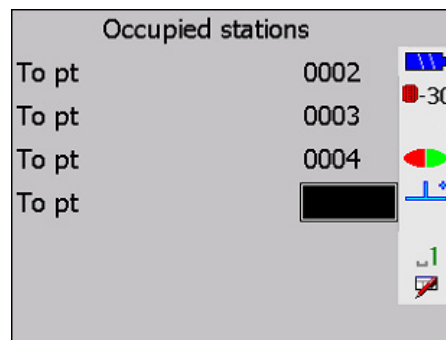


The SETX presents you with a complete list of stations on your traverse route, until one of the following conditions is present:

- No further stations observed
- More than one foresight station observed (for example, a branch was in the route)
- A station with known coordinates (for example, a **POS KI** keyboard input position record exists for the point); such a station closes the traverse
- An observation to a point that has a **POS** record with known coordinates closes the traverse
- A loop back to the first station of the traverse
- The maximum number of traverse stations that the SETX can handle (200) has been exceeded

### 9.1.2 Route

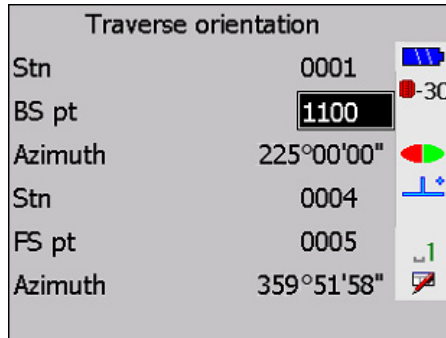
Press {←} if the route is complete. Otherwise, enter the next station's point name in the traverse route. The SETX will find more stations to add to the route if applicable.



Use {▲} and {▼} to move around the list. If you change a point name, the SETX discards the subsequent route and searches for a new one starting from the newly entered point.

### 9.1.3 Backsight and foresight azimuths

Once you accept the route, the SETX asks you for details about the backsight and foresight azimuths to give angular control in the traverse calculation:



The SETX presents suitable defaults for **BS** (backsight) and **FS** (foresight) points and azimuths.

The following rules apply to the specification of **BS** and **FS** azimuths:

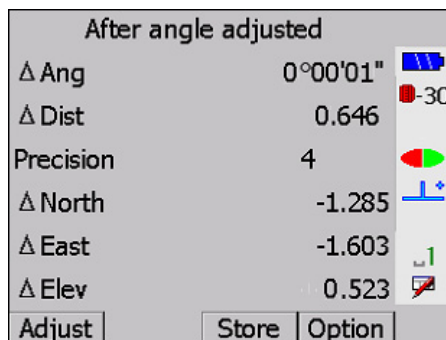
- Neither a **BS** or **FS** azimuth is compulsory. However, if you do not have both, an angular close is not done (the subsequent  $\Delta$ Ang result field in the *Precision* screen will be null). An angular adjustment cannot be done.
- Enter the azimuths directly or enter point names (see Section 15.2, *Entering Known Azimuths*, Page 15-2). The SETX calculates azimuths for you.
- A **FS** azimuth may not be specified unless there is a **BS** azimuth.

Press **{←}** to accept these default values or enter new values.

### 9.1.4 Traverse calculation

If you press **{←}** from the *Traverse orientation* screen, the SETX will calculate the precision of the traverse and display the results:

**NOTE** In the computation of the traverse closure, and in any subsequent traverse adjustment, the observations in both directions for any traverse leg are averaged to give the best values for that traverse leg. This also applies to observed vertical angles where a slope distance has not actually been measured in one direction; the average of the vertical angles in both directions are used in the computations.



$\Delta$ Ang .....Angular closure error







$\Delta$ Dist.....Horizontal closure distance

<b>Precision</b> .....	Precision of the traverse as a ratio of the total horizontal distance traversed to the closure distance
<b>ΔNorth</b> .....	Closure distance in Northing coordinates
<b>ΔEast</b> .....	Closure distance in Easting coordinates
<b>ΔElev</b> .....	Closure distance in elevation







**NOTE** If insufficient data was available to calculate the distance closure (for example, any leg of the traverse without distance information), the SETX reports only an angular closure.

## 9.2 Storing and Viewing Traverse Data

If you press **[Store]** from the *Results* screen, the precision results, closure notes, traverse route, and **BS** and **FS** details are stored in the database as note records. Once **[Store]** is pressed, an **Input accepted** message appears and **[Store]** disappears.

After angle adjusted		
Δ Ang	0°00'01"	
Δ Dist	0.646	 -30
Precision	4	
Δ North	-1.285	 +
Δ East	-1.603	 1
Δ Elev	0.523	
Adjust	Store	Option







You can press **{FUNC CTRL} + {0}** to review records in the traverse. The following screen displays:

Note BS pt 1100				
Note FS pt 0001	 -30			
<b>Note Method Compass</b>				
Note Missing dist/an	 +			
Note No fixed close	 1			
				
Srch	Shft	Prev	Next	P1

Press **{ESC}** to return to the previous screen, the *Traverse precision* screen.

## 9.3 Adjusting the Traverse

When a traverse adjustment is initiated, the following screen displays:

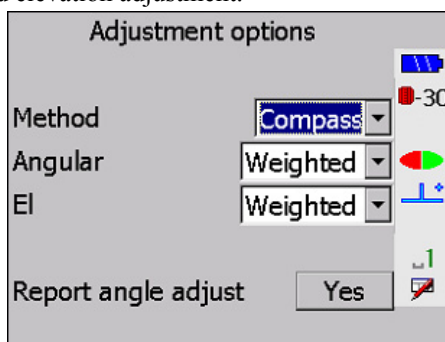
After angle adjusted		
Δ Ang	0°00'01"	
Δ Dist	0.646	 -30
Precision	4	
Δ North	-1.285	 +
Δ East	-1.603	 1
Δ Elev	0.523	
Adjust	Store	Option

- $\Delta$ Ang .....Angular closure error
- $\Delta$ Dist.....Horizontal closure distance
- Precision** .....Precision of the traverse as a ratio of the total horizontal distance traversed to the closure distance
- $\Delta$ North .....Closure distance in Northing coordinates
- $\Delta$ East.....Closure distance in Easting coordinates
- $\Delta$ Elev .....Closure distance in elevation

Adjustment options should be set before initiating the traverse adjust.

### 9.3.1 Adjustment options

Before starting the coordinate adjustment, press [**Option**] to specify the methods of coordinate, angular, and elevation adjustment.



Use the {◀} or {▶} keys to select the following options and then press {←} to accept your selection.

- Method**.....Select the **Compass** or **Transit** coordinate adjustment method (see Section 9.3.1.1, *Coordinate adjustment*, Page 9-5).
- Angular** .....Select **Weighted**, **Linear**, or **None** (see Section 9.3.1.2, *Angular adjustment*, Page 9-6).
- Elev** .....Select **Weighted**, **Linear**, or **None** (see Section 9.3.1.3, *Elevation adjustment*, Page 9-6)
- Report angle adjust** .....Select **Yes** or **No** to specify whether or not to display the updated closure and traverse precision details after the angular adjustment, but before the coordinate adjustment. The displayed angular closure after the angular adjustment is always zero.

#### 9.3.1.1 Coordinate adjustment

Two coordinate adjustment methods are available: Compass (or Bowditch) rule and Transit rule.

##### Compass rule formula

The Compass rule distributes the coordinate error in proportion to the length of the traverse lines.

$$\text{Northing adjustment} = \frac{L}{TL} \times \text{closure north}$$



$$\text{Easting adjustment} = \frac{L}{TL} \times \text{closure east}$$

Where:

L = length of the traverse line to the point

TL = sum of the traverse line lengths

### Transit rule formula

The Transit rule distributes the coordinate error in proportion to the northing and easting ordinates of each traverse line.

$$\text{Northing adjustment} = \frac{\Delta N}{\sum |\Delta N|} \times \text{closure north}$$

$$\text{Easting adjustment} = \frac{\Delta E}{\sum |\Delta E|} \times \text{closure east}$$

Where:

$\Delta N$  = change in northing for the traverse line

$\Delta E$  = change in easting for the traverse line

$\sum |\Delta N|$  = sum of the absolute value of all the changes in northings of all the traverse lines

$\sum |\Delta E|$  = sum of the absolute value of all the changes in eastings of all the traverse lines

#### 9.3.1.2 Angular adjustment

Three angular adjustment options are available:

**Weighted** ..... Any angular closure is distributed among the angles of the traverse route based on the sum of the inverses of the forward and back traverse line lengths at each angle. The backsight and foresight lines are considered to have infinite lengths for the purposes of this weighting computation.

$$\angle_{\text{adjustment}} = \frac{\frac{1}{\text{todist}} + \frac{1}{\text{fromdist}}}{\sum \left( \frac{1}{\text{todist}} + \frac{1}{\text{fromdist}} \right)} \times \angle_{\text{closure}}$$

**Linear** ..... Any angular closure is distributed evenly among the angles of the traverse route.

**None** ..... No angular adjustment is carried out.

#### 9.3.1.3 Elevation adjustment

Three elevation adjustment options are available:







**Weighted** ..... Any closure in the elevations is distributed in proportion to the length of the traverse line leading to the point (like the Compass rule used in the coordinate adjustment).

**Linear** ..... Any closure in the elevations is distributed evenly in each leg of the traverse route.

**None** ..... No elevation adjustment is carried out.

### 9.3.2 Starting the adjustment

To start the traverse adjustment, select **[Adjust]** or press **{←}**. This softkey appears only if the coordinate closure is not null.

After angle adjusted		
Δ Ang	0°00'01"	
Δ Dist	0.646	 -30
Precision	4	
Δ North	-1.285	
Δ East	-1.603	
Δ Elev	0.523	
<b>Adjust</b>	<b>Store</b>	<b>Option</b>

Angular adjustments are carried out first. If the *Report angle adjust* field was set to **Yes** in the *Options* screen, a report of the updated closure and traverse precision details displays. This display is the same as the initial traverse calculation display except that the angular closure is always zero.

**[Store]** will store the displayed information in a **NOTE** record.

To continue with the coordinate adjustment (and elevation adjustment if selected), select **[Adjust]** again or press **{FUNC CTRL} + {←}**. When the traverse adjustment is complete the adjusted coordinates are stored as position records with an **AJ** (Adjusted by Traverse) derivation code. After coordinates are stored, the SETX returns to the *Survey* menu.

As the SETX uses the latest point coordinates in its calculations, the adjusted traverse points will be used for calculations.

Coordinates for sideshots from an adjusted traverse station are updated automatically by the coordinate shift applied to the traverse station coordinates.

---

**NOTE** While the sideshot point coordinates are updated automatically by the coordinate shift applied to the adjusted traverse station, any slight change in orientation at the traverse station due to an angular adjustment is not applied.

---

# Chapter 10

# Resection

### In this chapter

- Steps for completing a resection
- SETX's calculation of a resection
- Steps for eccentric station setup as a normal resection

**Resection** uses least squares adjustment techniques to determine the coordinates of an unknown point.

Observations are made using the **Set Collection** program in the **Survey** menu; sets may be collected prior to using the resection or positioning program.

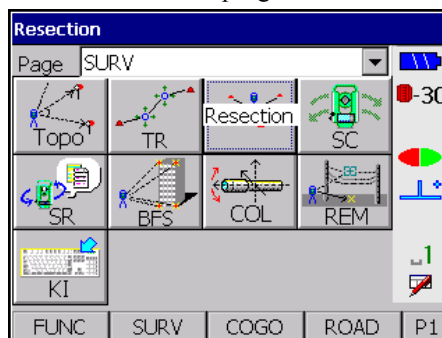
## 10.1 Using Resection

The Resection program calculates the coordinates of an unknown station by observing a number of known positions from the unknown point. The SETX performs a least squares reduction so that all data is used; redundant data generates better statistical results.

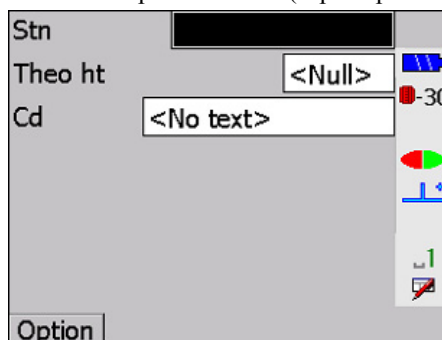
### 10.1.1 Performing a resection

Resection functions are accessed through the **Survey** menu.

1. Choose **Resection** to start the resection program.



2. The SETX asks you for a station point name and other standard station details for the unknown station. Enter the point name of the station where you have set up, the theodolite height, and the atmospheric details (if prompted for them).



- Use **[Option]** to access set collection parameters as described in Section 11.1, *Defining the Set Collection Method*, Page 11-1. With the collection of sets, the following screen displays (its layout varies slightly depending on which collection method is defined).

- Perform observations to two or more known points.
- After you are finished with observations, choose from three options, which are described in the following sections.

#### 10.1.1.1 Calculate resection

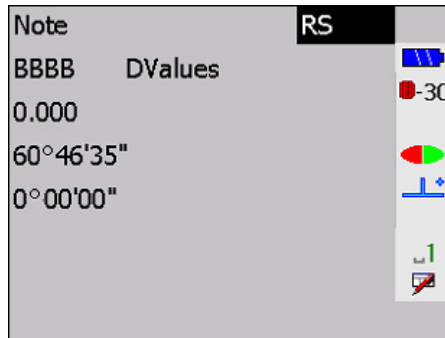
When you select this option, the SETX calculates the coordinates of the station point. If redundant data exists, a least squares calculation is performed. The screen displays **Processing data** and the number of the current iteration.

When calculations are complete, the SETX displays a station record containing the calculated coordinates:

Stn	RS	
Stn	060	
N	10.255	
E	10.466	
EI	1.073	
Theo ht	1.000	
Cd	<No text>	
<b>Edit</b>		

Use **[Edit]** if you want to change the code. Otherwise, press **{←}** to store the record. If you press **{←}**, the SETX stores a series of notes that show the differences between the expected and actual observation values for each point. For example, if the SETX

calculates station coordinates of 100, 300, the SETX calculates the inverse from the station to each observed point. The notes show the difference between the calculated inverse and the actual observations:



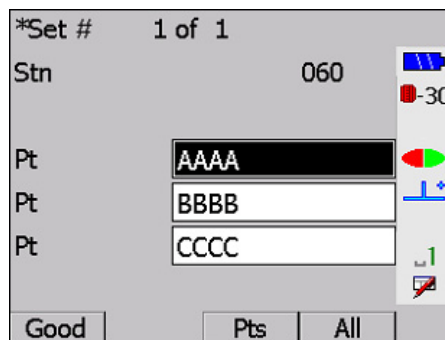
To cancel this process, press {ESC}.

### 10.1.1.2 Collect more sets

If you are not satisfied with the resection coordinates produced, you can collect more sets to recalculate coordinates.

### 10.1.1.3 Review existing sets

Before you select **Calculate resection**, you can use this option to view the data collected. If you find a set with errors, mark it “BAD” so it will not be used in calculations. An asterisk denotes a bad set as shown below:



(For information on reviewing sets and marking a set as BAD, see Section 11.3.7.2, *GOOD and BAD Sets*, Page 11-17.)

You can repeatedly review the observations and perform the resection calculation to see the effect of excluding a set.

## 10.1.2 Understanding resection calculations

Resection requires a minimum of either of the following:

- Two observations with horizontal and vertical angles, including at least one slope distance
- Three observations with horizontal angles

The SETX calculates a preliminary X-Y position from the minimum required data. It uses this result as the basis of a least squares reduction involving all the data. This iterative process terminates when the change in both the X and Y coordinates is less than 0.001 meters from one iteration to the next. The iterative process also terminates if convergence does not occur within nine iterations because the reduction is not stable.

When performing a resection calculation, be sure the geometry of the observations produces a stable result. For example, in a two distance resection the result will be unstable if the angle between the observations is close to  $180^\circ$ . Similarly, with a three point resection, an unreliable result will occur if the three points and the instrument station lie on a circle.

Once the X, Y coordinates of the resection station are computed, the observed vertical angles (and target heights) from the station to known points are averaged to produce the elevation of the station.

### 10.1.3 Using an eccentric station setup

An eccentric or off-line station setup can be done as a simple case of a normal resection.

#### Steps for completing an eccentric station setup

1. Set up on any arbitrary point near the first known point (the one that you cannot set up on directly).
2. Take a distance reading to this point using the Resection set collection. (You may wish to tape the distance.)
3. Take a reading to another known point, which will be used as a backsight. This reading may be angles only.
4. The Resection program calculates the new station position.

# Chapter 11

## Set Collection

### In this chapter

- Set collection options
- Observing sets
- Reviewing sets at the *SETS*, *ALL*, *POINTS*, *SETS-POINTS* and *SETS-POINTS-FACES* levels

The SETX provides a structured method for collecting multiple sets of observations from a station. The SETX averages observations collected on Face 1 and Face 2 of the instrument and also averages multiple sets of observations. The resulting observations can be used either for traverse calculations or resection calculations.

### 11.1 Defining the Set Collection Method

The SETX provides a mechanism for the structured collection of sets via a series of parameters. Set collection may be entirely “free-form” or may be completely driven through a pre-entered set of parameters and points.

When you select the **Set collection** option from the *Survey* menu, you are first asked to confirm the backsight orientation.

Confirm orientation	
Stn	A99
BS pt	[REDACTED]
H.obs	244°32'44"
V.obs	263°57'10"
Option	[REDACTED]

Select **[Option]** in *Set Collection* to display the following screens.

Method	Direction
Number of H sets	1
# dist rdgs	1
Face order	F1F2/F2F1
Obs order	123..321
Return sight	No
Pre-enter points	Yes
Recip Calc	Prompted

The eight field settings on this screen determine how the SETX does set collection. Each field is described briefly below, followed by a detailed description of each field.

**Method**.....Controls the set collection method. The options are:

**Table 12: Set Collection Methods**

Method	Description
<b>Direction</b>	Several points are observed using the same instrument orientation.
<b>Repetition</b>	A single angle is observed between two points several times using different instrument orientations.

**Number of H sets** .....Controls how many sets of horizontal angles are collected. See Section 11.1.1, *Number of H sets*, Page 11-2

**# dist rdgs** .....Controls how many distance observations are made during each observational sighting. It can have any value from 0 to 9

**Face order** .....Controls the switching between F1 and F2 during the collection of single as well as multiple sets. See Section 11.1.2, *Face order*, Page 11-2

**Obs order** .....Specifies the order in which the SETX prompts you to observe points when collecting individual sets. See Section 11.1.3, *Obs order*, Page 11-3

**Return sight** .....(*Direction method only*) Specifies whether you wish to sight again on the first observed point in a set when the end of the set is reached

**Pre-enter points** .....Determines if you enter a list of points that you will observe, prior to observing any points in the set. See Section 11.1.4, *Pre-enter points*, Page 11-3

**Recip Calc** .....Determines whether to perform reciprocal calculation. The options are **Prompted**, **Always**, or **Never**. See Section 11.1.5, *Recip Calc*, Page 11-3

### 11.1.1 Number of H sets

This field controls how many sets of horizontal angles are collected. This number is independent of whether both faces are being observed. For example, if the number of H sets is 3, and only **F1** is being observed, three physical rounds of observations are required. If both **F1** and **F2** are observed, then six physical rounds of observations are required (one for each face for each set).

### 11.1.2 Face order

This field controls the switching between F1 and F2 during the collection of single as well as multiple sets. The selections on the *Options* screen assume you are interested in multiple sets.

The choices are as follows:

- F1 only
- F2 only
- F1F2/F1F2
- F1F2/F2F1
- F2F1/F2F1
- F2F1/F1F2



Some selections show two sets, separated by a slash, indicating that both faces will be used. For example, F1F2/F2F1 specifies that, in the first set, observations will be made to points in the set beginning with Face 1 and then Face 2 of your instrument, and in the second set, you will reobserve the same points beginning with Face 2 and then Face 1 of the instrument. This pattern is repeated for subsequent sets (the third set will be collected in the same manner as the first, while the fourth set will be collected in the same manner as the second).

If you wish to observe only one set, taking first Face 1 then Face 2, you should choose either F1F2/F1F2 or F1F2/F2F1. (Since you are only collecting one set, ignore the second set specification)

### 11.1.3 Obs order

This field specifies the way the SETX prompts you to observe points when collecting individual sets. The options are as follows:

**Unprompted** .....SETX will not prompt you at all and observations may be made in any order. You are not allowed to select pre-enter points if **Unprompted** is the *Obs order* option.

**123...123** .....SETX prompts for the second face of a set in exactly the same order as it prompted the first face. For example, if you select **123...123...** and preenter points A, B, C, and D, you are prompted to observe points in the following order:

A, F1→B, F1→C, F1→D, F1→A, F2→B, F2→C, F2→D, F2

In this example, the face order was **F1F2/F1F2** (or **F1F2/F2F1**).

**123...321** .....SETX prompts for the second face of a set be prompted in reverse order:

A, F1→B, F1→C, F1→D, F1→D, F2→C, F2→B, F2→A, F2

### 11.1.4 Pre-enter points

When this field is **Yes**, the SETX allows you to enter a list of points that you will observe, prior to observing any points in the set. The SETX will use the list's order, in conjunction with the *Obs order* field, to prompt you for the next point to observe.

If this field is set to **No**, you will not be asked for the point names prior to observing the points. The SETX will, however, intelligently guess which point you are observing based on the observations taken, and assist you by supplying the point name, code and target height, if required. This feature is active only for sets collected by direction.

### 11.1.5 Recip Calc

The SETX can perform reciprocal calculations between a station and its backsight. These calculations can be performed in both normal topography and in set collection. The method to set for reciprocal calculation is slightly different for topography and set collection. Reciprocal calculation for set collection is discussed below. For information on reciprocal calculation for topography, see Section 3.5.4, *Configure reading*, Page 3-6.

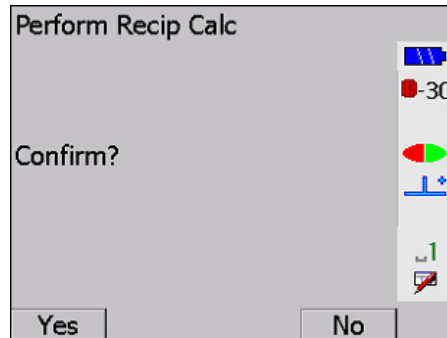
---

**NOTE** The **Recip Calc** field shown by pressing [**Cnfg**] on the read screen pertains to topography and does NOT affect set collection.

---

The options for reciprocal calculations in set collection are as follows:

**Prompted** ..... You will receive a prompt every time a reading is taken to a point which could be used in a reciprocal calculation



**Always** ..... Performance of all possible reciprocal calculation is automatic; the user does not receive a prompt

**Never** ..... SETX will not perform reciprocal calculations, even if one is possible, and the user receives no prompt

Notes are placed in the database when reciprocal calculations are performed. The first note is placed above the **Stn** and states **Vert Recip Calc refined Stn ### Elev.** The second note is placed above the BKB record and states **Recip Calc used Stns ##### & #####.**

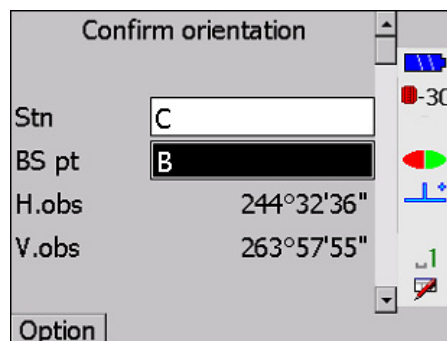
## 11.2 Observing Sets

After you define your set collection method, you can begin set collection.

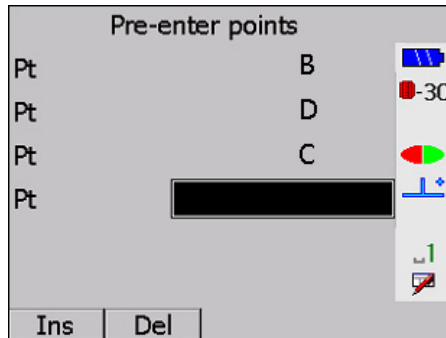
### 11.2.1 Pre-entering points

If the **Pre-enter points** field was set to **Yes**, the initial screen is for entering the names of the points that will be observed during each set.

1. Enter the point names. The first point displayed is the station's backsight (1100 in this example).



- Enter as many point names as you like; the list scrolls when you reach the bottom of the screen. If you make a mistake during entry, use the {▲} and {▼} keys to move to the incorrect entry, and then edit it in the usual manner.



- To edit the list of entries use the following softkeys:

**[Ins]** .....Adds an extra point name in the list before the currently highlighted point.

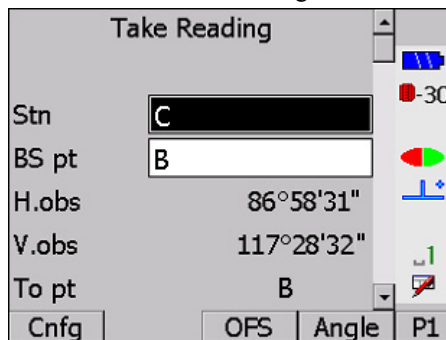
**[Del]** .....Removes the currently highlighted point name.

- Once the list is complete, press {←} to start observations.

**NOTE** If at any time you want to leave the set collection procedure completely, press {ESC}. A prompt asks whether you want to leave set collection.






### 11.2.2 Making the observations

- If you pressed {←} to continue with the collection of sets, the following screen displays. This screen's layout varies slightly depending on which collection method has been defined, but is similar to the following:



If you have requested point prompting, the *To pt* field shows you the point name to observe.

2. When the instrument is sighted correctly, press the **{READ}** key to initiate a reading. The standard observation screen will appear:







Code	BS	
Pt	B	
Target ht	1.600	 -30
H.obs	60°52'05"	
V.obs	108°12'31"	 +
S.Dist	10.105	 1
Cnfg	Ofs	Ofs-D
Os-2d	P2	

3. To change the *Pt*, *Code*, or *Target ht* fields, highlight the appropriate field and enter the new value. The SETX fills in the data fields (*H.obs*, *V.obs*, and *Dist*) when the values are available. The information on this screen depends on what you set as the *Obs Order*:

Table 13: Obs Order Description

Obs Order	Description
<b>Unprompted</b>	If the <i>Obs order</i> field is <b>Unprompted</b> and you have observed this point before, the code, point name and target height are filled automatically. The SETX determines whether the points are the same by checking to see if the new OBS distance is within 15 cm (<6") of the previous OBS distance. If this test passes, the SETX compares the horizontal angle of the two observations to see whether they are within a certain tolerance. This tolerance is calculated based upon the distance of the observation; the longer the distance, the smaller the allowed tolerance. The angular tolerance is calculated to yield approximately 15 cm arc distance. If the horizontal test also passes, a similar angular test is performed on the vertical angle.
<b>123...123 or 123...321</b>	When the <i>Obs order</i> is <b>123...123</b> or <b>123...321</b> , you are prompted for the next appropriate point name. The code and target height will be filled in if this point has been observed previously. To change these values, enter new ones.

4. If the *Pre-enter points* field is set to **Yes**, the SETX will display the following screen once a set is complete.

Stn	B	
Number of sets	2	
		 -30
		
		 +
		 1
		

If the *Pre-enter points* field is set to **No**, a face or a set is completed by pressing **{←}** at the *Take reading* screen.

## 11.3 Viewing Collected Sets

The observations stored in the database during set collection can be reviewed using the standard data review method (using {FUNC CTRL} + {0}). They also can be reviewed using the specialized **Set review** option, which presents the data in multiple sets. The **Set review** option also gives averages and deviations.

The SETX's **Set review** mechanism provides a structured way in which an SETX user may view sets. The structure of this review mechanism is similar to the set collection structure. It is based on an inverted field book; the field book is "traversed" by the **Set review** mechanism. [In a similar manner, a computer's directory tree/hierarchy is traversed using the DOS CD (Change Directory) and DIR (Directory) commands.]

Figure 7 illustrates the abstract structure implemented by the set review mechanism; please examine this diagram before proceeding.

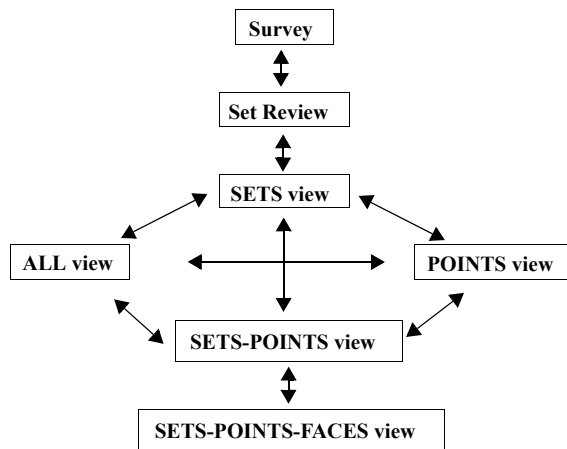


Figure 7: Set review

### 11.3.1 Example of viewing collected sets

As a means of explaining this abstract structure, the following two example sets, collected using the SETX, will be used. They represent the example survey illustrated in Figure 8, Page 11-8.

#### Example Set 1

```
SetFace H.ang V.ang S.Dist
```

```
Set 1Face 1
STNA0°0'00"90°00'00"100.000
STNB45°00'00"90°00'00"141.420
STNC90°00'00"90°00'00"100.000
```

After you have collected Face 1, the SETX displays this prompt.

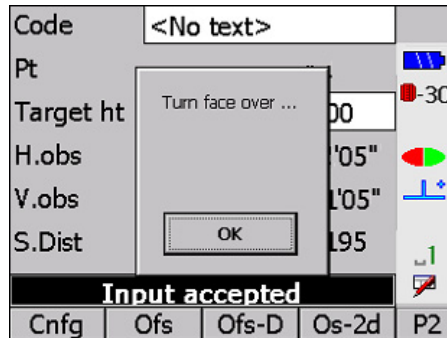
Code	<No text>	
Pt		
Target ht	Turn face over ...	-30
H.obs	'05"	
V.obs	'05"	
S.Dist	195	
<input type="button" value="OK"/>		
<b>Input accepted</b>		
Cnfg	Ofs	Ofs-D
Os-2d	P2	

## Example Set 2

```
SetFace H.ang V.ang S.Dist
```

```
Set 1, Face 2
STNC270°00'00"270°00'00"100.000
STNB225°00'00"270°00'00"141.420
STNA180°00'00"270°00'00"100.000
```

Upon completion of this set, the following screen displays:



Using **[Option]**, change *Face order* to **F1** only.

```
Set Face H.ang V.ang S.Dist
```

```
Set 2, Face 1(Only)
STNA60°00'30"90°00'30"100.020
STNB105°00'20"90°00'20"141.410
```

The azimuth from A to STN is 10°00'00".

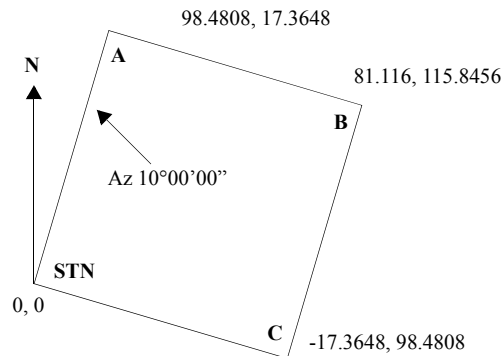


Figure 8: Example survey

The first set is a “perfect” representation of the layout of the points A, B, C with respect to **STN**, while the second set contains inaccuracies for the purposes of illustrating the *Set review* mechanism to its fullest.

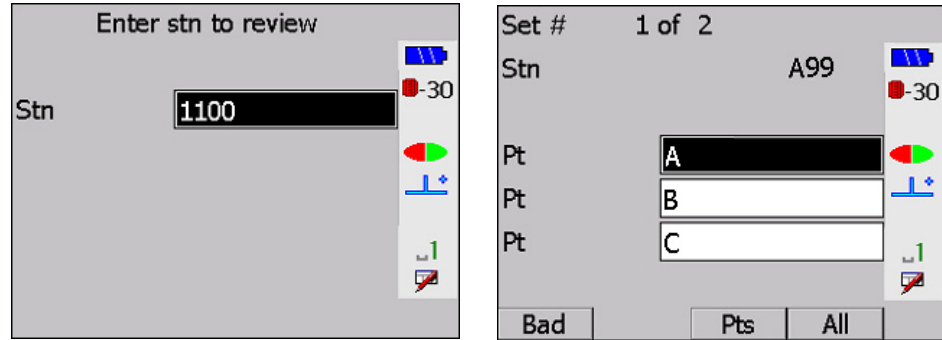
### 11.3.2 SETS level

The entire **Set review** structure is explained below using the two sets defined earlier.

There are two ways of reviewing sets:

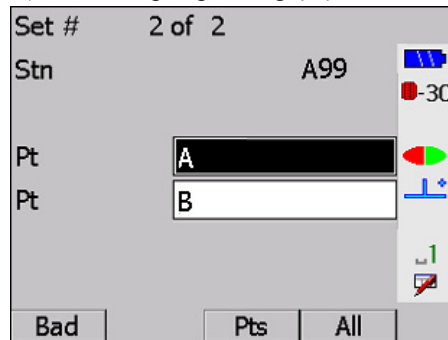
- Review when you collect sets.
- Use the **Set review** option in the *Survey* menu.

The initial **Set review** display is illustrated below:



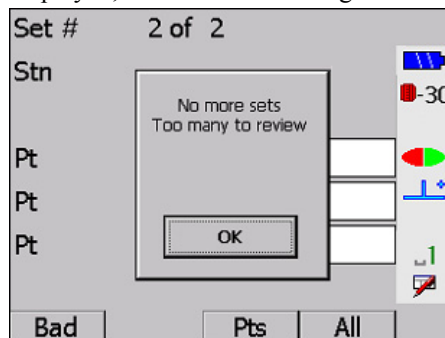
This display indicates all of the points observed during the collection of Set 1 from the **STN** station; it represents the **SETS** level (see Figure 7, Page 11-7 and Figure 8, Page 11-8).

Points observed in other sets obtained from **STN** are displayed by pressing {◀} and {▶} (see Figure 9, Page 11-10). For example, pressing {▶} shows the points observed in Set 2.



**NOTE** Point C was not observed in Set 2.

Pressing {◀} when the first collected set is displayed, or pressing {▶} when the most recently collected set is displayed, results in this message:



From the **SETS** level, it is possible to travel in four directions:

[All] .....Softkey takes you to the higher **ALL** level.

[Pts] .....Softkey takes you across to the equivalent **POINTS** level.

{←} .....Key takes you down to the lower **SETS-POINTS** level.

{ESC} .....Key exits **Set review**.

These levels are illustrated in Figure 9 and are described in the following sections.

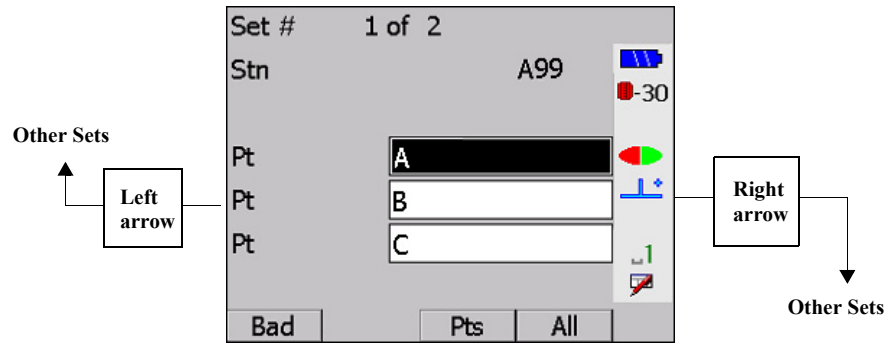
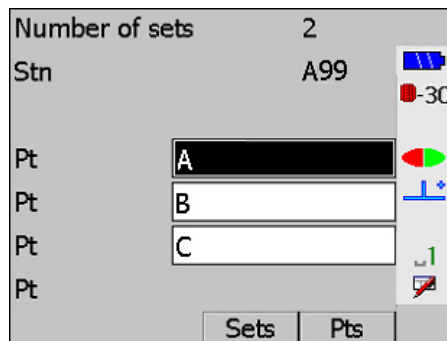


Figure 9: Set review SETS view

### 11.3.3 ALL level

Press [All] on the **SETS** level to enter the **ALL** level -- the top of the set hierarchy. For the two example sets, this level looks like:








It indicates that two sets have been collected from the station (STN), and observations have been made to the points labeled A, B, and C within these sets.

From the **ALL** level you can proceed as shown in Figure 10, Page 11-12.

Press {ESC} or [Sets] to return to the **SETS** level (where the current set is the set you left -- Set 1).








Press **{FUNC CTRL} + {←}** or **[Pts]** to reach the **POINTS** level. Information about the point currently highlighted displays.

Number of sets	2	
Stn	A99	 -30
Pt	A	
Pt	B	
Pt	C	
Pt		
		<b>Sets</b> <b>Pts</b>

### 11.3.4 POINTS level

The **POINTS** level is equivalent to one **SETS** level stratum in the **Set review** hierarchy. It illustrates the average of all observations made to a point from each set in the station.

If you press **[Pts]** with the highlight on Point B in **SET1** (while in the **SETS** or the **ALL** level), the following screen will be displayed:

Pt	B	 -30
Ref H.ang	51°20'24"	
St.dev	0°00'00"	
Max diff	0°00'00"	
Set # 1	0°00'00"	
Set # 2	-0°00'00"	
		<b>V</b> <b>SD</b> <b>Sets</b> <b>All</b>

When horizontal angles for several different sets display, the horizontal angle in each set is adjusted so the angles may be compared. (Each set may have been oriented differently at the time it was collected — different backsight circle readings.)

The angle comparison/adjustment is calculated as follows:

1. The first set is treated as a reference set. For each subsequent set  $n$ , the first observation to a point  $P$  (with nonnull horizontal angle) that also appears in the reference set is found.
2. The two horizontal angles are compared; if they lie within a tolerance  $T$  of each other, the difference is assumed to be observational inaccuracy, and set  $n$  is not realigned. If the two horizontal angles differ by more than  $T$ , the two sets are considered to be oriented differently. Set  $n$  is realigned by subtracting the difference between the angles from each horizontal angle in set  $n$ . Now the angles can be compared with the observations in the reference set.
3. The first nonnull horizontal angle of the reference set is converted to an azimuth for display, and all other horizontal angles are reoriented accordingly.

The tolerance  $T$  is currently set to 1 minute (1/54 gon). An out-of-tolerance observation (with reference to the global **H. Obs**, **V. Obs**, and **EDM** tolerances) is displayed with an asterisk (\*).

**NOTE** Tolerance settings are accessed through the **Tolerances** option of the **Functions** menu.

In the example sets, the first two horizontal angles to Point B in Sets 1 and 2 are  $45^{\circ}00'00''$  and  $105^{\circ}00'00''$ , so the two sets are assumed to be oriented differently. (Tolerance  $T$  is smaller than 60 degrees.) The horizontal angles for Set 2 are realigned to match set 1 by subtracting  $60^{\circ}00'30''$ . This results in (after the subsequent addition of 10 degrees, the azimuth to B from STN) azimuths of  $55^{\circ}00'00''$  and  $54^{\circ}59'50''$  for Sets 1 and 2, the average being  $54^{\circ}59'55''$ .

**NOTE** Angles are averaged within their sets before averages between sets are computed; observations are not weighted individually.

From this **POINTS** level you may proceed as indicated in Figure 10:

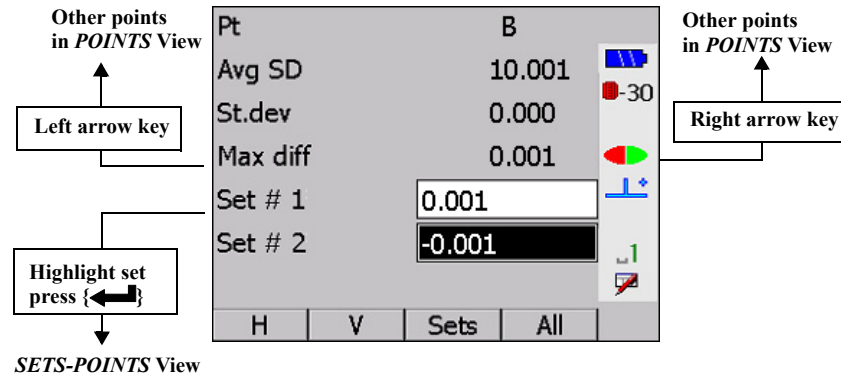


Figure 10: Set review POINTS view

1. Press **{ESC}** to exit *Set review*.
2. Press **[All]** to view the **ALL** level.
3. Press **[Sets]** to enter the **SETS** display. The current set depends on which set is highlighted when you press **[Sets]**. The cursor in the **SETS** level is placed over the current point (B).

4. The {▶} and {◀} arrow keys display information for different points. For example, pressing {▶} on the first screen of this section results in the next screen for Point A1:

Pt	C	
Avg H.ang	69°29'08"	
St.dev	0°00'00"	
Max diff	0°00'00"	
Set # 1	0°00'00"	
V	SD	Sets All

Pressing {◀} when the first point in all sets is displayed, or pressing {▶} when the last point is displayed, results in this message:

Pt	D	
Avg H.ang	40°00'45"	
St.dev	0°05'05"	
Max diff	0°05'05"	
Set # 2		
V	SD	Sets All

No more points  
Too many to review

OK

5. To view the vertical angles observed for Point B from STN in all sets, press [V].

Pt	B	
Avg V.ang	89°59'59"	
St.dev	0°00'00"	
Max diff	0°00'00"	
Set # 1	0°00'00"	
Set # 2	0°00'00"	
H	SD	Sets All







6. View the distances observed for Point B from STN in all sets by pressing [SD].

Pt	B	
Avg SD	10.001	
St.dev	0.000	
Max diff	0.001	
Set # 1	0.001	
Set # 2	-0.001	
H	V	Sets All

Press {◀} to view the *SET-POINTS* level. The current point is B, and the current set is determined by the cursor position at the time you press {◀}.

### 11.3.5 SETS-POINTS level

Use **SETS-POINTS** level to view the various observations to a point in a specific set. (Typically, but not necessarily, these observations are one **F1** and one **F2**.) If you are in Set 1, Point B, at the **SETS** review level, the **SETS-POINTS** level is accessed by pressing **{←}**. The following screen display at this level:

Set #	1	
Pt	B	
F1 H.obs	68°11'55"	 -30
F2 H.obs	248°11'55"	
Avg H.obs	68°11'55"	
Max Δ	0°00'00"	
Δ Set Avg	0°00'00"	
V	SD	<Set Set>

- The third and fourth lines list the horizontal angles of each observation made to Point B in Set 1.
- The fifth line gives the average (represented as an **F1** observation) of the horizontal observations made to the Point B in Set 1.
- The sixth line gives the maximum difference between the average and the individual horizontal observations.
- The seventh line gives the difference between the average from the fifth line and the average over all sets (Sets 1 and 2).

If more than two observations to a point occur within a set, the fields will scroll.

Return sights are displayed independently of initial sights to the reference point. The way in which return sights are isolated is described in Section 11.3.7, *Special cases*, Page 11-16.

In the **SETS-POINTS** level, you may proceed as indicated in Figure 11:

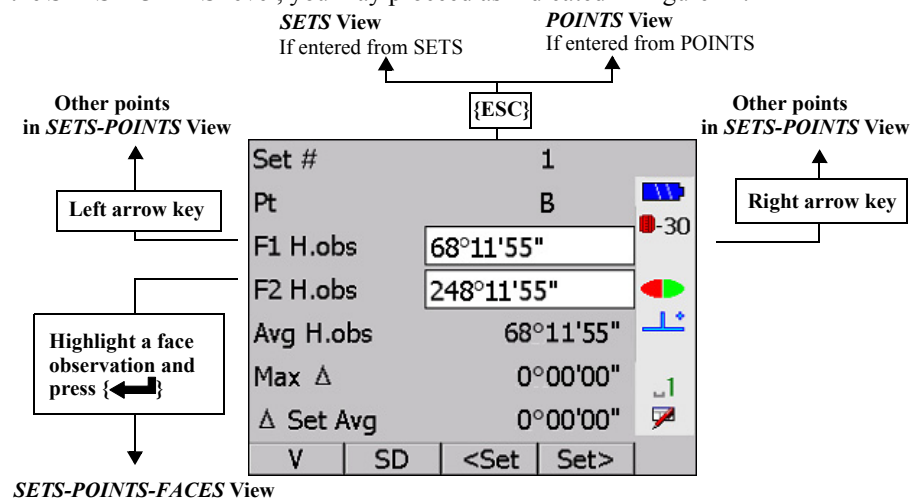
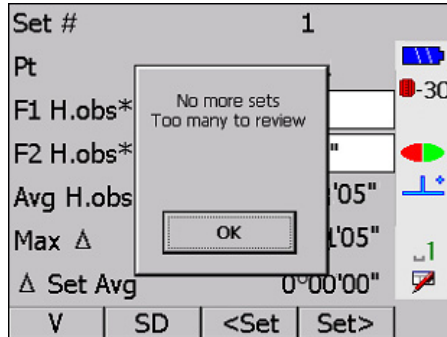


Figure 11: Set review SETS-POINTS view

- **{ESC}** takes you up the hierarchy to either the **SETS** level or the **POINTS** level, depending on from which of these you came.
- **[V]** and **[SD]** show information equivalent to the above display, but for vertical angles and slope distances respectively.

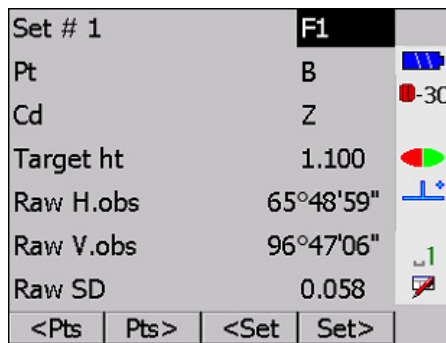
- The {▶} and {◀} arrows give data on points within the current set.
- The [← Set] and [Set→] softkeys display previously and subsequently collected sets. If the current point appears in the set you move to, that point will be highlighted. Otherwise, the first point in the set is highlighted. If [← Set] is pressed when the first set collected is displayed, or [Set→] is pressed when the last set collected is displayed, the following message appears:



- Press {←} to invoke the Set review hierarchy's lowest level, which gives a *SETS-POINTS-FACES* display (a complete raw observation).

### 11.3.6 SETS-POINTS-FACES level

Highlight the F1 observation in the previous display and press {←}:



From this level you can proceed as shown in Figure 12.

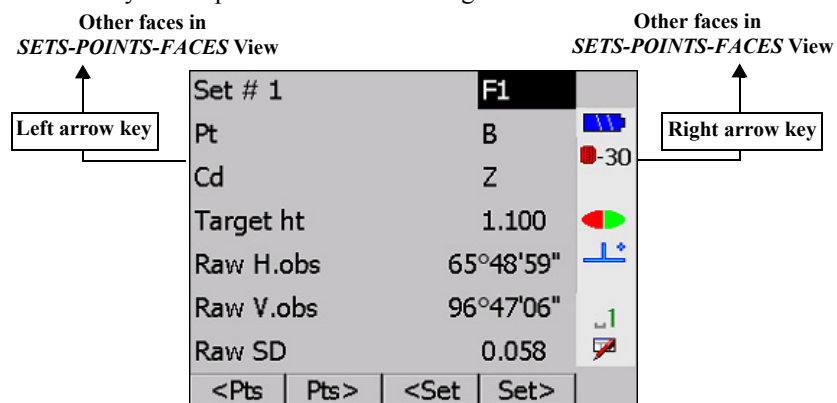
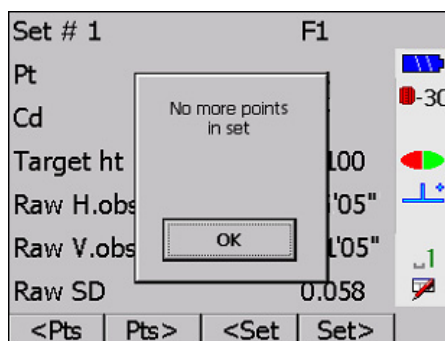
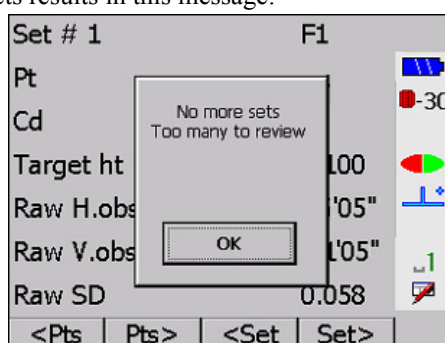


Figure 12: Set review SETS-POINTS-FACES view

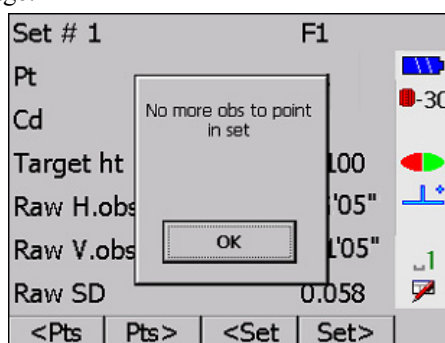
- Press [**← Pts**] and [**Pts→**] to display raw observations of previous and subsequent points within the current set:



- [**← Set**] and [**Set→**] display raw observations of the current point (if possible, otherwise the first point) in previous and subsequent sets. Pressing these softkeys when there are no more sets results in this message:



- [**▶**] and [**◀**] move between the raw observations to a point within the current set (usually there are only two observations, one on **F1** and one on **F2**). Pressing these keys when there are no more observations to the current point within the set results in the following message:



- [**ESC**] returns you to the next level up (*SETS-POINTS* with current point = 1100 and current set = 1).

### 11.3.7 Special cases

Although the preceding discussion has not presented every possible display for the two example sets, it illustrates most of the cases. Special cases are noted here.

#### 11.3.7.1 Return sights

When collecting sets, you often make an observation to the reference object (typically the backsight) at the beginning and end of each set. The second observation in each pair is the return sight. The return sight permits you to distribute any return error (the difference in horizontal angle between the two reference observations) over the entire set, thus removing errors due to inaccuracies in the circle.

When you review a set containing a return sight, the horizontal angles have been adjusted for return error (before any other adjustment of the set takes place). The return sight appears as a separate entry in the hierarchy. For example, a set containing observations to points A, B, C and D, followed by a return sight to A, displays the **POINTS** level like this:

$$A \leftarrow \rightarrow B \leftarrow \rightarrow C \leftarrow \rightarrow D \leftarrow \rightarrow A_1$$

$A_1$  denotes the return sight

All levels of the **Set review** hierarchy have return error distributed, with the exception of the lowest raw observation level.

### 11.3.7.2 GOOD and BAD Sets

The SETX permits you to mark a set as BAD if it contains inaccurate data or incorrect point identifier(s). Whenever an averaged set (MC records) is produced, BAD sets are omitted from the averaging process. An averaged set is produced:

- Each time a set collection session is completed
- Each time a set is marked BAD
- Each time a BAD set is remarked GOOD

The **Set review** mechanism permits the general reviewing of collected sets, with particular emphasis on the identification of sets that contain erroneous or out-of-tolerance observations. Sets that ought to be marked BAD are identified so you may evaluate whether they will corrupt subsequent calculations (such as a traverse).

Use **[Bad]** to mark a set BAD at the **SETS** level. A BAD set is displayed with an asterisk (\*).

Once a set is marked BAD, it is no longer included in any averaging calculations. Averages, standard deviations, and so on, that appears in the **POINTS** and **SETS-POINTS** levels of the **Set review** hierarchy do not take BAD sets into account. Basic information for BAD sets still appears, including the differences between BAD sets and the new averages.

You can mark a set that you suspect of interfering with the averages as BAD and then examine how the averages change. If you determine that the suspected set does not change the averages by an inordinate amount (if at all), change it back to GOOD by using **[Good]**.

---

**NOTE** If you change the marking of any sets, a new series of averaged **MCs** is output to the database at the end of the **Set review** session.

---



---

**NOTE** A set that has been obtained from comms input is available for further set collection, set review, or resection.

---

### 11.3.7.3 Collimation Correction

Collimation correction is applied to every level above the lowest (“raw observation”) level in the **Set review** hierarchy. Therefore, all angles displayed in **Set review** have collimation correction applied except in the **SETS-POINTS-FACES** level.

# Chapter 12

# Building Face Survey

### In this chapter

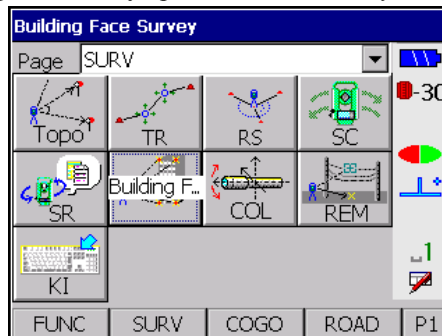
- Coordination of points in a vertical plane using single angle-only observations
- Building face surveys in nonvertical planes

The building face program allows points on both vertical and nonvertical planes to be coordinated by angle-only observations. The primary use of the building face program is to pick up details of a building where the prism cannot be placed.

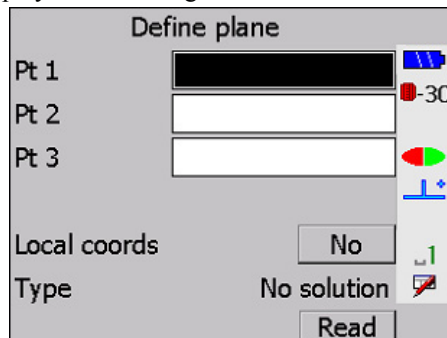
The building face is defined by observing three accessible points on the building or by entering their known coordinates. Angle-only observations are then made and the SETX calculates and stores the coordinates of the intersection of the angle observation with the plane.

## 12.1 Defining the Building Face

1. Select the **Building face survey** option from the *Survey* menu to begin.



2. The SETX will display the following screen:





3. The **Pt 1** and **Pt 2** fields allow you to enter the point names for two points to define a vertical building face plane. You can also use **[Read]** provided to fix the points by observation, if desired. Both **Pt 1** and **Pt 2** must have horizontal coordinates to properly define the building face. If a point is entered that has a null northing or easting, the following message will be displayed.

The screenshot shows the 'Define plane' dialog box. The 'Pt 1' field contains '1234'. The 'Pt 2' and 'Pt 3' fields are empty. The 'Local coords' dropdown is set to 'No'. A red banner at the bottom of the dialog displays the message 'Null position'. A 'Read' button is visible at the bottom right.

4. You have the option of filling in the **Pt 3** field. If **Pt 3** is not filled in, it is assumed that the plane is vertical. For example, the screen may appear like the following:

The screenshot shows the 'Define plane' dialog box. The 'Pt 1' field contains 'AAAA', 'Pt 2' contains 'BBBBB', and 'Pt 3' is empty. The 'Local coords' dropdown is set to 'No'. The 'Type' dropdown is set to 'Vertical'. A 'Read' button is visible at the bottom right.

5. The **Type** field indicates the type of plane you have defined. The three possibilities are as follows:

Table 14: Plane Types

Type	Description
No solution	Does not have enough information to fix the plane.
Vertical	Has enough data to fix a vertical plane.
3D	Has enough information to fix an arbitrary plane.

When **Pt 3** is filled in, the SETX assumes that you are defining a plane that may be nonvertical. With **Pt 3** filled in, the screen will look like this (notice that **Type** is now **3D**):

The screenshot shows the 'Define plane' dialog box. The 'Pt 1' field contains 'AAAA', 'Pt 2' contains 'BBBBB', and 'Pt 3' contains 'CCCC'. The 'Local coords' dropdown is set to 'No'. The 'Type' dropdown is set to '3D'. A 'Read' button is visible at the bottom right.

## 12.2 Selecting a Coordinate System

1. The **Local coords** field in the **Define plane** screen controls the coordinate system to which the computed coordinates are referenced. Set this field to **No** to compute the coordinates in North, East, and Elevation coordinates.

Set the **Local coords field** to **Yes** to have the calculated coordinates referenced to Point A as the origin of the local coordinate system.

Calculated points are recorded with three coordinates:

- Horizontal distance from Point A
- Elevation
- Offset from the plane

Point A is the origin of the local coordinate system, positive east is in the direction from A to B, and positive elevations come from the plane toward the instrument.

Setting the **Local coords** field to **Yes** provides a simple way of directly plotting the building face with no further processing. See Figure 13.

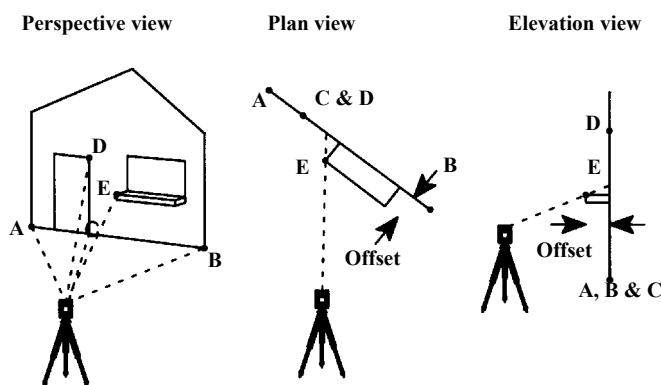
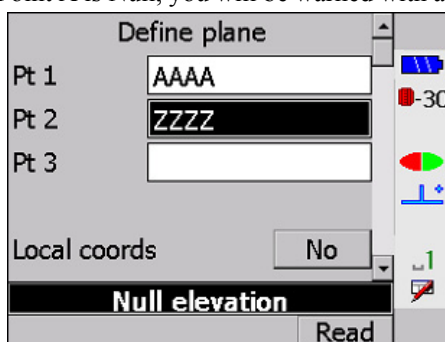


Figure 13: Building face survey

2. To define a local coordinate system, Point A cannot have any Null coordinates. As already mentioned, the horizontal coordinates must not be Null in order to define the plane. However, the elevation must also not be Null if local coordinates are desired. If the elevation of Point A is Null, you will be warned with a **Null elevation** message:



If you change **Local coords** to **Yes**, the **Type** field changes from **Vertical** to **No solution**. This results because the SETX cannot determine local coordinates without an elevation for Point A.

## 12.3 Surveying a Vertical Plane

Once you have specified the two points that define the building face plane, press {←}. A Note is saved in the SDR database recording the point numbers of the two points defining the building face plane, and whether local coordinates are in effect. You will be presented with a reading screen that looks like the following:

Take Reading	
Stn	A99
BS pt	1100
H.obs	63°35'41"
V.obs	86°55'33"
Building Face Survey	
Angle-only	
Cnfg	Angle

You can now observe detail points on the building face using angle-only observations. The SETX will compute and save the coordinates for the points, according to the coordinate system selected.

If you are saving the building face points in a local coordinate system, the local coordinates of the two points defining the plane will automatically be saved using the next two auto point numbers.

You can either press the {READ} key or [Angle] to take readings to points on the building face. The observation screen, as shown below, has an *Ofs dist* field that allows you to enter any known offset distance of a point from the building face plane (as in the case of Point D in Figure 13, Page 12-3).

Code	<No text>
Pt	AAAA
Ofs dist	0.000
H.obs	63°35'40"
V.obs	86°55'49"
Cnfg	
Angle	

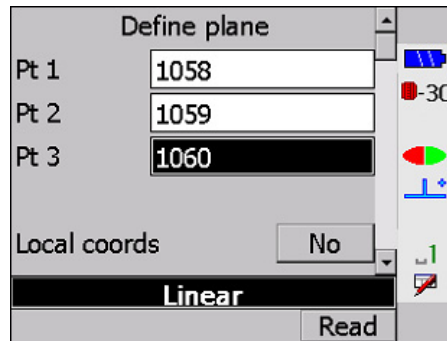
A positive offset distance indicates that the observed point is “in front” of the plane, as observed from the occupied station. A negative offset distance indicates that the observed point is “behind” the building face plane.

## 12.4 Surveying Nonvertical Planes

Surveying a nonvertical plane is very similar to surveying a vertical plane. Read the previous sections on defining a building plane, selecting a coordinate system, and surveying in a vertical plane before proceeding.

The first difference between surveying vertical and nonvertical planes is in the definition of the plane; the nonvertical plane requires three points. The SETX assumes that the plane you are defining may be nonvertical if you fill in a value for **Pt 3**. All three points must be fully defined; no coordinates may be Null. You will see **Null position** or **Null elevation** warning messages if points are undefined, and *Type* will display **No solution**.

One unapparent restriction is that the three points cannot be in a line. If the points are linear, you will see the warning message **Linear** and the *Type* field will display **No solution**.



The second major difference of a nonvertical plane is the method used to determine a local coordinate system. The first point is still the origin of the local coordinate system; however, the second point defines due east, not positive east, as with a vertical plane. The instrument station is still assumed to have a positive elevation in the local coordinate system, as it does with vertical planes.

Once the plane has been defined, and you understand how the local coordinate system works for nonvertical planes, picking up detail observations is the same as for vertical planes.

# Chapter 13

## Collimation Errors

### In this chapter

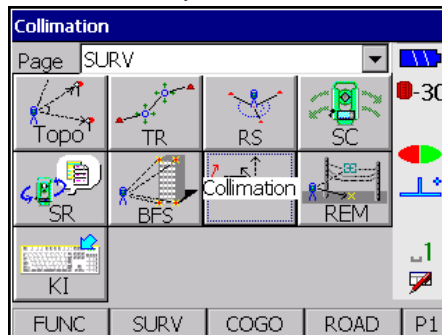
- Collimation error measurement

### 13.1 Measuring Collimation Error

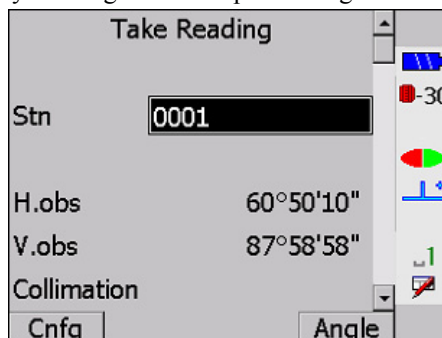
The **Collimation** option in the *Survey* menu allows you to measure the collimation error in your instrument so that the SETX can correct subsequent single face observations. The errors are measured by making angular observations using both faces of the instrument to one or many points. The minimum required data is a Face 1 (**F1**) observation and a Face 2 (**F2**) observation to a single point.

#### Steps for completing collimation error measurement

1. Choose **Collimation** from the *Survey* menu.



2. Begin with the standard station and backsight setup.
3. The SETX prompts you to sight the first point using Face 1 of your instrument:



4. Press the **{READ}** key for regular observations or **[Angle]** for angles-only observations to the point using Face 1.

**[Cnfg]** accesses the *Configure reading* screen. For more information, see Section 3.5.4, *Configure reading*, Page 3-6.

5. The SETX prompts you to sight the same point using Face 2:

6. Press the **{READ}** key or **[Angle]** to observe the point using Face 2. This completes the minimum set of readings necessary to calculate collimation error.

Continue to take as many Face 1, Face 2 pairs as desired to any number of points. Observing two or more points with significant vertical separation will improve the result.

7. Press **{←}** to see the calculated collimation error so far.

8. Press **{←}** if you want to accept the result and store a collimation (**COL**) record in the database. Pressing **{ESC}** results in a confirmation prompt to discard data.

If you want to collect more collimation error data, press **[NO]**. Press **[YES]** to discard the collimation error data without storing a collimation (**COL**) record in the database.

Once a collimation record is added to the database, corrections are applied to all subsequent observations until either the instrument type is changed or a new collimation record is added. The details of the correction calculation are given in Section 29.2.5, *Collimation correction*, Page 29-4.

Collimation is not maintained across all jobs. When you start a new job, the same instrument is assumed, but the collimation measurement is not.

# Chapter 14

## Remote Elevation

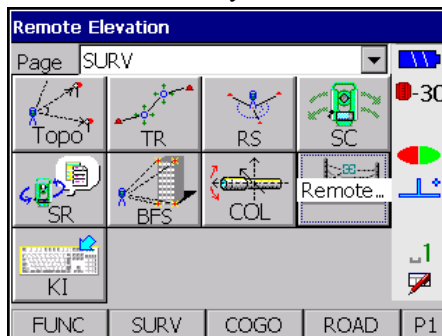
### In this chapter

- Remote Elevation program

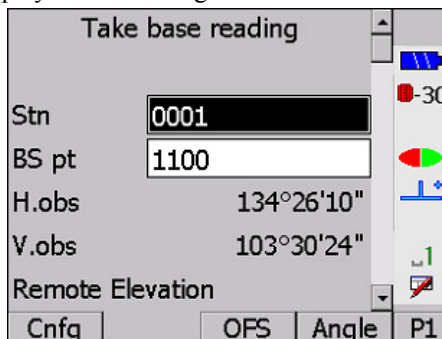
Use the Remote Elevation program to coordinate points when you are unable to place a prism at the required point, but can place the prism either directly above or below the point. You observe (with a prism) a base point directly underneath or above the target point and then observe a vertical angle to the target point. The SETX calculates the intersection of the extended vertical angle with a vertical line from the base point.

### Steps to take a remote elevation reading

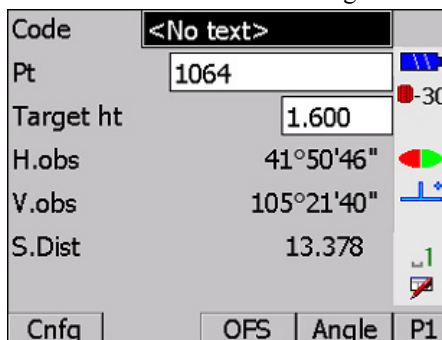
1. Select **Remote elevation** from the *Survey* menu.



2. Begin with the standard station and backsight setup.
3. Then the SETX displays the following screen.



4. Direct the rodman to place the prism rod directly under the desired point. Point the survey instrument to the prism and press the **{READ}** key to observe the base point. The SETX displays a screen similar to the following:



5. Press **{FUNC CTRL} + {←}** to accept the base point observation. The SETX will display the following screen.

Remote Elevation	
Cd	<No text>
Pt	1067
V.obs	101°53'03"
Height	1.500
V.obs	0.540
Store	

6. As the scope moves up or down, the elevation value changes. Once sighted on the point, press **[Store]** to record the values.

---

**NOTE** **Height** is the difference in height from the base point of the prism point to the observed target point.

---

7. You have three options.
- Press the **{READ}** key again to observe the point
  - Press **[Store]** to accept the result and store it as a **POS** (position) record.
  - Press **{ESC}** to exit.



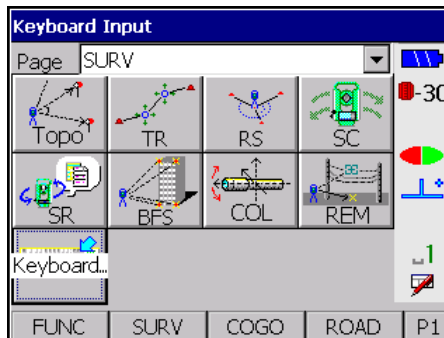
# Chapter 15

# Keyboard Input

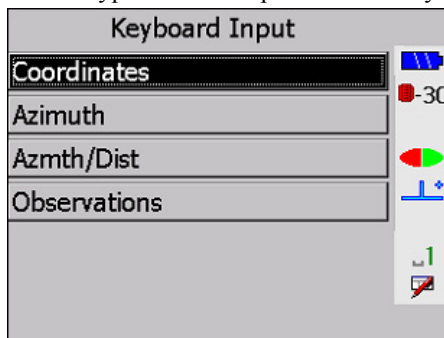
### In this chapter

- Entering coordinates
- Entering azimuths
- Entering azimuths with distances
- Entering observations

You can enter data directly into the SETX using the keyboard. Select **Keyboard input** from the *Survey* or *COGO* menus.

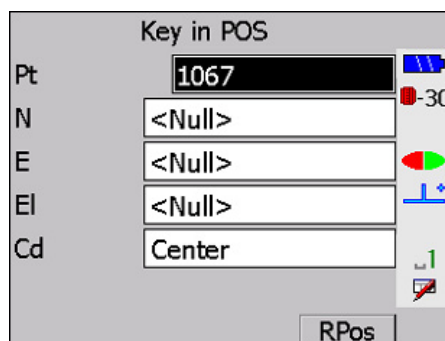


The SETX displays four record types that are input from the keyboard.



## 15.1 Entering Known Coordinates

**Coordinates** is the first option from the *Keyboard Input* screen, which displays the following screen.



Enter the point name in the *Pt* field, and the point's North, East and elevation coordinates in *N*, *E* and *El* fields. You also can assign a code in the *Cd* field. Press {←} to add a position record with the **KI** derivation code to the database.

**RPos/Pos** .....Switch between the *Key in POS* and *Road pos* screens. The *Road pos* screen allows you to enter *Pt*, *N*, *E*, *El*, *Sta...ing*, *Offset*, and *Cd* values for a road position point.

## 15.2 Entering Known Azimuths

**Azimuth** is the second option on the *Keyboard Input* screen. Use it to tell the SETX a known direction from one point to another.

Provide the following information:

**Cd**.....Assign a code

**To pt** .....Enter the target point name

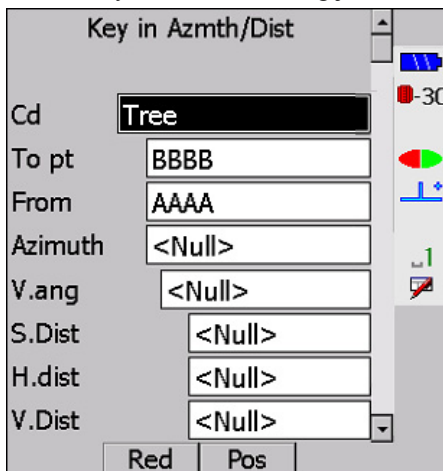
**From** .....Enter the source point name

**Azimuth**.....Enter the azimuth value

Press {←} to store the azimuth between the points as a **RED** record in the database.

### 15.3 Entering Known Azimuths with Distance

**Azmth/Dist** is the third option on the **Keyboard input** screen. Entering an azimuth and distance between two points is very similar to entering just an azimuth.



Provide the following information:

- Cd**.....Assign a code
- To pt** .....Enter the target point name
- From** .....Enter the source point name
- Azimuth** .....Enter the azimuth value

The four fields at the bottom of the screen are used to determine the horizontal and vertical distances between the two points. As you enter a value in one of these fields, two of the other fields may be updated. The SETX uses the two most recently entered values to determine the remaining two. The only two values that are stored on the database are **H.dist** and **V.Dist**.

When you have the correct azimuth and distance values entered, use the following methods to store the information:

- [Red]** or **{←■}** .....The azimuth and distance data are stored in the database as a **RED** record in **RED** view
- [Pos]** .....The **RED** record will be stored in **POS** view (thereby overriding any previous information about the point, see Chapter 6, **Coordinate Search Logic** for details on database searching)

## 15.4 Entering Known Observations

Use the **Observations** option to enter a known vector from one point to another into the SDR database.

Keying in known observations requires a backsight point (**BS pt**). The following diagram illustrates the backsight point and its relation to other points.

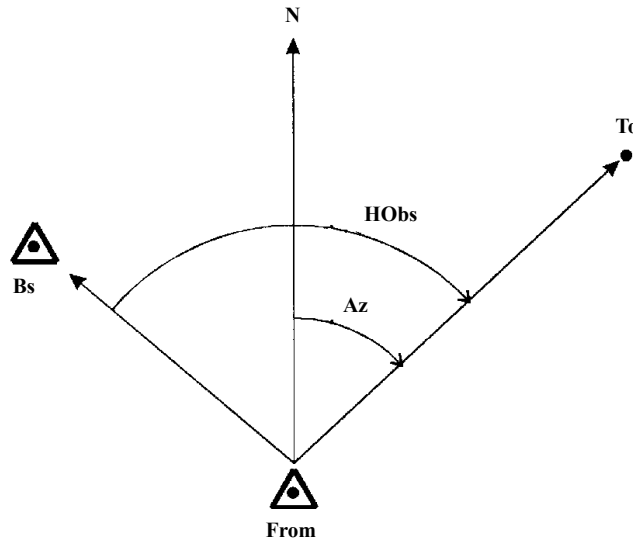


Figure 14: Backsight point

The following screens appear when **Observations** is chosen.

Key in Obsvsn	
Cd	Tree
To pt	0002
From	0001
BS pt	<Null>
Azimuth	<Null>
V.ang	<Null>
S.Dist	<Null>
H.dist	<Null>
V.Dist	<Null>
MC	Red Pos

Provide the following information:

**Cd**.....Assign a code

**To pt**.....Enter the target point name

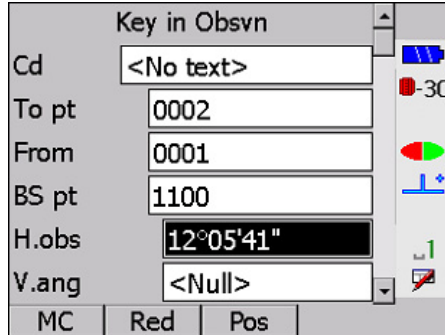
**From**.....Enter the source point name

**BS pt**.....Enter a known backsight point or leave blank if no known coordinates exist

**Azimuth**.....Enter the azimuth value

The four fields at the bottom of the screen are used to determine the horizontal and vertical distances between the two points. As you enter a value in one of these fields, two of the other fields may be updated. The SETX uses the two most recently entered values to determine the remaining two.

If you have a known backsight point, enter its point name in the BS pt field and press {←}. The SETX displays the following screen.



The *H. obs* field has replaced the *Azimuth* field. Enter the horizontal angle in the *H.obs* field. Scroll down and enter values for *V. ang*, *S. Dist*, *H. Dist*, and *V. Dist* as before.

When all distances and azimuths are correctly entered, use the following methods to store the information:

- [MC] or {←} .....Stores an MC record in **MC** view in the database
- [Red] .....Stores an MC record in **RED** view in the database
- [Pos] .....Stores an MC record in **POS** view in the database

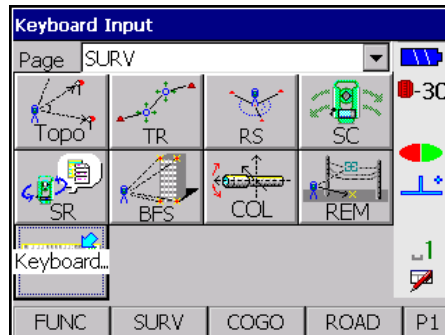
# Chapter 16

## Set Out Design Coordinates

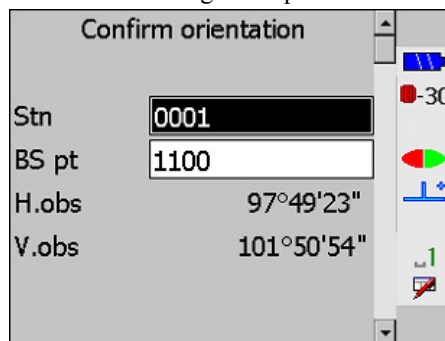
### In this chapter

- Adding points to the setout list
- Deleting points from the setout list
- Setting out a point

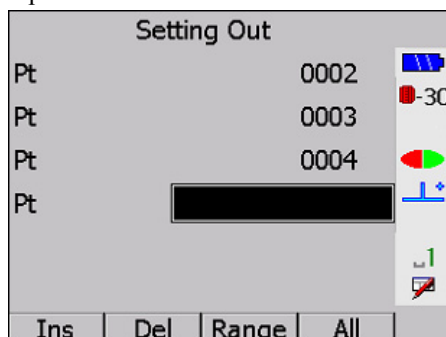
Use the **Set Out Coords** option in the **COGO** menu for positioning design coordinates in the field. It is necessary to set up your instrument on a known location. (The Resection program allows you to conveniently set up on any suitable point.)



Begin with the standard station and backsight setup.



Once a station and backsight are set up, the SETX checks for an existing list of points to set out for the job. If it finds a list, the SETX displays it; if not the SETX displays an empty list. From this screen you can enter, modify, insert, or delete point names in the set out list. You can also add all known points, add all points between two point names (for example, all points from 1000 to 1100), add all points within a specified distance of the current station, or add all points with a certain code.



## 16.1 Adding Points to a Set Out List

Several ways exist to add new points to the list.

- Enter point names in the blank entry at the bottom of the list. Press {▼} to move to the bottom.
- Press [Ins], which inserts a blank entry on the current line, enter point name. If the point does not exist in the job, you will be prompted to key in its coordinates.

The screenshot shows a dialog box titled "Key in POS". It has five rows of input fields: "Pt" with the value "1112", "N" with "<Null>", "E" with "<Null>", "El" with "<Null>", and "Cd" with "<No text>". To the right of these fields are several icons: a blue flag, a red circle with "-30", a green circle, a blue crosshair with a plus sign, and a green circle with "1". At the bottom right is a button labeled "RPos".

- Add all the points in the current job to the set out list by pressing [All]. The SETX will display the following screen. Select **Add all POSs to list**.

The screenshot shows a dialog box with three main options: "Add all POSs to list" (highlighted), "Delete all from list", and "Sort by Azimuth". To the right are the same icons as in the previous screenshot: a blue flag, a red circle with "-30", a green circle, a blue crosshair with a plus sign, and a green circle with "1".

- Press [Range] to add a range of point names to the list. After you specify the range using any or all of the selection methods provided, the SETX adds to the list all points that meet the conditions.

The screenshot shows a dialog box titled "Enter Range". It has four rows of input fields: "From" with "0002", "To pt" with "0006", "Radius" with "<Null>", and "Cd" with "<No text>". To the right are the same icons as in the previous screenshots: a blue flag, a red circle with "-30", a green circle, a blue crosshair with a plus sign, and a green circle with "1".

**Point range** .....The first selection method is a simple numeric range of points from the point name specified in the *From* field to the point name specified in the *To pt* field (inclusive). Any point names in the range that do not already exist are ignored.

**Distance range** .....If a distance value is entered into the *Radius* field, only points within that distance (radius) from the current station will be included in the list.

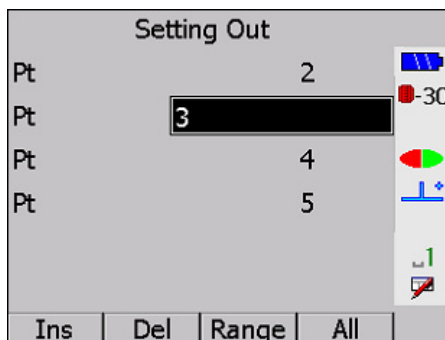
**Code range** .....A code can be specified in the *Cd* field; only points with a matching code will be included in the list.

Press {←} to commence the range selection. The selected points will then be added to the current list of points to be set out. Combine these selection methods to select a very specific group of points or select this range option several times to add different ranges of points to the list.

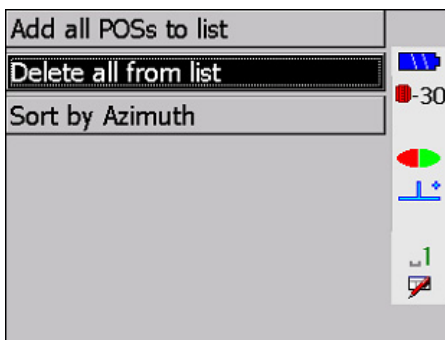
After entering points into the list, the cursor will be positioned at the bottom of the list. You can go to the top of the list by pressing {▲}.

## 16.2 Deleting Points from a Set Out List

To eliminate a point name from the list, move the highlight bar to the point name and press [Del].



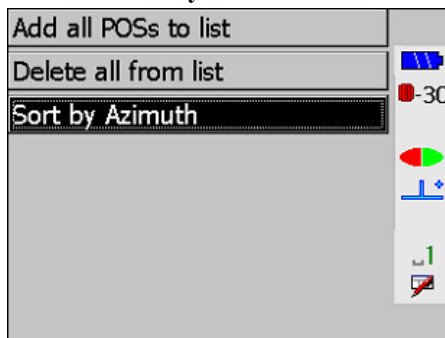
To remove all the point names from the list, press [All]. The SETX will display the following screen. Select **Delete all from list**.



The SETX will then display the screen for adding set out points.

## 16.3 Sorting a Set Out List by Azimuth

The SETX can sort the set out list by azimuth as referenced from the current station to each point. Press [All], and select **Sort by Azimuth**.



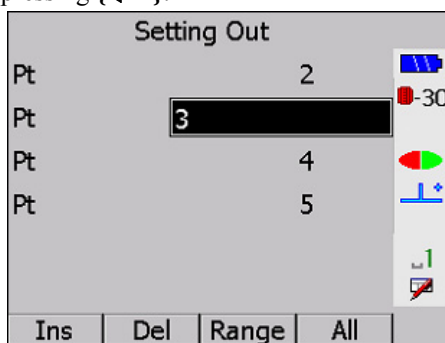


The SETX will display a **Working...** message that will move up and down the screen as the SETX sorts the list. A long list may take a couple of minutes to sort. When the sort is complete, the point entry list will be displayed. The point names will be in order of increasing azimuth, using the current station as the from point.

## 16.4 Setting Out a Point

Guidelines for setting out a point are described below.

1. Choose a particular point from the list of points on the screen to set out by highlighting it and pressing {←}.









2. The SETX shows you all the information required to set out the point: the necessary horizontal and vertical angles to observe, the desired slope distance to the point, the reduced horizontal and vertical distances, and the azimuth.









3. Align your instrument to the horizontal angle shown. The SETX is put into countdown mode automatically to help you. Rotate the instrument until the countdown reaches zero, then direct the prism pole in line.

4. Sight on the prism and press the **{READ}** key on the SETX. The following screen displays:

Target ht	1.400	
H.obs	<Null>	
V.obs	<Null>	 -30
S.Dist	<Null>	
		
		 1
		
Cnfg	OFS	Angle P1







5. Enter a value in the *Target Ht* field and press **{FUNC CTRL} + {←}**.
6. Information for setting out the plan position of the point displays the following screen:

Right	41.003	
In	40.549	
Fill	1.836	 -30
Aim H.obs	168°59'36"	
Aim V.obs	89°01'50"	
H.obs	35°54'24"	
V.obs	111°57'21"	 1
		
Cnfg	Store	Target

- Right/Left**.....Distance to move either left or right to get on line. The direction is from the instrument operator's point of view.
- In/Out**.....Distance to move either in (toward the instrument) or out (away from the instrument) to get the prism on to the target point.
- Cut/Fill**.....Amount of cut or fill that the currently observed position represents relative to the design point. Remember that the currently observed point is the physical point at the bottom of the prism pole.
- Aim H. obs**.....Horizontal angles required to sight to the target
- Aim V. obs**.....Vertical angles required to sight to the target.
- H.obs**.....Horizontal observation angle
- V.obs**.....Vertical observation angle
7. Press the **{READ}** key or **[Target]** softkey to refine your prism location on a horizontal plane. You can take as many observations to the prism as needed. After each observation, the *Left/Right* and *In/Out* fields are updated to reflect the latest position of the prism relative to the target point.

**NOTE** To avoid setting out a point vertically, you can press **[Store]** as a shortcut to immediately store the results and return to the point selection screen.

8. Press **{←}** to continue to the setting out point vertically. The vertical setting out display is similar to this screen:

Fill	0.777	
Aim V.obs	88°06'11.8"	
Cut o/s	0.000	 -30
H.obs	323°19'56.0"	
V.obs	89°16'34.0"	
		
		
Cnfg	Store	Target

**Cut/Fill** ..... Amount of cut or fill that the currently observed position represents relative to the design point. Remember that the currently observed point is the physical point at the bottom of the prism pole.

**Aim V.obs** ..... Vertical angle that should be observed to obtain the design height plus the cut offset.

**Cut o/s** ..... Is normally zero. However, if the design point is underground, you may want to enter a **Cut o/s** value of 1.000, for example, to accurately stake an above ground mark. (To set out a fill offset, enter a negative value in the **Cut o/s** field.) The vertical angle in the **V.obs** field changes to reflect the new desired position. If you observe this vertical angle, the actual Cut value in the first field changes to 1.000.

**H.obs** ..... Horizontal observation angle

**V.obs** ..... Vertical observation angle

The SETX automatically starts a vertical countdown mode. When the countdown is zero, you will be sighting on the design elevation plus the value of the Cut offset.

9. Choose one of the following actions when the procedure is completed.

**{ESC}** ..... To return to setting out the plan position of the current point. This action might be necessary if the prism pole is inadvertently moved during the setting out of the elevation.

**[Store]** ..... Press this softkey to store the current setout position. The SETX then prepares to store the results, and will show you the default point name and code that it will use.







Store Result		
Cd	<No text>	
Pt	3	 -30
Δ North	0.927	
Δ East	0.237	
Cut	<Null>	
		
Yes	No	

Table 15: Steps to Store the Setout Position

Step	Description
1	Change the point name, the code or both. The default code includes a reference to the name of the point that was set out.
2	When the point name and code are acceptable, press {←}. A position record and note showing differences between design and actual position will be stored.
3	Press {ESC} to return to the setting out of points.
4	Once the position record is generated, the SETX returns to the list of point names to be set out so that you can choose another point to set out. If the list is now empty, it will prompt you to add points to the list.

{←}.....Press this key once a satisfactory elevation has been set out.

# Chapter 17

## Set Out Line

### In this chapter

- Setting out points along a line, in either the horizontal or vertical plane
- Checking that points are on a defined alignment

This function can be used for setting out and checking alignment of curblines, construction boards, and grades of pipes.

A baseline or an offset from that baseline can be defined and its points set out in the field. Alternatively, a baseline can be established from which observations are described, allowing points to be set along the line of an offset.

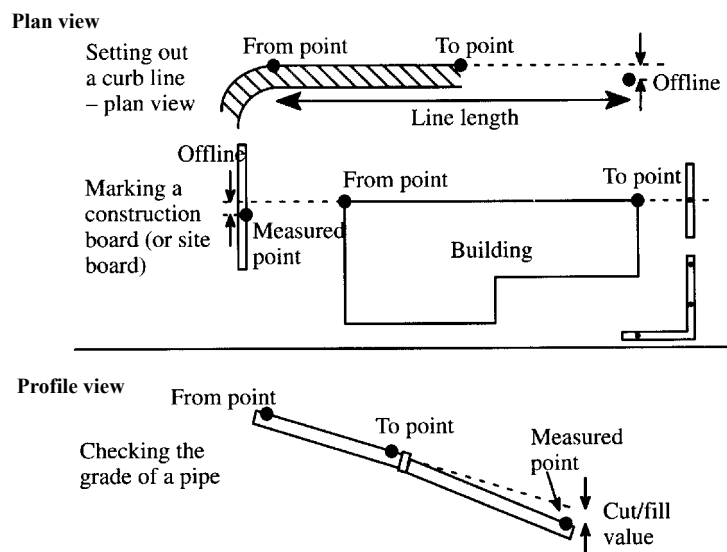
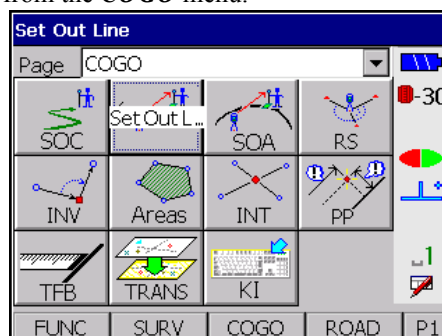


Figure 15: Setting out a line

### 17.1 Defining the Baseline

The SETX allows several methods of defining the baseline when setting out a line. The usual method for defining the baseline is to specify two points. However, you also can specify one point plus an azimuth, or a grade or vertical angle, to allow the setting out of points along the defined line.

1. Select **Set out line** from the **COGO** menu.



2. Begin with the standard station and backsight setup.

- Enter a point ID in the *From* field.

- Then enter one of the following to define the baseline:

- To point
- Azimuth
- Grade
- Vertical Angle

A **{READ}** key is available when either the *From* or *To pt* fields are selected, enabling direct readings to be taken to establish these points if desired. If an unknown point name is entered, the *Key POS* screen will appear, allowing you to enter the appropriate coordinate values.

When the *Grade* field is selected, [1:], and [%] are presented. [1:] and [%] control the display and entry of grade values. If desired, up or down vertical grades can also be defined by entering the appropriate vertical angle values to suit the current instrument's *V.obs* setting. For example, if the current instrument setting is for Zenith vertical angles then entering a vertical angle of 0° or 0 gons will result in the *Grade* field displaying **Up (Vert)**.

- Press **{FUNC CTRL} + {←}** to accept the entries.

## 17.2 Setting Out a Defined Line

Once the baseline is defined, you can set out the points which define the line.

- The following *Set Out Line* screen displays (after **{FUNC CTRL} + {←}** is pressed):

**Offset**.....Sets out points along a line parallel to the actual design line at the specified offset distance. This facility can be used to avoid the possibility of heavy machinery disturbing the stakes. A negative offset value indicates an offset to the left of the defined line.

**Segments** .....The *Segments* field displays the number of segments, between the **From** and **To** points, into which the total line length is split. If you set this field to 1, the total arc length (or chord length) will be displayed in the *Len incr* field. If you want to set out an arc that is split evenly into five sections, enter 5 into this field, and the appropriate length increment to achieve this will be displayed in the *Len incr* field.

**Len incr** .....Specifies distance increments along the set out line at which you want to set out points. For example, if you wish to set out points every 20 feet (or meters) along the set out line, enter 20 into this field.

**Line len**.....Defines the distance along the specified baseline from the selected **From** point to the set out point.

You can enter into the *Line len* field the appropriate distance to the point to be set out or you can use the other fields on the screen to determine the distance.

[ ← ] and [ → ] decrease and increase the current distance in the *Line len* field, for the point to be set out, by the value in the *Len incr* field.

- **[Store]** stores the coordinates of the point to be set out. Appropriate code and point numbers may be allocated to the points. The calculated values on this screen are not editable. However if the elevation value is Null, you can enter an appropriate elevation value for the point.

Store Design Point	
Cd	<No text>
Pt	1000
N	0.773
E	1.119
EI	0.062
<input type="button" value="Yes"/> <input type="button" value="No"/>	

- **[Line]** allows you to set out point relative to the established baseline as described in Section 17.3, *Setting Out Points Relative to an Established Line*, Page 17-4.

- Pressing **{FUNC CTRL} + {←}** on the *Set Out Line* screen accepts the current point on the baseline to be set out. The SETX shows you all the information required to set out the point: the necessary horizontal and vertical angles to observe, the desired slope distance to the point, the reduced horizontal and vertical angles, and the azimuth.

Aim horiz circle	
Aim H.obs	146°31'39"
Aim V.obs	90°00'00"
H.dist	31.000
H.obs	88°43'07"
V.obs	85°31'40"
dH.o	57°48'31"
Azimuth	90°00'00"
V.Distance	9.900
S.Distance	33.031
Cnfg	

- Return to Section 16.4, *Setting Out a Point*, Page 16-4, for further details relating to setting out procedures.
- Choose one of the following actions when the procedure is completed.

Table 16: Actions Available After Setout

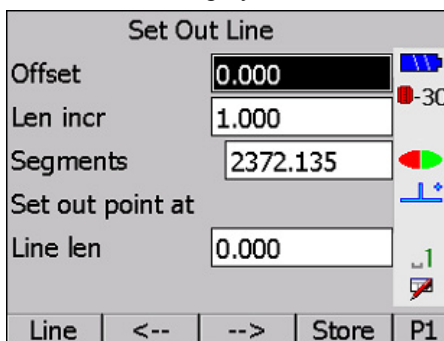
Action	Description																
<b>ESC</b>	Press <b>{ESC}</b> to return to setting out the plan position of the current point. This action might be necessary if the prism pole is inadvertently moved during the setting out of the elevation.																
<b>Store</b>	When the point name and code are acceptable, press <b>{←}</b> to store a position record and a <b>NOTE</b> record that indicates how far offline the set out point was from the required line. A negative offline value indicates that the measure point was to the left of the required line. Press <b>{ESC}</b> to return to the setting out of points. Once the position record is generated, the SETX returns to the <i>Set out line</i> screen so that you can choose another point to set out.																
	<table border="1"> <thead> <tr> <th colspan="2">Store Result</th> </tr> </thead> <tbody> <tr> <td>Cd</td> <td>&lt;No text&gt;</td> </tr> <tr> <td>Pt</td> <td>1000</td> </tr> <tr> <td>Offline</td> <td>0.000</td> </tr> <tr> <td>Δ North</td> <td>8.281</td> </tr> <tr> <td>Δ East</td> <td>7.108</td> </tr> <tr> <td>Fill</td> <td>0.664</td> </tr> <tr> <td colspan="2">Yes No</td> </tr> </tbody> </table>	Store Result		Cd	<No text>	Pt	1000	Offline	0.000	Δ North	8.281	Δ East	7.108	Fill	0.664	Yes No	
Store Result																	
Cd	<No text>																
Pt	1000																
Offline	0.000																
Δ North	8.281																
Δ East	7.108																
Fill	0.664																
Yes No																	
<b>Enter</b>	Press <b>{←}</b> once a satisfactory elevation has been set out.																

### 17.3 Setting Out Points Relative to an Established Line

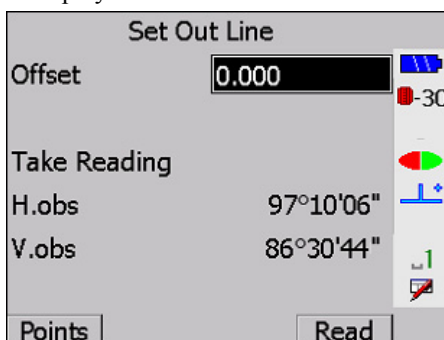
Once the baseline is defined, you can set out points relative to the line or offset from that line. The line is extrapolated such that any observation is described relative to the line and can be directed in order to set out along the line.



- The following **Set Out Line** screen displays after the baseline definition is accepted:



- Press **[Line]** to set out points relative to the baseline.
- The following screen displays:



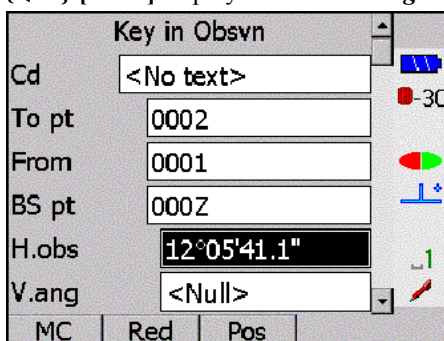
**Offset**.....For setting out points relative to a line parallel to the defined line at the specified offset distance. A negative offset value indicates an offset to the left of the defined line.

**H.obs**.....Horizontal observation angle







**V.obs** .....Vertical observation angle

**[Points]** .....This softkey allows you to set out the points of the defined baseline as described in Section 17.2, *Setting Out a Defined Line*, Page 17-2.






**{FUNC CTRL} + {←}/[Read]**Displays a **Take reading** screen:



4. Sight on the prism and initiate the appropriate reading. The following screen displays:

Target ht	1.800	
H.obs	<Null>	
V.obs	<Null>	 -30
S.Dist	<Null>	
		
		
		
Cnfg	OFS	Angle P1

5. Enter value in the *Target Ht* field and press {FUNC CTRL} + {←}.  
 6. Information about the observed point relative to the defined baseline is displayed.

Set Out Line		
Offline	-2.594	
Out	3.732	 -30
Fill	0.240	
H.obs	95°03'48"	
V.obs	86°31'12"	
Press READ to update		
Cnfg	Store	Read

- Offline**.....Perpendicular distance from the observed point to the baseline  
**In/Out** .....Distance to move either in (toward the instrument) or out (away from the instrument to set the prism on the defined line  
**Cut/Fill** .....Vertical distance from the observed point to the perpendicular intersection of the line  
**H.obs** .....Horizontal observation angle  
**V.obs**.....Vertical observation angle
7. Press the {READ} key or [Read] softkey to refine your prism location. You can take as many observations to the prism as needed. After each observation, the *Offline*, *In/Out* and *Cut/Fill* fields are updated to reflect the latest position of the prism relative to the defined line.
8. Choose one of the following actions when the procedure is completed.
- Press {ESC} to return to setting out the plan position of the current point. This action might be necessary if the prism pole is inadvertently moved during the setting out of the elevation.

- Press **[Store]** to store the current setout position.
- Press **{←}** or **[Yes]** to proceed to the *Store Result* screen. The SETX then prepares to store the results. It will show you a default point name and code that it will use.

Store Result	
Cd	Hedge
Pt	1000
Offline	0.000
Fill	0.355

Change the point name, the code or both. The default code includes a reference to the name of the point that was set out. When the point name and code are acceptable, press **{←}**. A position record will be stored. A NOTE record, indicating how far off line the set out point was from the required line, also is stored. A negative off line value indicates that the measure point was to the left of the required line.

Press **{ESC}** to return to the setting out of points. Once the position record is generated, the SETX returns to the *Set Out Line* screen so that you can choose another point to set out.

# Chapter 18

## Set Out Arc

### In this chapter

- Arc calculation using a variety of methods
- Coordination of points along arcs

This program provides a generalized arc calculator to allow the definition of curves from almost any combination of parameters. Points along the arc can be coordinated and directly set out. Elevations for arc points are linearly interpolated where possible.

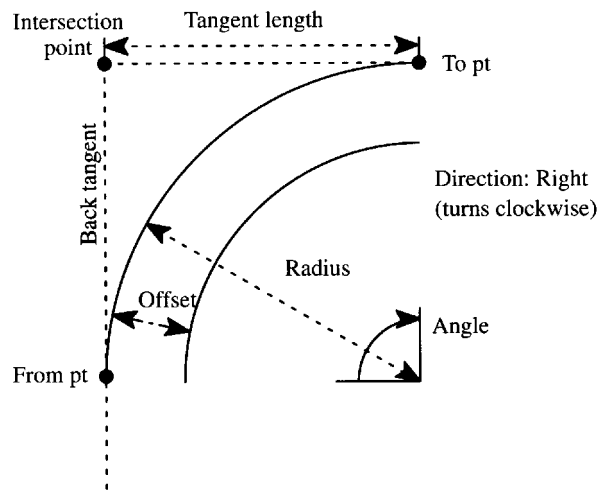
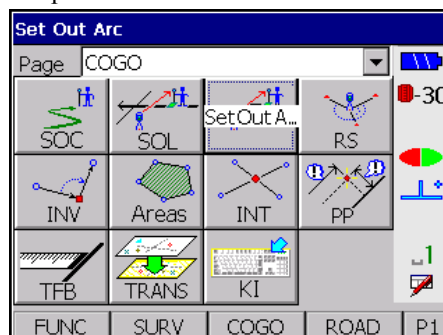


Figure 16: Arc details

### 18.1 Defining Arcs

The first step in setting out arc points is to define the arc.

1. Select the **Set out arc** option from the **COGO** menu.



2. Begin with the standard station and backsight setup.

3. The *Define arc* screen displays. Enter the appropriate information:

The screenshot shows the 'Define arc' screen with the following fields and values:

Field	Value
Direction	Left
From	1000
To pt	1005
Center	1003
Radius	0.575
Angle	104°53'26"
Arc len	1.052
Chord In	0.911
Tan len	0.747
Back tan	14°53'26"
Inters	

Table 17: Define Arc Screen Fields

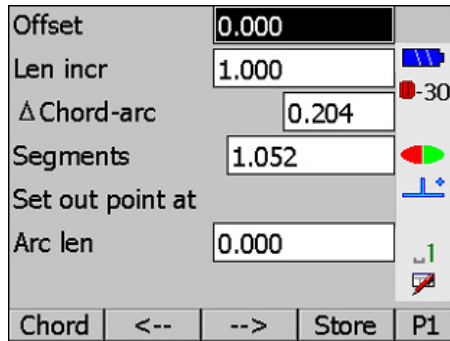
Field	Description
<b>Direction</b>	Specifies whether the arc turns right (clockwise) or left (counter clockwise) when viewed from the <b>From</b> point. This field toggles between <b>Right</b> and <b>Left</b> when you press {◀} or {▶}.
<b>From</b>	(required) Enter a point from which the arc initiates in the direction defined. <b>Note:</b> You must enter the <b>From</b> field plus one of the other point fields ( <b>To pt</b> , <b>Center</b> or <b>Intersect pt</b> ). If points are specified for three of the four possible point fields, the arc details will be computed from the relationship of these points. Otherwise you can enter one of the arc definition fields ( <b>Radius</b> , <b>Angle</b> , <b>Arc len</b> , <b>Chord In</b> , <b>Tan len</b> or <b>Back tan</b> ) to fully define the arc. See Figure 16, Page 18-1 for an illustration of which arc definition values you can specify. The values for the rest of the fields are calculated and displayed (except for the point fields).
<b>To pt</b>	(optional) Describe the point upon which the arc terminates.
<b>Center</b>	(optional) Define the center of the arc.
<b>Radius</b>	(optional) Define the radius of the arc.
<b>Angle</b>	(optional) Define the subtended angle.
<b>Arc len</b>	(optional) Define the distance along the arc.
<b>Chord In</b>	(optional) Define the straight line distance between the <b>From</b> and <b>To</b> points.
<b>Tan len</b>	(optional) Define the tangent length.
<b>Back tan</b>	(optional) Define the back tangent length.
<b>Intersect pt</b>	(optional) Define the intersection of the tangents.
<b>[Read]</b>	This softkey displays when the cursor is on any of the point name fields, to enable direct readings to be taken to establish these points if desired. If an unknown point name is entered, the <b>Key in coords</b> screen will appear, allowing you to enter the appropriate coordinate values.

**NOTE** Elevations are linearly interpolated along the arc. The assumption is made that the elevations of the Center and Intersection points are equal to the elevation halfway along the arc between the **To** and **From** points, for the purposes of determining elevations. This assumption is not always true, but is a reasonable approximation.

4. Once the arc has been defined, **[Create]** will appear when the cursor is placed on any blank point field. If this softkey is selected, the computed coordinates for that point will be stored. You are given the opportunity to view the calculated coordinates and assign an appropriate code and point name to the point. If the elevation value is Null you are able to enter an appropriate elevation into the field. For example, this option is useful for calculating the IP or center point of an arc.

## 18.2 Defining Points to Set Out

Once the arc is defined, you can set out the points which define the arc. The *Set out arc* screen displays after the arc is defined and {FUNC CTRL} + {←} are pressed.



The following is found on the *Set Out Arc* screen:

- Offset** .....Can be used to define a parallel offset from the originally defined curve. A negative value indicates an offset to the left; a positive value illustrates an offset arc to the right (Figure 16, Page 18-1).
- Len incr** .....(*Length increment*) Enables you to specify the arc length (or chord length) increments around the arc at which points will be set out. For example, if you wish to set out points every 50 feet around the arc, enter 50 into this field. [←] and [→] decrease/increase the current arc length (or chord length) to be set out by the value in the *Len incr* field.
- ΔChord-arc**.....Displays the maximum chord-to-arc separation that applies for the specified *Len incr*. This is useful for checking that the points to be set out around the arc will be spaced closely enough. Entering a required maximum chord-to-arc separation will result in the appropriate length increment being computed, such that this separation is achieved.

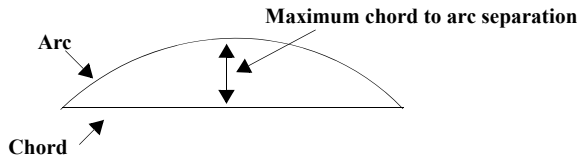








Figure 17: Chord-to-arc separation







- Segments**.....The *Segments* field displays the number of segments, between the **From** and **To** points, into which the total arc length is split. If you set this field to 1, the total arc length (or chord length) will be displayed in the *Len incr* field. If you want to set out an arc that is split evenly into five sections, enter 5 into this field, and the appropriate length increment to achieve this will be displayed in the *Len incr* field.
- Arc len** .....Displays the arc length from the **From** point to the point to be set out. You can enter into the *Arc len* field the appropriate arc length to the point to be set out or you can use the other fields on the screen to determine the arc length.

- [RndUp]**.....This softkey, when selected, will round the value in the *Segments* field up to the next whole number. This is useful where you want to set out points at even increments around an arc while ensuring that a specific maximum chord-to-arc separation is maintained. In this situation you can enter the required chord-to-arc separation into the  $\Delta$ *Chord-arc* field and then select **[RndUp]** to ensure that a whole number of segments will be set out.
- [Chord]** .....This softkey is pressed, the last prompt changes to *Chord In* rather than *Arc len* and the softkey changes to **[Arc]**. This enables the points along the arc to be set out to achieve defined chord lengths rather than arc lengths. For example, if you want to set out points around an arc so that the chord length between the points is 50 feet, select **[Chord]** and enter 50 into the *Len incr* field. Select **[Arc]** to return to defining the set out points in terms of arc lengths.
- [Store]** .....This softkey allows you to store the coordinates of calculated points along the arc. Appropriate code and point numbers may be allocated to the points. The calculated values on this screen are not editable. However, if the elevation value is Null, you can enter an appropriate elevation value for the point.

Cd	<No text>	
Pt	1002	
N	37.000	 -30
E	58.000	
EI	0.000	
		 1
		
Yes		No

The following explains the steps to define points to be set out.

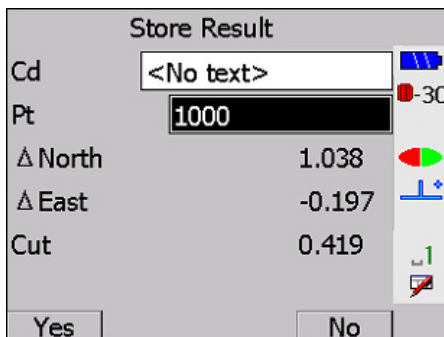
1. Press **{FUNC CTRL} + {←}** to accept the current point on the arc to be set out. The SETX shows what you need to get: the necessary horizontal and vertical angles to observe, the desired horizontal distance to the point, the azimuth, and the reduced slope and vertical distances.

Aim horiz circle		
Aim H.obs	146°31'39"	
Aim V.obs	68°11'54"	 -30
H.dist	11.050	
H.obs	96°00'48"	
V.obs	97°17'23"	 1
dH.o	50°30'51"	
Azimuth	90°00'00"	
V.Distance	1.007	
S.Distance	11.077	
Cnfg		

2. Refer to Section 16.4, *Setting Out a Point*, Page 16-4 for further details relating to the setting out procedure.
3. Choose one of the following actions when the procedure is completed.

**{ESC}** .....To return to setting out the plan position of the current point. For example, if the prism pole is inadvertently moved during the setting out of the elevation.

**[Store]** .....To store the current setout position. The SETX then prepares to store the results, and shows you the default point name and code it will use.



**Table 18: Steps to Store the Setout Position**

Step	Description
1	Change the point name, the code or both. The default code includes a reference to the name of the point that was set out.
2	When the point name and code are acceptable, press <b>{←}</b> to store a <b>position</b> record and a <b>NOTE</b> record that tells how far offline the set out point was from the required arc. A negative offline value means the measure point was left of the line.
3	Press <b>{ESC}</b> to return to the setting out of points. After a position record generates, the SETX returns to the <b>Set Out Arc</b> screen. Choose another point to set out.

**{←}** .....Once a satisfactory elevation has been set out.



# Chapter 19

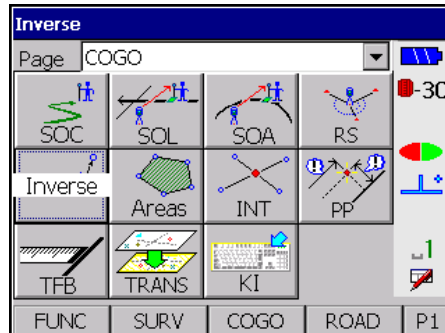
## Inverse

### In this chapter

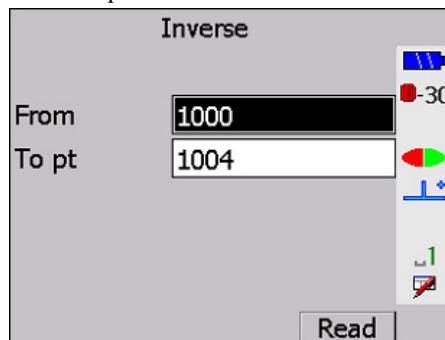
- Using the inverse program to calculate a reduced record from two known coordinates

The inverse program calculates a reduced record from two known coordinates.

- Select **Inverse** from the **COGO** menu.



- Enter a **From** point and a **To** point.



- Once you enter these points in the appropriate fields, press **{←}**. If either of the points is not known, you have an opportunity to enter the coordinates.
- Once the coordinates of both points are known, the vector between them is calculated and displayed:

RED	IN	
From	1000	
To pt	1004	
Azimuth	284°53'26"	
H.dist	20.911	
V.Dist	6.440	
S.Dist	21.012	

- If you press **{FUNC CTRL} + {←}**, the data is stored in the database as a reduced (**RED**) record. If you do not wish to save the result, press **{ESC}** to exit to the menu.

# Chapter 20

## Area Calculation and Subdivision

### In this chapter

- Area calculation
- Area calculation by a parallel subdividing line
- Area calculation by a subdividing line intersecting corner points

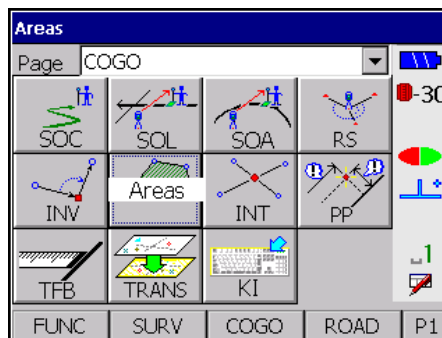
This program allows you to calculate the area of land enclosed by a specified set of corner points and to subdivide that area (if desired). You can subdivide an area in one of two ways:

- Make the subdividing line pass through one of the corner points. The coordinates of the intersection point of the subdividing line and the area's perimeter are calculated.
- Make the subdividing line parallel to a given line. The two points where the subdividing line intersects the perimeter of the area are calculated.

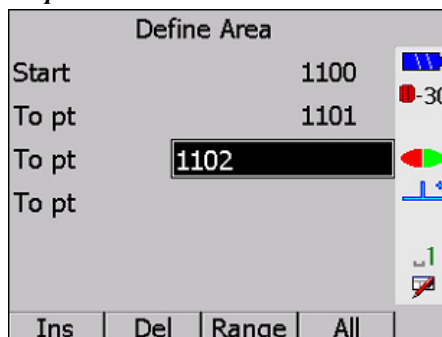
**NOTE** All coordinates calculated by this program are stored as **POS** records with an **AR** derivation code.

### 20.1 Calculating Area

1. Select **Areas** from the **COGO** menu.



2. Enter the first point number of the area in the **Start** field. Enter the remaining point numbers for the corners of the area in one of the following manner:
  - Enter each point in a **To pt** field



- Press **[Range]** to enter all points within a specific range.

- Press **[All]** to enter all POS points.

The order you enter points is important because the program assumes that the perimeter passes through the corner points in the order they are entered. For example, the area specified by entering point numbers 1, 2, 3, 4, 5 or 5, 4, 3, 2, 1 implies the same shape. However, numbers 1, 2, 3, 4, 5 and 1, 2, 5, 3, 4 imply different shapes.

3. For each point entered, the program checks that:
  - The point exists
  - Both northing and easting are not null
  - The point is a duplicate entry
  - The edge between the point and the previous point does not cross any of the existing edges (to avoid a figure 8). If an error is detected, a message appears, and you are prompted for the point number.

---

**NOTE** Do not enter the initial point number at the end of the list of point numbers or a duplicate point error occurs. The Areas program includes this edge implicitly.

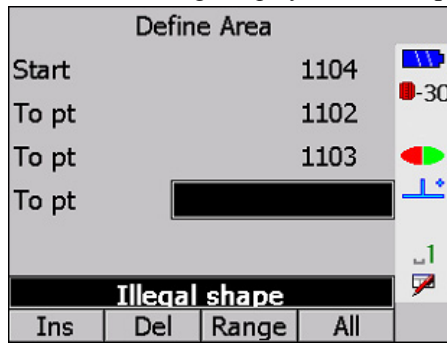
---

4. Press **{←}** at the *To point* prompt to end point entry.

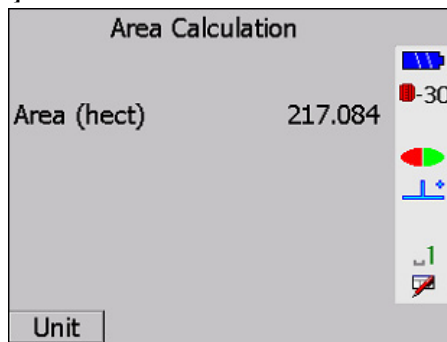
The program performs two error checks before it starts calculation:

- At least three points must be specified
- The edge from the last point entered to the first point entered cannot cross any other edges

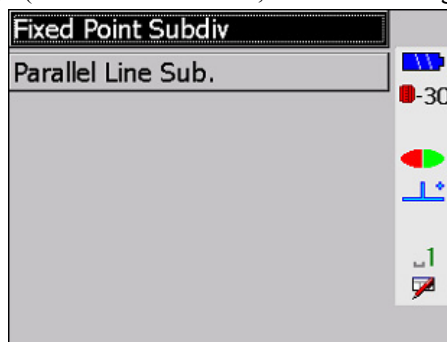
If an error is detected, an error message displays and the *To point* prompt returns.



After you correct any errors, the calculation begins. When it is complete, a note record containing the area calculated and the units of the area displays. To change the units of the area, press [Unit].



5. Press {←} if you want to store the record and continue with the subdivision. Extra notes are stored with the point numbers that outline the area. Press {ESC} if you want to discard the calculation. If the area is stored, a menu with the two methods of subdividing displays (for more information, see the following section).



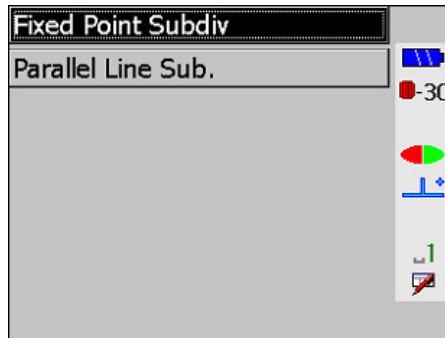
6. Press {ESC} to exit from the program. (No note will be made.)

## 20.2 Subdividing by Rotating from a Fixed Point

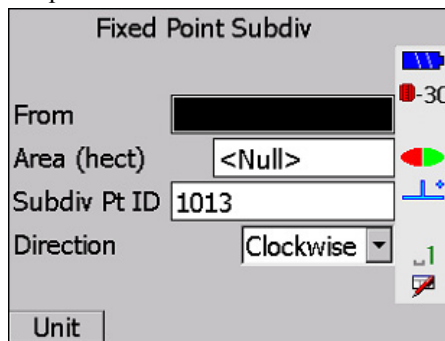
The following screen illustrates the required field information for subdividing the area just calculated. The area is subdivided by specifying a corner point and rotating a line around the perimeter in a specified direction.

### Steps for completing subdivision

1. After the area is calculated, select **Fixed Point Subdiv** and press {←}.



2. Enter one of the corner points in the *From* field.

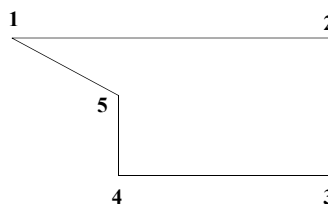


The program enters the area from the previous calculation. The area must be greater than 0 and less than the previously calculated area of the entire polygon, if you enter a value.

3. Select *Direction* by toggling between **Clockwise** and **Anticlock**. After this input is complete, the point number for the point to be calculated is assigned. The calculation of its coordinates begins. A line from the given point is rotated in the given direction until the given area has been enclosed. If you see an illegal shape error, see Section 20.2.1, *Illegal shape error*, Page 20-4.
4. Press {←} to store a **POS** record for the calculated position or {ESC} to discard it.

### 20.2.1 Illegal shape error







An **Illegal shape** error may occur as illustrated in this example.



Two types of **Illegal shape** errors for the fixed point subdivision are shown here.

- If the subdivision is performed by swinging a line from Point 4 and the direction is clockwise, problems occur at Point 1. The subdividing line goes outside the perimeter.
- The second type of problem occurs if you start from Point 4 and go anticlockwise. If the solution is between 5 and 1, part of the subdividing line lies outside the perimeter. (Similar problems occur in parallel area calculations.)

If the **Illegal shape** error occurs, the program returns to the **Subdivision** menu. Otherwise the coordinates of the required point are calculated and displayed:

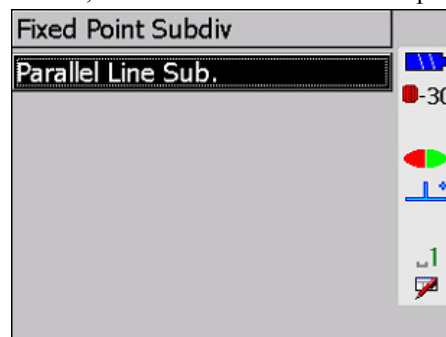
Pt	1013	
		 -30
N	1525.000	
E	1311.475	
EI	8.461	
		

### 20.3 Subdividing with a Line Parallel to an Existing Line

The following screen shows the information required for subdividing the area just calculated using a line parallel to an existing line.

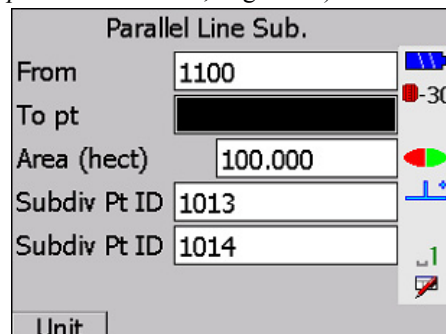
#### Steps for completing the subdivision

1. After the area is calculated, select **Parallel Line Sub** and press **{←}**.









The screenshot shows a menu titled "Fixed Point Subdiv" with "Parallel Line Sub." highlighted. To the right of the menu are several icons: a blue icon, a red icon with "-30", a green icon, a blue icon with a plus sign, and a green icon with a plus sign.

2. Specify the end points of the parallel line by entering values in the **From** and **To pt** fields. Points do not need to be corner points. Error checks are performed (see Section 20.3.1, *Specify end point error checks*, Page 20-6)



The screenshot shows the "Parallel Line Sub." dialog box with the following fields and values:

From	1100	
To pt		 -30
Area (hect)	100.000	
Subdiv Pt ID	1013	
Subdiv Pt ID	1014	
Unit		







3. Press **{←}** to store the subdivision **POS** records or **{ESC}** to discard them.

### 20.3.1 Specify end point error checks

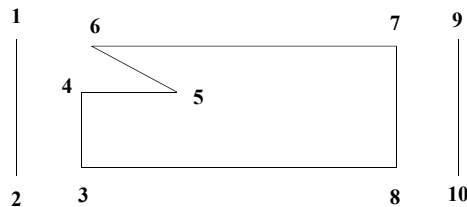
Error checks are performed on end points to see whether they exist, or that their northing and easting coordinates are nonnull. If an error is detected, a message is displayed, and the point number is prompted for again.

The program asks for the required area of the subdivision. The program will not accept it unless it is greater than 0 and less than the previously calculated area of the entire polygon. The point numbers for the points to be calculated are assigned.

Calculation of the coordinates of these points begins. If the line does not pass through the area, calculation starts at the point closest to the line. If the line passes through the area, the program calculates distance and begins with the closest point. Once the starting point is selected, a line parallel to the specified one is moved across the area from the starting point until the area is subdivided. The coordinates of the points of intersection (of this line with the perimeter) are calculated and displayed.

Pt	1013	
N	1202.550	
E	1609.174	 -30
EI	0.000	
Pt	1014	
N	0.000	
E	158.383	
EI	48.102	

An **Illegal shape** error may occur as illustrated in this example:



A subdivision of 3, 4, 5, 6, 7, 8 parallel to line 1, 2 is required. The starting point is either 3 or 4 as they are equidistant from line 1, 2. After 3 and 4, the next point examined is 5. (It is closer to 1, 2 than 8.) If the solution lies between 4 and 5, there is no problem. If it does not, the next point examined is 6, which means going back toward 1, 2. This is a problem, because the dividing line goes outside the perimeter. This situation produces an **Illegal shape** error.

Another example of an **Illegal shape** error is illustrated by subdividing 3, 4, 5, 6, 7, 8 parallel to 9, 10. The first two points examined are 7 and 8. Point 6 is examined next. (It is closer than point 3.) If the solution occurs between 6 and 7, there are two possibilities.

The solution may be between 5 and 7; this situation presents no problem. If the solution is between 6 and 5, however, the subdividing line crosses the perimeter and an **Illegal shape** error results.

Although a particular area may prove to be illegal for certain subdivisions, every area can be subdivided in some way.

If an **illegal shape** occurs, the program returns to the **Subdivision** menu. Otherwise the coordinates of the required points are calculated and displayed.

# Chapter 21

## Intersections

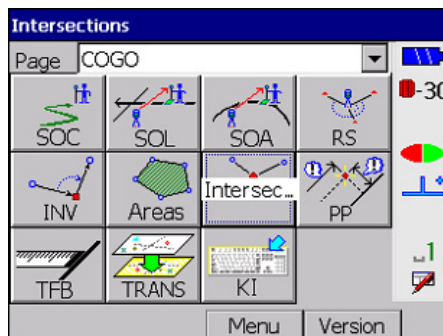
### In this chapter

- Computing the following intersection calculations

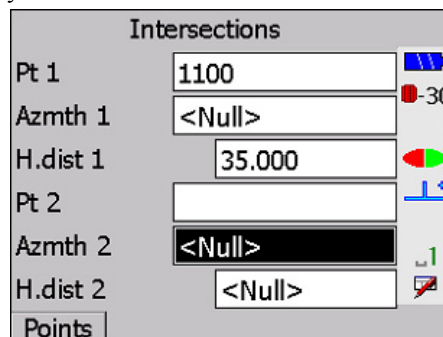
The **Intersections** option allows you to compute the following intersection calculations:

- Two azimuths
- Azimuth and distance
- Two distances

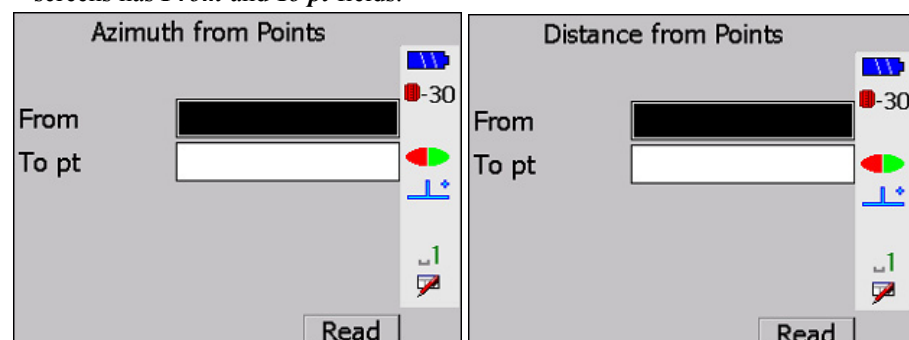
1. Select the **Intersections** option from the **COGO** menu, and the following screen is displayed:



2. Enter the first point in the **Pt 1** field.
3. Select either the intersection azimuth or horizontal distance under **Pt 1** by highlighting one. You can specify either an azimuth or a horizontal distance, but not both.



4. Press **[Points]** to calculate the azimuth or horizontal distance (alternatively, you can enter the value yourself). **[Points]** computes an inverse between two existing points to derive this value. One of two screens appears, either **Azimuth from Points** or **Distance from Points**, depending on the currently selected field. Each of these screens has **From** and **To pt** fields.





5. Enter the *From* and *To pt* values or press the **[Read]** softkey to read points directly. The azimuth or distance is computed. The computed value is automatically entered in the selected field on the redisplayed *Intersections* screen.
6. Enter the second point for the intersection calculation in the *Pt 2* field. Follow Steps above to enter the intersection azimuth or distance.

---

**NOTE** As you can see from the previous steps, you can choose the type of intersection calculation by the fields you select. For example, if the azimuth fields are selected and filled in for both points, a two-azimuth intersection is computed.

---

7. Press **{FUNC CTRL} + {←}** to initiate the intersection computation. The computed intersection coordinates display on a screen similar to this one:

Intersection Result	
Cd	<No text> <span style="float: right;">W</span>
Pt	1100 <span style="float: right;">30</span>
N	-34.956 <span style="float: right;">1</span>
E	-1.757 <span style="float: right;">+</span>
El	<Null> <span style="float: right;">1</span>
<span>Store</span> <span>S-O</span> <span>Other</span>	

8. If two possible intersection solutions exist (often the case with azimuth and distance and two distances), then **[Other]** appears. Select **[Other]** to display between the two solutions.
9. Complete any or none of these steps before saving:
  - Set the point out by pressing **[S-O]**.
  - Assign a suitable code
  - Accept the auto point number in the point field or alter it
  - Enter an elevation for the intersected point
10. Press **[Store]** or **{←}** to save the intersected point, or discard the result by pressing **{ESC}**. If you enter values in the *Code*, *Pt*, or *El* fields, then choose to discard the calculation result, a confirmation prompt will display. After saving or discarding the intersection point calculation, the main intersection calculation screen appears.
11. Exit from the **Intersection Result** option by pressing **{ESC}**. The program returns to the *COGO* menu.

---

**NOTE** In the azimuth and distance method, you cannot use the same point for the starting point for both the azimuth and the entered distance. This specification is the same as entering an azimuth and distance from the selected point. If you want to do this method, use the **Key in azmth & dist** function in the **Keyboard input** option.

---

# Chapter 22

# Point Projections

### In this chapter

- Projecting points onto a line or arc
- Calculating offsets to a baseline

This program projects a point onto a line or arc. It calculates the distance and offset of the point relative to the specified baseline (or arc), and it computes the coordinates of the intersection point, which can then be directly set out. Elevations are interpolated where possible.

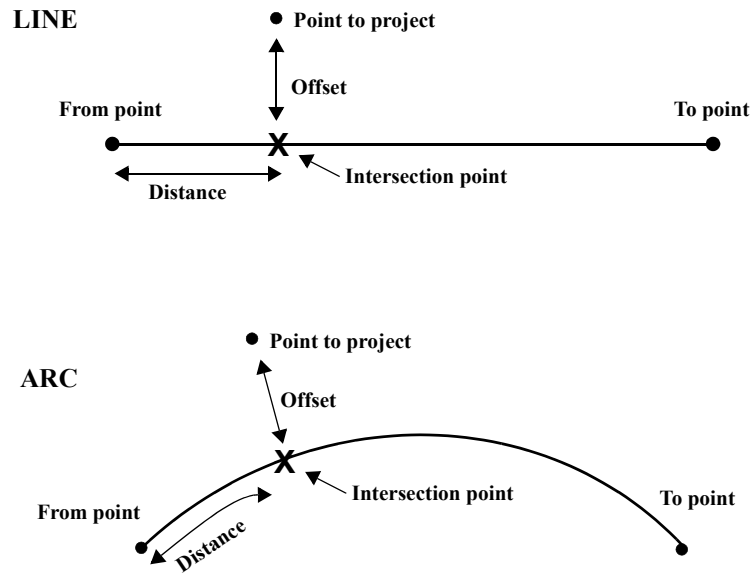


Figure 18: Point projection

## 22.1 Defining Baseline/Arc

The definition of the baseline (or arc) is done using the same screens as provided in the **Set out line** and **Set out arc** options. See Section 17.1, *Defining the Baseline*, Page 17-1 and Section 18.1, *Defining Arcs*, Page 18-1 for details. **[Arc]/[Line]** is provided to allow you to change between defining a baseline or arc, as appropriate, for the point projection you want to carry out.






The 'Define Baseline' dialog box contains the following fields and controls:

From	H010	
To pt		-30
Azimuth	<Null>	
V.ang	<Null>	
Grade	<Null>	1

At the bottom, there are two buttons: 'Arc' and 'Read'.

## 22.2 Projecting Points

Once you have specified the baseline or arc onto which you want to project points, press **{FUNC CTRL} + {←}** and you are presented with the **Point Projection** screen, which allows you to specify the first point you want to project onto the defined baseline or arc.

Point Projection	
Pt	1102 
Dist	2166.719 
Offset	182.905 
Δ Elev	-42.977 
<div style="display: flex; justify-content: space-between; width: 100%;"> <span>Store</span> <span>Inters</span> <span>Read</span>  </div>	

The following is displayed on the screen:

**Dist, Offset, ΔElev**..... These calculated fields are only displayed once a point number has been specified in the **Pt** field.

The **ΔElev** value is calculated using the elevation interpolated along the baseline or arc compared with the elevation of the specified point. If it is not possible to compute the **ΔElev** value, it will be displayed as Null and you will be able to enter the appropriate value if known.

**Pt** ..... Displays the point number. If you enter a different point number into this field, a message displays asking if you wish to discard the data.

If you press **[NO]**, the **Point Projection** screen appears with the point number unchanged so you can save the results. If you discard the data, the **Point Projection** screen will be redisplayed with the projection values calculated for the new point.

**{FUNC CTRL} + {←}** or **[Store]**. Press either to save details of the point projection carried out as Notes in the SDR database.

The point number of the projected point, along with the **Dist** and **Offset** values, are recorded in a single Note with the **ΔElev** value being recorded in a second Note if the value was not Null.

**[Read]** ..... This softkey is displayed when the **Pt** field is selected, allowing an instrument reading to a new point to be taken directly.

If this softkey is selected, the result of the previous calculation will be saved, if applicable.

**[Next]** ..... If you are projecting onto an arc, this softkey will appear on the **Point projection** screen.

If this softkey is selected, the next solution will be displayed. A second possible solution occurs when the defined arc is greater than 180° and the projection azimuth crosses it twice.

**[Inters]** ..... This softkey enables you to compute and save the perpendicular intersection point on the baseline or arc.

If you press **[Inters]**, a screen similar to that shown following is displayed, which shows the computed coordinates for the intersection point.

You can enter an appropriate code for the point if desired and also change the point number. If the elevation for the intersection point cannot be interpolated, it is displayed as Null and you may enter the appropriate value if known.

Point Projection	
Cd	PLAIN56
Pt	1013
N	1644.128
E	1411.210
EI	52.977
Store S-O	

Pressing {FUNC CTRL} + {←} or [Store] will save the computed intersection point in the SDR database.

[S-O]..... This softkey enables you to directly set out the computed intersection point. You are presented with the standard setting out options once [S-O] has been pressed. Refer to Section 16.4, *Setting Out a Point*, Page 16-4, for details relating to the setting out operation.

# Chapter 23

## Taping from Baseline

### In this chapter

- Setting out by distance and offset
- Collection of topographical detail by distance and offset

For some instances, a plan may show corners of a building, in terms of distance and offset, from a baseline.

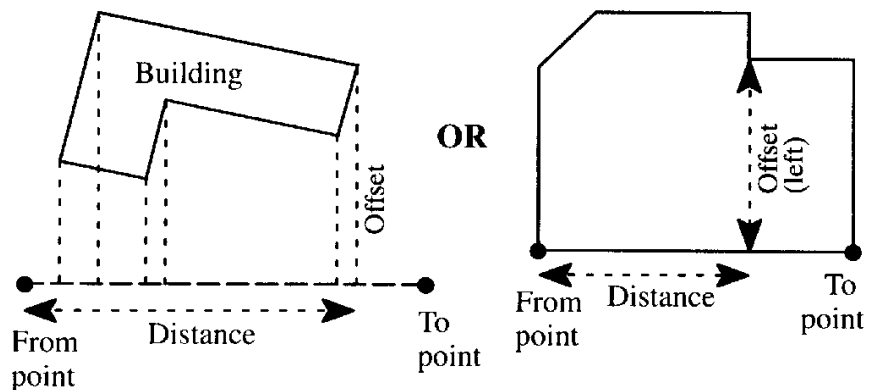
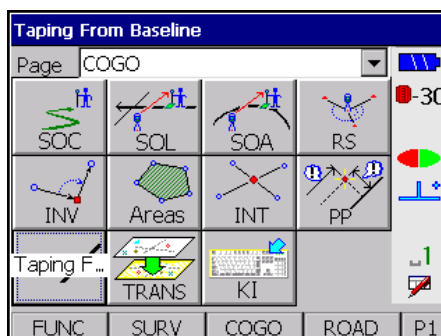
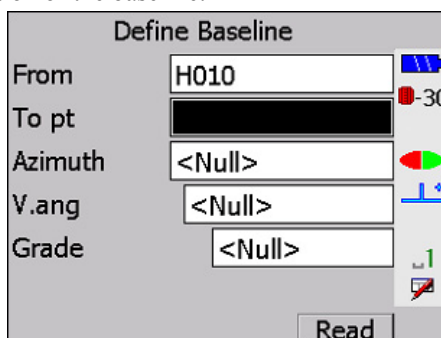


Figure 19: Measurements from a baseline

To facilitate setting out points in this format, select **Taping from Baseline** from the **COGO** menu:



The baseline may be defined by survey or boundary points, or two corners of the building itself. Once the two baseline points are specified, distance and offset data can be entered. The entry of the baseline definition is done in exactly the same manner as the definition of the baseline in the **Set out line** option. See Section 17.1, *Defining the Baseline*, Page 17-1, for details on the definition of the baseline.



## 23.1 Setting Out Points from a Baseline

When you press {FUNC CTRL} + {←} after the baseline definition has been completed, you will be presented with a screen similar to the following:

Enter the appropriate set out distance along the baseline and offset from it for the point to be set out into the *Dist* and *Offset* fields, respectively. A negative offset value indicates that the point to be set out is to the left of the baseline, when viewed from the **From** point toward the **To** point. A negative distance value indicates that the point to be set out is in the opposite direction to that of the baseline (the point is “behind” the From point).

The  $\Delta Elev$  field can be used for specifying a known difference in elevation, from the interpolated height along the baseline to the point being set out. A negative difference in elevation value indicates the point to be set out is below the interpolated elevation along the baseline.

Select [S-O] once the distance, offset and, if desired, difference in elevation values have been entered. Initially, you will be given the opportunity to save the computed point in the SDR database (with an associated Note recording the entered distance, offset and difference in elevation values). Next, you will be presented with the standard setting out options. Refer to Section 16.4, *Setting Out a Point*, Page 16-4, for details relating to the setting out operation.

Select [Dsgn] to store design points.

## 23.2 Establishing Coordinates from Taped Measurements

In addition to setting out points based on the specified baseline, this program also can be used for computing the coordinates of points fixed by measurement from the baseline.

In this case, the measured distance along the baseline and offset from it are entered into the *Dist* and *Offset* fields, respectively. The  $\Delta Elev$  field can be used for specifying the measured difference in elevation between the baseline and the fixed point. The program assumes that the difference in elevation relates to the interpolated elevation along the baseline.

Once you have entered the measured values in relation to the baseline press **[Store]**. This displays the calculated coordinates for the fixed point, and allows the point name, code, and elevation (if Null) to be entered if desired. You can then confirm that you want to store the computed point in the SDR database (with an associated Note recording the measured distance, offset and difference in elevation values).

Field	Value	Icon
Cd	<No text>	Blue flag
Pt	1013	Red circle -30
N	5.960	Green circle
E	12.034	Blue crosshair
El	<Null>	Green circle 1

Yes No

# Chapter 24

# Transformations

### In this chapter

- Helmert transformations of job coordinates to a different coordinate system
- Linear transformations of job coordinates to a different coordinate system

The SETX provides linear and Helmert transformations of survey points from one coordinate system to another. The most common application for transformation is converting a survey from site coordinates to a local projection.

The parameters for Helmert transformation are calculated using a least squares method to deal with redundant data. The northing and easting coordinate values are transformed using the computed transformation parameters; however, the elevation values are adjusted by the average elevation difference between the elevation of the control points in the proper coordinate system and the elevation of the equivalent points in the actual survey job.

The SETX's Helmert transformation uses a separate job for each of the two coordinate systems. This reduces the chance of getting them confused. The SETX prompts you to select a job containing points in the old coordinate system. The currently selected job acts as the destination for the newly transformed points. The easy way to remember this is that the new points are stored in the **current job** (as usual).

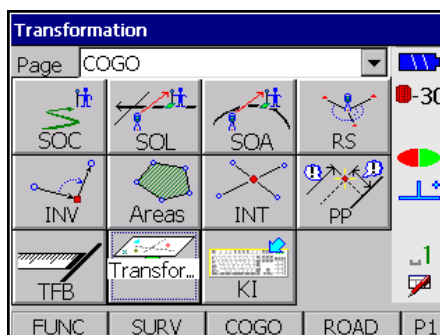
The SETX uses a combination of translation, rotation and scaling to effect the linear transformation.

## 24.1 Using Helmert Transformation

To carry out a Helmert transformation you must first create a job containing the correct datum coordinates of the control points.

You may want to input coordinates from a computer, or you can create a new job and key in the coordinate values from a plan. In either case — and this is important — these datum points will now be in the current job. The names used for the points in this job must be the same as the names of the equivalent points in the job to be transformed.

1. Select **Transformation** from the *COGO* menu.

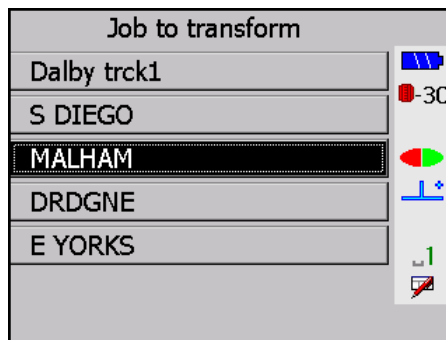




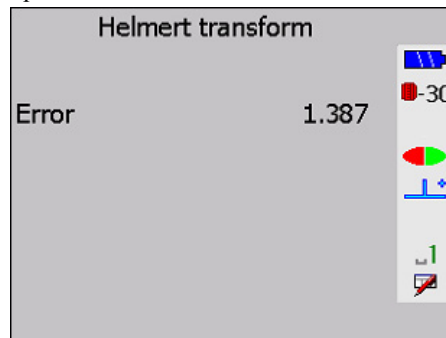
2. The SETX displays the following screen, from which you choose the Helmert transformation.



3. Press {←}. The SETX will display the following screen, from which you choose a job.



4. Highlight the name of the job to be transformed and press {←}. The SETX will search for any point names that are common to both jobs, and compare the coordinates in both jobs. It uses the coordinates of the equivalent points in the two jobs to calculate the best transformation Helmert parameters using least squares methods. Once this process is complete, the average deviation error is shown. This is a result of the least squares calculation from the redundant data supplied.

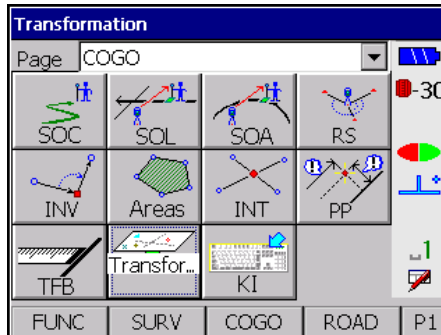


5. If the error is unacceptably large, press {ESC} to escape. Otherwise, press {←} to start the transformation. Each uncommon point in the old coordinate system job will be transformed and stored in the current (new coordinate system) job. This process may take some time for large jobs. Each point number is shown as it is transformed. The control points common to both jobs are not transformed, as they already exist in both jobs. This also preserves the accuracy of the control points.

## 24.2 Using Linear Transformation

The linear transformation also can be used to perform a translation or rotation.

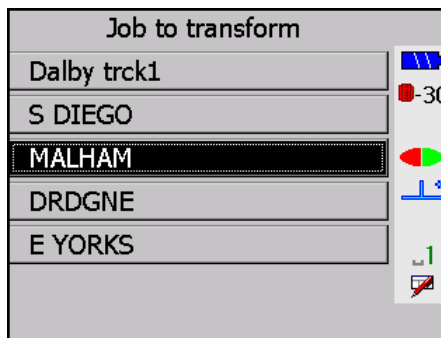
1. Select **Transformation** from the **COGO** menu.



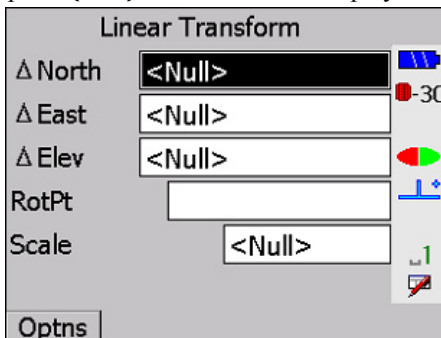
2. The SETX displays the following screen, from which you choose Linear transformation.



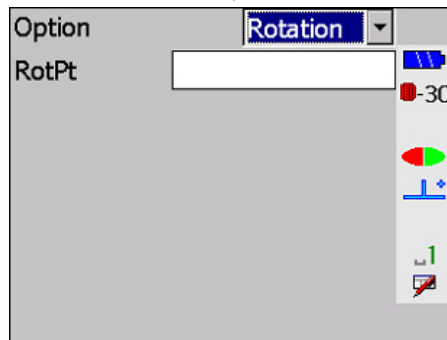
3. Press {←}. The SETX will display the following screen, from which you choose a job for transformation.



4. Highlight a job and press {←}. The SETX will display the following screen.



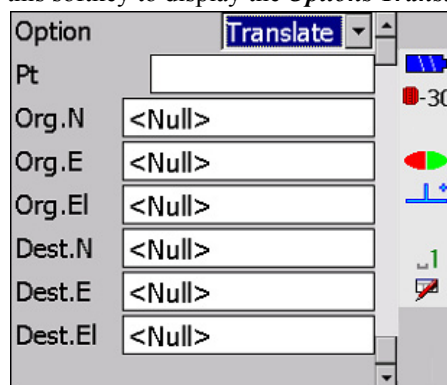
5. You can enter  $\Delta$ North,  $\Delta$ East,  $\Delta$ Elev, and Scale values from this screen to perform a translation. You also can enter in the **RotPt** field a point around which to rotate. If you enter a point name in the **RotPt** field, the screen will change to the following:



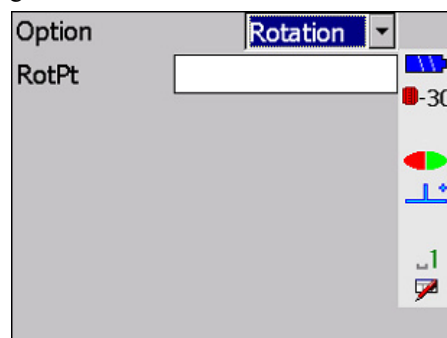
Enter an angle value in the rotation field and press {←→} to perform a rotation.

**NOTE** You can also use combinations of translations and rotations to perform linear transformations.







6. [Optns] will display a screen that provides other ways to enter the Delta values and the rotation. Press this softkey to display the **Options Translate** screen.









7. When using the **Options Translate** screen, you can select a point already in the destination job by entering its point name in the **Pt** field. If you enter a point name, the coordinates (both original and destination) will be *display only* and the Delta values on the main linear transformation screen will also be *display only*. These values can be edited if you reenter the **Options Translate** screen and change the point that was selected.
8. Change to the **Option Rotation** screen by pressing {←} and {→}. The SETX will display the following:



- Enter a point around which to rotate in the *RotPt* field and press {FUNC CTRL} + {←}. The SETX will display the following screen, showing old and new azimuth fields.

Option	Rotation	
RotPt	2	
Old Azim	<Null>	 -30
From		
To pt		
New Azim	<Null>	 1
From		
To		

- If you know the old and new azimuth values enter them and press {←}. If you do not know the azimuths, enter *From* and *To* points and the SETX will calculate the azimuths and enter them on the screen.

Option	Rotation	
RotPt	2	
Old Azim	42°03'00"	 -30
From	1	
To pt	3	
New Azim	224°26'28"	 1
From		

**NOTE** Obtaining the azimuths can be done by entering both azimuths, entering all four points, or by entering one of the azimuths and then entering the two points for the other azimuth.

- Press {FUNC CTRL} + {←} a final time to initiate the linear transformation.

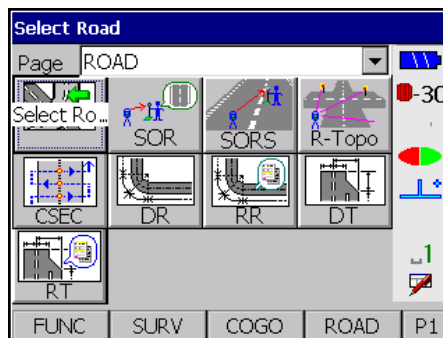
# Chapter 25

# Roading

### In this chapter

- Transferring road design to the SETX
- Defining horizontal alignment, vertical alignment, templates, sideslopes, road cross-sections, superelevation, and widening
- Steps for setting out roads, cross-sections, and sideslopes

The SETX roading program is designed for setting out urban roads and highways. It allows you to define the centerline of a road in both the horizontal and vertical planes and to attach cross-sectional templates to the centerline with superelevation (and widening) applied if desired. You can then set out any point along the road by specifying its station (chainage) and offset.



The options available in the *Roading* menu are as follows:

- Select Road**.....Select an existing road with which to work
- Set Out Road**.....Set out points with desired stations and offsets
- Set Out Road Surface**.....Set out points relative to the computed surface of a defined road
- Road Topo** .....Perform topographical survey relative to a defined road
- Cross-Section Survey** .....Survey cross-sections of roads or other linear features (see Chapter 26, **Cross-Section Survey**)
- Define Road**.....Define the horizontal and vertical alignments of the road, and its cross-section definition (which templates to use)
- Review Road** .....Review a road definition
- Define Template**.....Create a new template or replace an existing template
- Review Template**.....Review an existing template definition

## 25.1 Transferring Road Design to the SETX

The roading program is not intended for road design, although this can be done. Road design typically originates from one of two sources: an office-based computer design system or a plotted design already on paper.

- If the design is in a computer, transmit it to the SETX using a PC's serial communications program (see Section 27.5, *Direct Communications - Transferring Data Files*, Page 27-5).

- If it is on paper, enter the design elements in the SETX using the **Define Road** option discussed in this chapter.

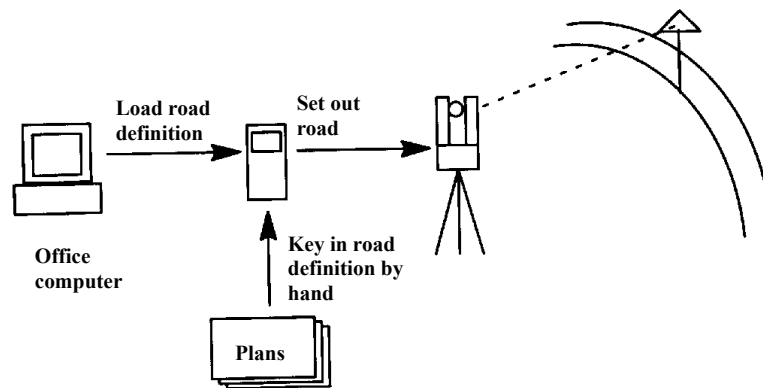


Figure 20: The roading process (options)

### 25.1.1 Alignment roads and string roads

The SETX can handle two types of road definition.

- A *string road* is composed solely of **RPOS** records, each containing the position of a discrete point, described as both coordinates and station (chainage) and offset.
- An *alignment road* is composed of the horizontal and vertical element definitions, cross-sections, templates, super elevation and widening. These elements can be entered manually or uploaded from a computer system.

#### 25.1.1.1 String road overview

The string road type is specifically intended to make it easy to use the output of many computerized road design packages. Because they allow roads to be defined in terms of strings that do not necessarily have a mathematical relationship to the centerline, templates cannot be used to describe the design. Instead, points at intervals along each string in the design are written as **RPOS** records to an SDR road file. The string name can be written to the **RPOS** code field.

When this string road is sent to the SETX, you can then set out the design in terms of stationing (chainage) and offset and string name, in a similar manner to an alignment road. The main difference is that you can only set out those discrete points in the road definition. You cannot interpolate between them. You can set out a horizontal offset to the centerline if desired.

25.1.1.2 Alignment road overview

The general steps for defining and setting out alignment roads are listed below. This preview provides a good orientation to the detailed procedures in the rest of the chapter.

1. Define the horizontal plane by entering a series of connected elements, which can be points, straight lines, arcs or spirals. Each element starts where the previous element finishes. Once you enter the horizontal design, it cannot be edited (although it can be replaced in its entirety).

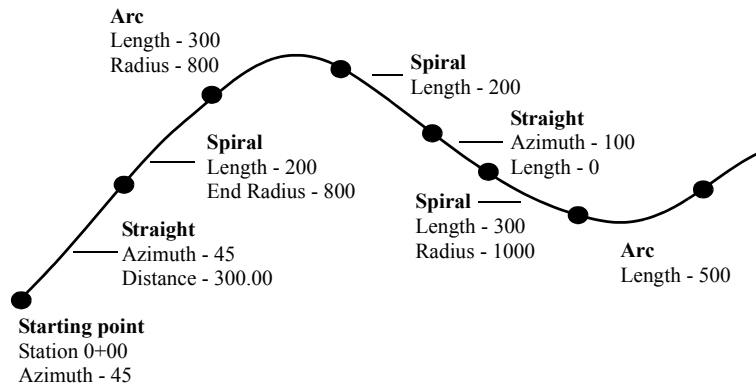


Figure 21: Road centerline design

2. Define the vertical design of the centerline as a series of elements that can be vertical arcs or vertical parabolas. Straight sections can be specified by defining a curve of zero length. Elements are defined by the vertical point of intersection (VPI) for each curve. Each element starts where the previous element finishes. Once you enter the vertical design, it cannot be edited. (Although it can be replaced in its entirety, independent of the horizontal design.)

The vertical design does not have to start or finish at the same station as the horizontal design. For example, the horizontal alignment might start at a station of 100 and the VPI at a station of 90.

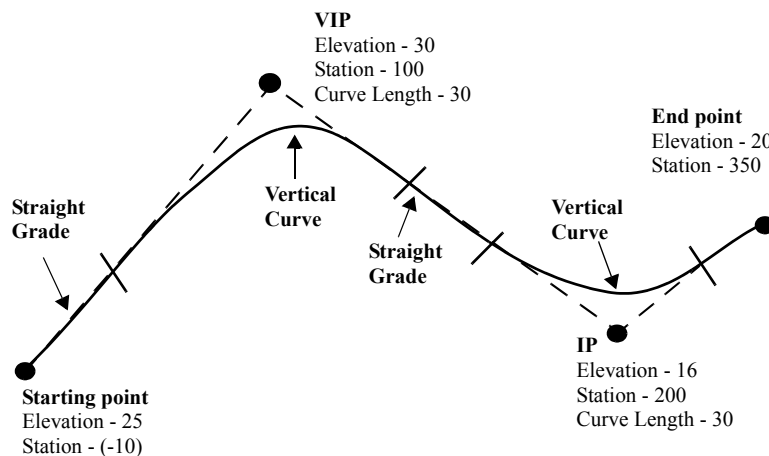


Figure 22: Road vertical design

3. Define templates as a series of connected points, each point relative to the previous point or relative to the centerline. A point can be vertically above or below the previous point.
4. Define cross-sections by specifying which templates are attached to specified portions of the centerline. The SETX will interpolate between templates.

5. The superelevation definition allows you to apply superelevation and widening to the road.

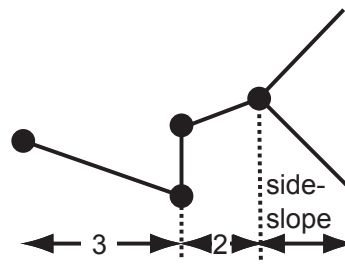


Figure 23: Cross-sectional template

Templates are defined independently of the road so you can use a single template to define the cross-section of more than one road.

The road cross-section definition specifies which template to use on the left of the centerline and which to use on the right. The template can be changed at different stations (chainage) along the road.

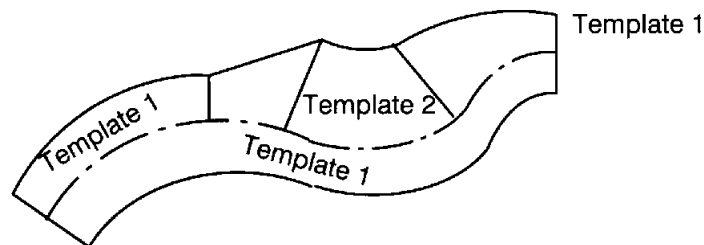


Figure 24: Horizontal overview

Once a road has been defined, the road and template definitions are independent of your survey jobs, and can be deleted, loaded and transmitted without reference to any survey job. However, setting out occurs within a particular survey job (or jobs), so the road and template definitions are copied into the job to provide a record of the road definition. (If the road definition has already been copied into the job, the SETX verifies that it is the most recent version.)

When you key in a road definition, the SETX searches the current job to find the coordinates of any point entered.

---

**NOTE** Roads can be independent of the coordinate system you are using. If the starting point of the horizontal alignment has coordinates, the road is considered coordinated. However, you can leave the coordinates null, and the road is uncoordinated.

---

6. Set up your instrument station in one of two ways:
- For a coordinated road, specify either the coordinates or the station and offset of the station point.
  - For an uncoordinated road, you must specify a station and offset for the station point. (The road geometry cannot be related to a coordinate.) Similarly, the back-sight point must have a known station and offset (or azimuth).



- Set out by selecting a road and specifying a desired station and offset. The SETX analyzes the horizontal and vertical alignments and calculates a plan (North, East) position for the centerline at the desired station. The current template at the station is then applied normal to the centerline, and the elevation is calculated.

In addition to station and offset, you also can specify a horizontal and vertical offset. They are applied to the calculated coordinates. The vertical offset affects the elevation. The horizontal offset is applied horizontally in a direction normal to the centerline.

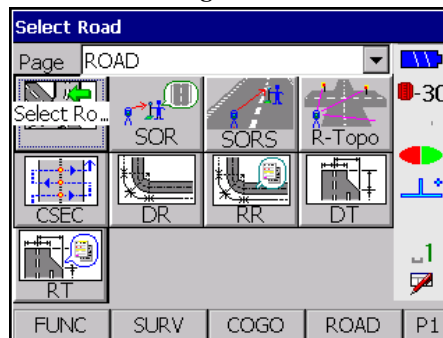
- Use the same procedure for setting out design coordinates as described in Chapter 16, **Set Out Design Coordinates**.

## 25.2 Selecting/Creating a Road

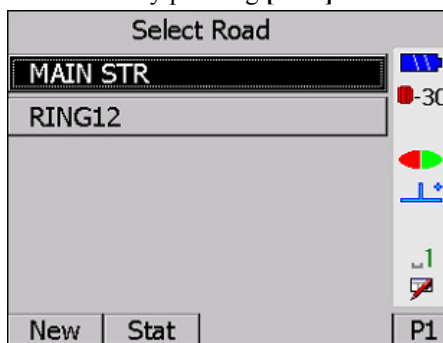
To work with the roading features, you need to identify an existing road or create a new one.

### Creating a new road

- Choose **Select Road** from the *Roading* menu.



- Access the *Create Road* screen by pressing [New].



If no roads exist within your current project, the *Create Road* screen displays first.

- Enter a name, up to 16 characters. For example, you could call your road “Highway one.”

- Roads are independent of survey jobs. They can have the same names as jobs, but this is not recommended.
- Confirm a projection scale factor for the road. The scale factor is for internal SETX use, and *must be the same as any job scale factor* you use to set out the road or for road topo.
  - Press {FUNC CTRL} + {←}.
  - Enter information in the *Note* screen (or leave blank), then press {FUNC CTRL} + {←}.

**NOTE** Once a road has been created, it is considered the “selected” road. All road programs will use it as the definition until a different road is selected.

### Selecting an existing road

- Choose **Select Road** from the *Roading* menu.

- Use the {▲} and {▼} keys to highlight the desired road and press {←}.

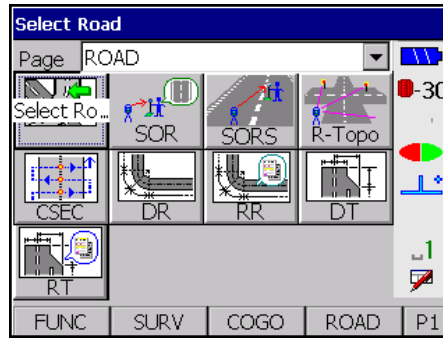
{PgUp} and {PgDn} allow you to page through numerous roads. {Stat} is described in the following two sections.

**NOTE** Once a road has been selected, all road programs will use it as the definition until a different road is selected.

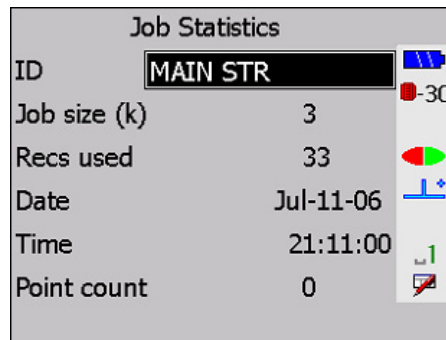
### 25.3 Accessing Road Statistics/Renaming a Road

You can display the job statistics for a road, and in the *Job Statistics* screen, you can rename the road.

1. Choose **Select Road** from the *Roding* menu.



2. Highlight the road to be accessed.
3. Select **[Stat]**.



4. The following fields display the following information, and only the name of the road can be modified.

**ID**.....Name of the current road

**Job size (k)**.....(information only) Size of the job, in kilobytes, that the job currently occupies in memory.

**Recs used**.....(information only) Approximate number of records (point positions, observations, notes, etc.) currently stored in the job.

**Date and Time**.....(information only) Date and time that the job was last accessed; therefore, the date and time displayed will not necessarily relate to the last time data was saved in the job. For example, the process of selecting a job as the current job will access the job files and therefore update the date and time.

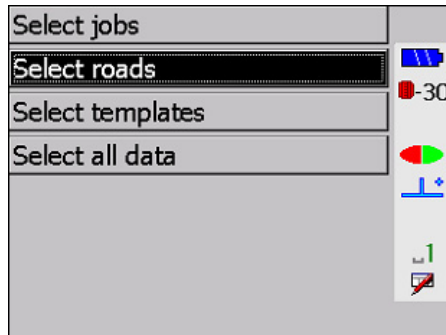
**Point count**.....(information only) Number of points currently stored. A new job will have a point count of 0.

5. Press **{←}** to accept changes or **{ESC}** to return the *Select Road* screen.

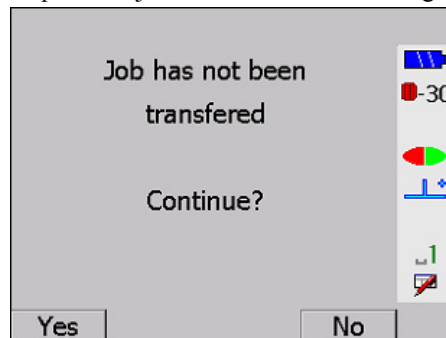
## 25.4 Deleting a Road/Template

After you transmit a job to a PC or printer, you can remove it from memory.

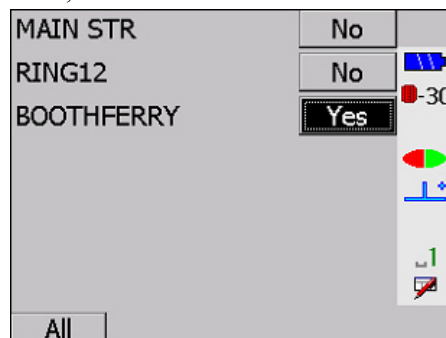
1. Select **Job Delete** from the *Functions* menu. This screen is used for the deletion of roads and templates as well as survey jobs, so you need to select what you are removing. (This selection may vary depending on what configuration you have).



2. Highlight *Select roads* and press {←}. The SETX checks to see if there are any roads that have been transmitted and are available for deletion. If there are none, it advises you to send or print the jobs first with the following screen.



3. If roads or templates are available for deletion, a list displays. Available roads/templates are marked **No**; unavailable ones are marked **N/A**.



4. Place the cursor on the road/template you are deleting, then use the {◀} or {▶} keys to toggle settings from **No** to **Yes**.
5. Press {←} to delete the road/template.

**NOTE** [All] allows all available roads/templates to be selected for deletion.

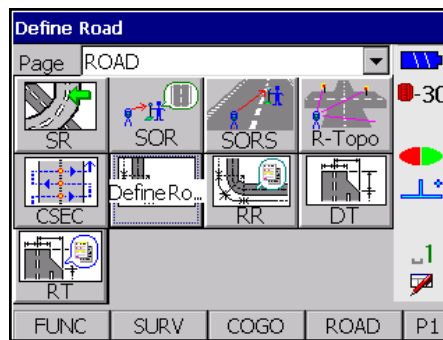
## 25.5 Selecting a Road Definition Type

Roads are defined as one of two types (see Section 25.1.1, *Alignment roads and string roads*, Page 25-2): **String road** and **Alignment road**.

**NOTE** Once the road type has been defined as string or alignment, you cannot change to the other type; however, you can modify the definition within the current type.

### Steps to define a road

1. Select the road you want to define (see Section 25.2, *Selecting/Creating a Road*, Page 25-5).
2. Choose **Define Road** from the **Roading** menu. If no road is currently selected, you will be prompted to select one.



3. From the **Select Road Type** screen, highlight the type of road you want to define.



**NOTE** If the type has already been defined, the associated definition screen will display.

4. Press {←}.
5. The associated type definition screen displays (see Section 25.6, *Defining a String Road*, Page 25-10 or Section 25.7, *Working with Alignment Roads*, Page 25-10).

## 25.6 Defining a String Road

When you selected to define a string road, the following screen will appear:

String road	
Pt	RING201
Sta...ing	0.000
Offset	0.000
N	0.000
E	0.000
El	0.000
Cd	<No text>

Enter the details and press {←}. This procedure will store a road position record (**RPOS**) in the road definition and defines the position of a point on the road at that station and offset.

Enter as many of these records as you want. Press {ESC} when you have finished.

## 25.7 Working with Alignment Roads

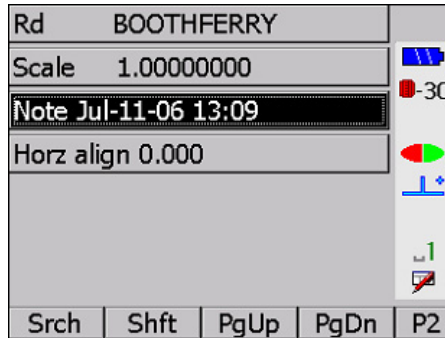
Once you have created or chosen an alignment road, a screen similar to the following will be displayed, depending on whether the road has horizontal and/or vertical alignments already defined:

Define horizontal	
Define horizontal	
Define vertical	
Define Xsection	
Define super	
Review	

If an option starts with **Replace**, it means that part of the road definition already exists. If you select **Replace**, you are asked to confirm the replacement.

Replace horizontal	
Confirm?	
Yes	No

Press **[Review]** to display the road name, scale factor and any notes entered when the road was created. The road review is similar to data base review. For more information on the reviewing technique, see Chapter 5, **Viewing Survey Data**.

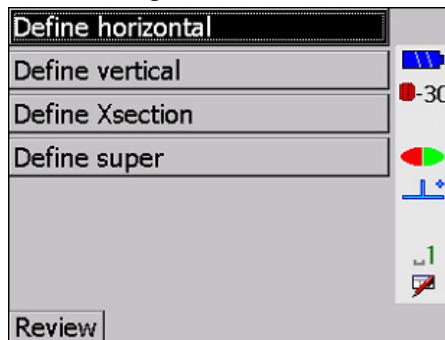


The following four sections explain how to create an alignment road. Section 25.13, *Roading Calculations*, Page 25-29 describes the calculations used in the above processes.

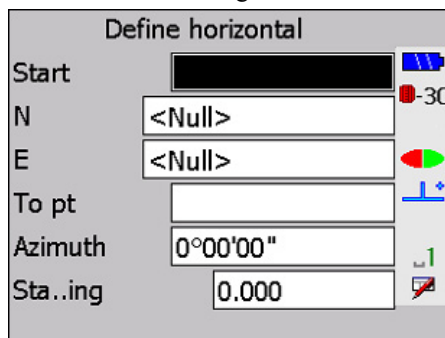
## 25.8 Defining a Horizontal Road Alignment

Steps for defining horizontal alignment are as follows:

1. Choose **Define horizontal** or **Replace horizontal**.



2. Enter the start point for the horizontal alignment:



The only essential information on this screen is the **Stationing** (chainage) field.

3. Define the station at the start of the road in the **Stationing** field. The value may be negative.
4. Be sure the **Azimuth** field is a nonnull value. Although the azimuth is not essential for all calculations, if a spiral or an arc is defined next, this azimuth is used.
5. (*Optional*) Enter point coordinates in one of three ways: (If you do not enter coordinates, the road is uncoordinated).

- Enter a point name for the start of the centerline in the **Start** field and the point's coordinates are displayed in the **N** and **E** fields.







**NOTE** The point name is not stored in the road definition. Only the coordinates are stored because the road is independent of all survey jobs; it cannot contain any job-specific point names.)

- Enter coordinates directly into the **N** and **E** fields.
  - Key in coordinates to create a position (**POS**) record if you enter an unknown point name in the **Start** or **To pt** fields (see Chapter 16, **Set Out Design Coordinates**).
6. (Optional) Enter the starting azimuth for the road centerline directly into the **Azimuth** field or enter a point name in the **To pt** field. The SETX calculates an azimuth from the start coordinates to the point.
  7. Press {←} to accept the screen.

If you enter a **To pt**, the SETX assumes that you want to use the **To pt** as part of your alignment; it takes you directly to the entry of a horizontal point element (Section 25.8.1.4, *Horizontal point*, Page 25-15). If you do not want to include the point as part of the alignment, press {ESC}, and the SETX displays the menu of horizontal elements (described in the next section).

### 25.8.1 Adding and deleting horizontal elements

Once the start point of the horizontal alignment has been defined, you will see a menu listing the four possible horizontal elements and the station (chainage) and coordinates of the end of the last element defined. (If the road is uncoordinated, then the **Horz point** option is not available, and the coordinates are not displayed.)

<b>Horz straight</b>		
Horz arc		
Horz spiral		 -30
Horz point		
Sta..ing	0.000	
N	0.000	
E	0.000	
<b>Review</b>	<b>Undo</b>	

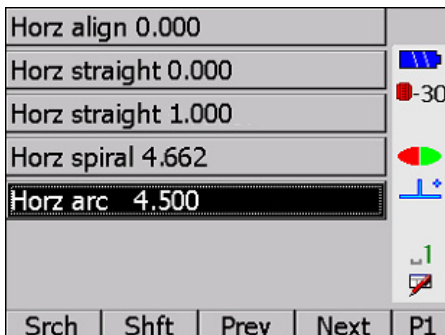
Also displayed for your information are the coordinates, if known, and the station at the end point of the last element defined. Each element is described in the following sections. A horizontal alignment consists of any number of these elements linked together in order.

#### Steps for defining horizontal elements

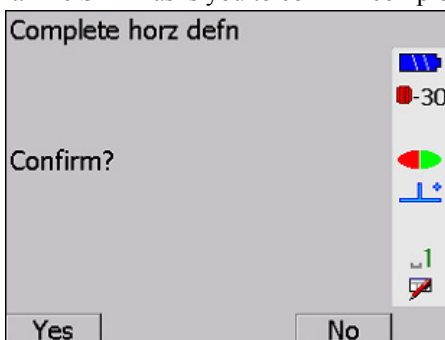
1. Define as many elements as you want by highlighting an element in this list and pressing {←}. Each element is added to the end of the horizontal alignment. The definition of the four horizontal elements is covered in Section 25.8.1.1, *Horizontal straight*, Page 25-13 through Section 25.8.1.4, *Horizontal point*, Page 25-15.



- 2. Press **[Review]** to review the horizontal elements in the road definition. This procedure is almost identical in layout and operation to the review of survey data using **{FUNC CTRL} + {0}**, (see Chapter 5, **Viewing Survey Data**). The only difference is that it shows the road definition rather than the job data.



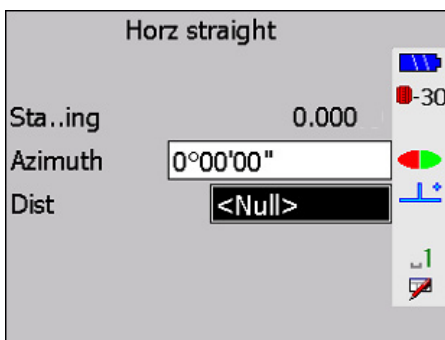
- 3. Press **[Undo]** to delete the last horizontal element defined.
- 4. Press **{ESC}** on the *Elements* menu when you have entered all the elements in your horizontal alignment. The SETX asks you to confirm completing the alignment:



When you confirm the completion, your horizontal alignment is finalized. The four different horizontal elements are described in the next four sections.

### 25.8.1.1 Horizontal straight

When you choose **Horz straight** from the *Horizontal elements* menu, the following screen displays:



**Stationing**.....(*information only*) Shows you the station (chainage) at the start of the straight section.

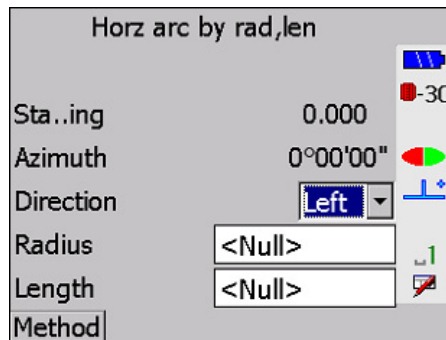
**Azimuth** .....Determines the direction of the straight. It defaults to the azimuth at the end of the previous element. If the straight is the first element in the alignment, it defaults to the starting azimuth of the centerline. Generally, you will not need to change this value. It is acceptable to do so, but the alignment will not be smooth; a sudden change of direction will occur.

**Distance** .....Specifies the length of the straight section.

Press {←} to accept the screen.

**25.8.1.2 Horizontal arc**

When you choose **Horz arc** from the *Horizontal* elements menu, the following screen displays:



**Stationing** .....(*information only*) Shows you the station (chainage) at the start of the arc.

**Azimuth** .....(*information only*) Displays the azimuth at the end of the previous element, which is used as the azimuth for the start of the arc.

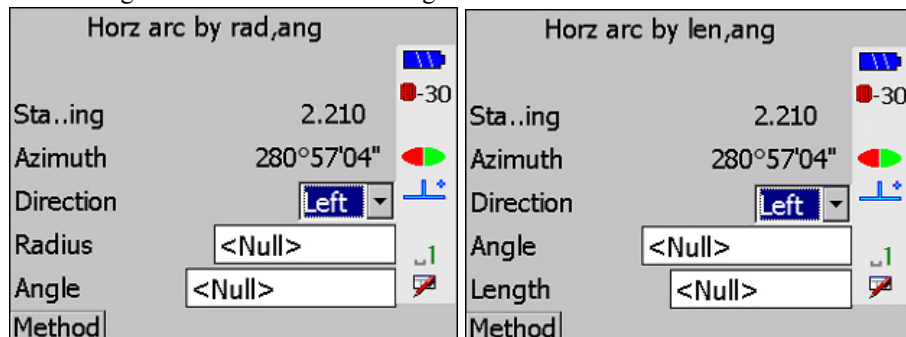
**Direction** .....Specifies whether the arc is a left or right hand curve.

**Radius** .....Specifies the radius of the arc.

**Length** .....Specifies the length of the arc.

Press {←} to accept the screen.

Instead of specifying the arc by length and radius, you can press [**Method**] to change to different definition methods. These methods are radius and subtended angle or length and subtended angle as shown in the following screens.

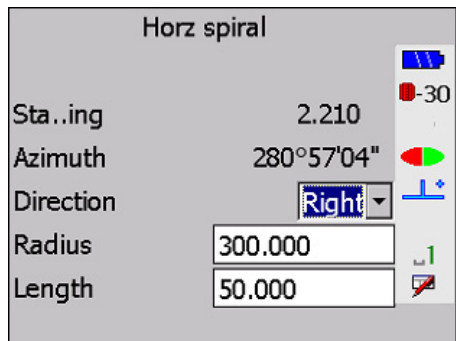


**NOTE** The SETX always stores arcs internally as radius and arc length. If you use an alternate definition method, the SETX converts it to an equivalent arc defined by radius and arc length. A note record is generated in the definition to remind you of the original definition. For example, if you define an arc using angle and arc length, the SETX stores a definition showing radius and arc length with a note showing the subtended angle that you specified:

```
HORZ ARC Sta..ing 82.000 Dist 210.760 Radius 300.000
NOTE RO Angle 40515'08"
```

**25.8.1.3 Horizontal spiral**

When you choose **Horz spiral** from the *Horizontal elements* menu, the following screen displays:



**Stationing** .....(information only) Shows you the station (chainage) at the start of the spiral.

**Azimuth** .....(information only) Displays the azimuth at the end of the previous element, which is used as the azimuth for the start of the spiral.

**Direction** .....Specifies whether the spiral is a left or right hand curve.

**Radius** .....Specifies the smallest radius of the spiral.

**Length** .....Specifies the length of the spiral.

Press {←} to accept the screen.

If a spiral element follows a horizontal straight or point, it is assumed to be an entry spiral, with an initial infinite radius that gradually decreases. If the spiral follows an arc, it is assumed to be an exit spiral, with its radius starting at the specified value and gradually increasing.

A spiral following another spiral is opposite that of the spiral it follows (a spiral following an entry spiral is an exit spiral, and vice versa).

**25.8.1.4 Horizontal point**

A horizontal point element is similar to a horizontal straight, except that it is defined by the coordinate where the element ends rather than as a continuation of the previous element. Horizontal point records are meaningful only in a coordinated road definition.

When you choose **Horz point** from the *Horizontal elements* menu, the following screen displays:

Horz point	
Sta..ing	2.210
Azimuth	280°57'04"
Pt	B09
N	4291.000
E	6693.000

**Stationing**.....(*information only*) Shows you the station (chainage) at the end of the previous element.

**Azimuth**.....(*information only*) Displays the azimuth at the end of the previous element.

Three ways exist to enter a point's coordinates:

- Enter the point's coordinate values in the *N* and *E* fields. A point name is not stored with the definition since the road definition is independent of any survey job.
- Enter a point name to transfer its coordinates into the *N* and *E* fields.
- If you enter an unknown point, the SETX lets you create a new position record using the standard keyboard input method (see Chapter 15, **Keyboard Input**).

Key in POS	
Pt	B10
N	4438.200
E	7021.840
El	262.200
Cd	<No text>

RPos

If you enter a point that creates a line not tangential to the previous element in the alignment, the SETX gives you a confirmation prompt:

Azimuth change	
Confirm?	
Yes	No

When you finish entering the point's coordinates, press {←} to accept the screen.

## 25.9 Defining a Vertical Alignment Road

Define the vertical alignment in a similar manner to the horizontal alignment (see Section 25.8, *Defining a Horizontal Road Alignment*, Page 25-11). Two differences are as follows:

- Only two element types exist for vertical alignment: parabolic curves and circular curves. These elements are joined by straight lines of constant grade.
- Curves are defined by the points of intersection of the tangents of each curve rather than as a continuation of the previous element.

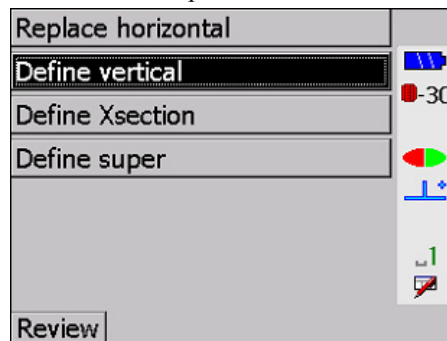
The defined curves are linked by the straight tangent lines (see Figure 22, Page 25-3). The vertical curves can be end-to-end without a straight grade connecting them. Note that curves may have zero length, which effectively gives you a vertical point.

### 25.9.1 Vertical alignment start point

Once you have chosen **Define Road** from the *Roading* menu, define the vertical alignment start point.

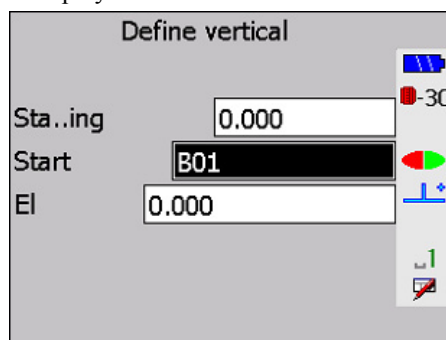
#### Steps for defining the start point

1. Choose one of the **Define vertical** options:



If the option displays as **Replace vertical**, it indicates a part of the definition exists. If you choose the **Replace** option, you receive a prompt confirming the replacement.

2. The following screen displays:

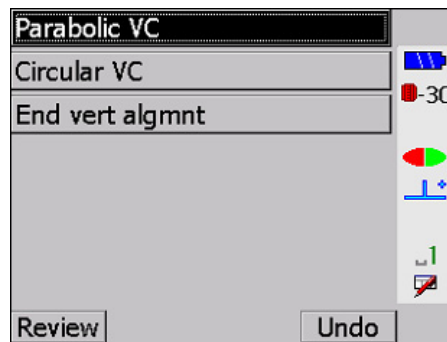


3. Define the point by specifying the station (chainage) in the *Stationing* field so that the vertical alignment can be related to the horizontal alignment.

**NOTE** The horizontal and vertical alignments do not have to start at the same station.

4. Enter the point elevation in the *El* field. You also can enter a point name in the *Start* field, and the elevation appears in the *El* field. (The point name itself is not actually stored in the vertical definition since the information and survey job are independent.)

5. Press {←} to accept the screen. The following screen then displays the element choices:



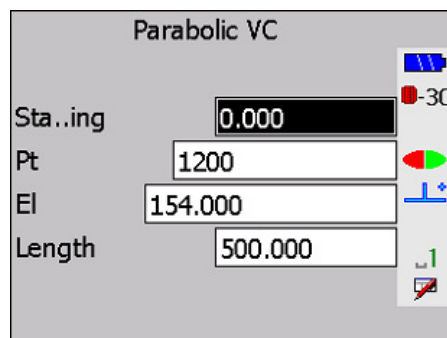
The softkeys perform the following functions:

- [Review]** .....Displays the elements in the vertical definition for review purposes
- [Undo]** .....Deletes the last vertical element defined

6. Highlight one of the element choices, then press {←}.

### 25.9.2 Parabolic vertical curves

When you select the **Parabolic VC** option from the *Vertical alignment* menu, this screen displays:



Define the intersection point (**IP**) and length for a parabolic curve in this screen. The direction of the curve is determined by the relative position of the previous and following **IPs**.

Three ways exist to define the intersection point:

- Enter values in the *Stationing* and *El* fields.
- Enter a point in the *Pt* field, and the elevation appears in the *El* field.
- If you enter an unknown point name, create a position (**POS**) record using the standard keyboard input method (see Section 15.1, *Entering Known Coordinates*, Page 15-1).

Use the *Length* field to specify the horizontal distance covered by the curve.

Press {←} to accept the screen.

The SETX checks that the intersection point is suitable for the previous curve. If not, the message **Curve overlap** appears.

### 25.9.3 Circular vertical curves

When you select the **Circular VC** option from the *Vertical alignment* menu, this screen displays:

Define the intersection point (**IP**) and radius for a circular curve in this screen. The direction of the curve is determined by the relative position of the previous and following **IPs**.

Three ways exist to define the intersection point:

- Enter values in the *Stationing* and *EI* fields.
- Enter a point in the *Pt* field, and the elevation appears in the *EI* field.
- If you enter an unknown point name, the SETX lets you create a position (**POS**) record using the standard keyboard input method (see Section 15.1, *Entering Known Coordinates*, Page 15-1).

Use the *Radius* field to specify the radius of the vertical curve.

Press {←} to accept the screen.

The SETX checks that the intersection point is suitable for the previous curve. If not, the message **Curve overlap** appears.

### 25.9.4 Straight grades

The length of a vertical curve can be zero, which results in two straight grades meeting at the vertical intersection point. If you want to set out a straight grade in isolation from other geometry, define a road containing start and end points but no vertical curves.

### 25.9.5 Vertical alignment end point

Since curves are defined by three points, the vertical definition has to be finished by defining an end point (see Figure 22, Page 25-3).

### Steps for defining the end point

1. Select the **End Vert alignmt** option from the *Vertical alignment* menu. This screen displays:

2. Define the point by specifying the station (chainage) in the *Stationing* field.
3. Enter point elevation in the *El* field. You can also enter a point name in the *Pt* field, and the elevation appears in the *El* field.
4. Press {←} to accept the screen.

## 25.10 Applying Superelevation and Widening

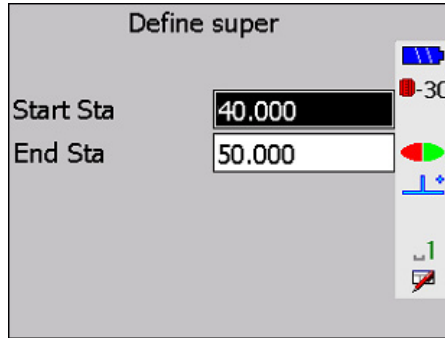
Superelevation and widening are applicable only to alignment roads. Do the following to apply superelevation or widening to an alignment road.

1. Select or define an alignment road.
2. Choose **Define Road** from the *Roading* menu.

3. The SETX will display the following screen.



- Select **Define super**. The SETX displays the following screen:

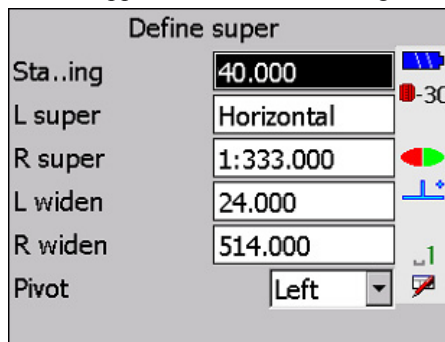


- Enter values for the following fields:

**Start Sta** .....Specifies the starting station (chainage) of this application.

**End Sta**.....Specifies the end station for this application.

- Press {←} to accept the screen.
- You can now specify the actual values of superelevation and widening to be applied at as many stations within the application as needed using the following screen:



**Stationing**.....Specifies the station to which these values are applied

**L super**.....Specifies the superelevation to apply to the template on the left side of the road. Highlighting the **L super** field will display three softkeys:

**R super**.....Specifies the superelevation to apply to the template on the right side of the road. Highlighting the **R super** field displays the same three softkeys presented for the L super field:

**L widen** .....Specifies the amount of widening to add on to the elements of the template on the left hand side of the road

**R widen** .....Specifies the amount of widening to add on to the elements of the template on the right hand side of the road

**Pivot**.....Specifies whether the center, left or right part on the cross-section is to be held at constant elevation during the application of superelevation and widening

Highlighting the **R super/L super** fields displays the following three softkeys:

- [Horizo] - applies horizontal superelevation to the left/right side of the road
- [1:] - converts a superelevation value to a ratio format (1:300)
- [%] - converts the superelevation value to a percentage.

8. Press {←} to accept the screen. The SDR will store a set of records defining superelevation and widening for a continuous section of road. The following is a typical set of superelevation records.

```

DEFINE SUPER Start stn 7.000      End stn 367.760
APPLY SUPER Sta..ing 7.000    L super %-3.000 R super %-3.000
                L widen 0.000    R widen 0.000    Pivot Center
APPLY SUPER Sta..ing 32.000    L super          R super
                L widen 0.000    R widen 0.000    Pivot Center
APPLY SUPER Sta..ing 57.000    L super %-3.000 R super
                L widen          R widen          Pivot Center
APPLY SUPER Sta..ing 82.000    L super %-6.000 R super %6.000
                L widen 5.000    R widen 10.000  Pivot Center
APPLY SUPER Sta..ing 292.760  L super %-6.000 R super %6.000
                L widen 5.000    R widen 10.000  Pivot Center
APPLY SUPER Sta..ing 317.760  L super %-3.000 R super
                L widen          R widen          Pivot Center
APPLY SUPER Sta..ing 342.760  L super          R super
                L widen 0.000    R widen 0.000    Pivot Center
APPLY SUPER Sta..ing 367.760  L super %-3.000 R super %-3.000
                L widen 0.000    R widen 0.000    Pivot Center

```

### 25.10.1 Deleting superelevation and widening

If you make a mistake or want to delete superelevation, press {ESC} to return to the *Road definition* screen. A new option, **Delete super**, is available. Highlight this option and press {←} to erase the superelevation and widening. A new superelevation and widening or new limits of application can now be applied.

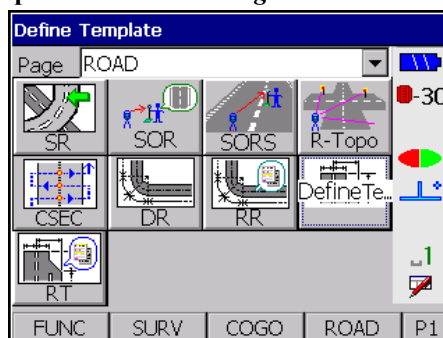
The SETX will prompt you to confirm deletion of the superelevation.

## 25.11 Defining Templates

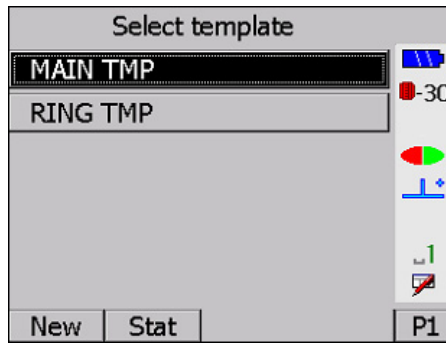
A template defines a cross-section of a road for one-half of the road only. Templates are named with 16-character names and are stored independently of both survey jobs and road definitions.

Templates must not fold on themselves so as to create an overhang. Two consecutive points may be at the same offset though (one vertically above the other).

1. Choose **Define Template** from the *Roading* menu.

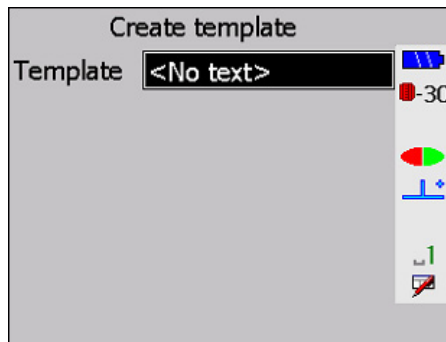


- The *Select template* screen displays. Access the *Create template* screen by pressing [New].

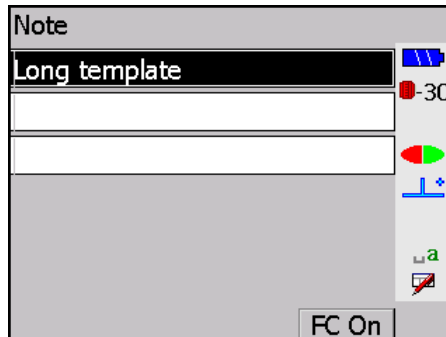


If no templates exist, the *Create template* screen displays first.

- Enter a template name and press {FUNC CTRL} + {←}.



- Enter as many descriptive notes as you want:

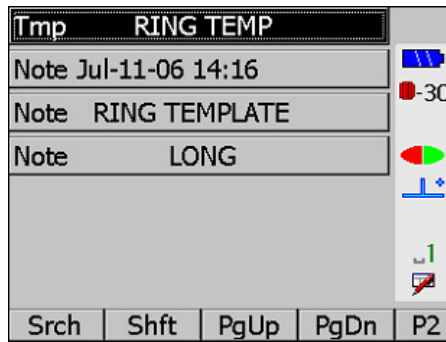


- Press {FUNC CTRL} + {←} when you are done. Then, you will see the template elements menu:



The first three options, **Templ-Offs/Htdiff**, **Temp-Grade/Dist**, and **Temp-Dist/VDist**, are used to create consecutive joined cross-section lines. You can use as many as you need. The last option, **Templ-Sideslope**, is used for defining a sideslope and can be only the last component in a template.

You can review the template definition by pressing **[Review]**. This step will show you the records that define the template so far:

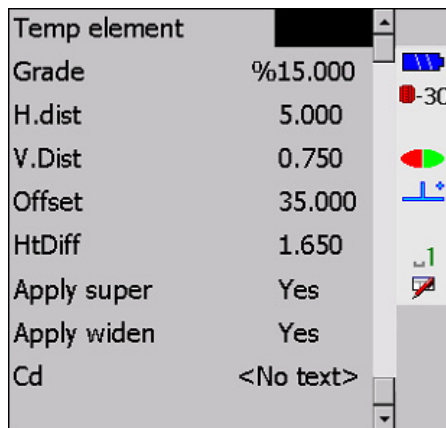


The first three methods of defining the elements produce the same type of record:

```

TEMP ELEMENT Grade %-3.000      H.dist 25.000V.dist -0.750
                Offset 25.000    HtDiff -0.750Apply super Yes
                Apply widen Yes  Cd HIGHWAY
    
```

Note also that these first three methods allow different methods of definition. The SETX will also calculate the values not entered, all of which can be seen in review:



The grade may be specified as either a percentage “%” or as a ratio “1:” and will be displayed in printed output and review in the same format as it is entered.

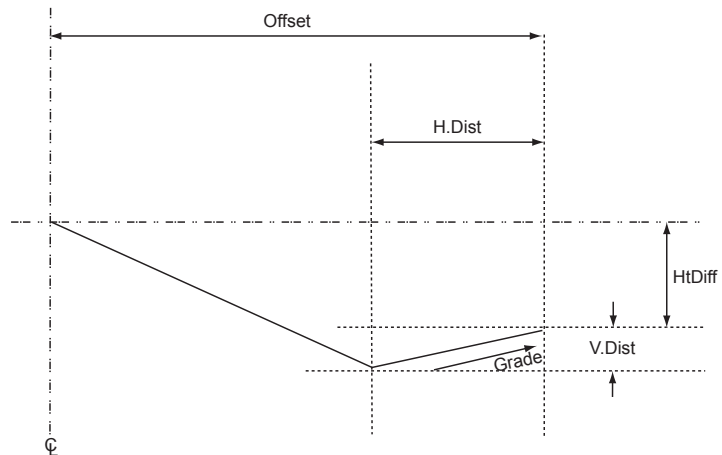
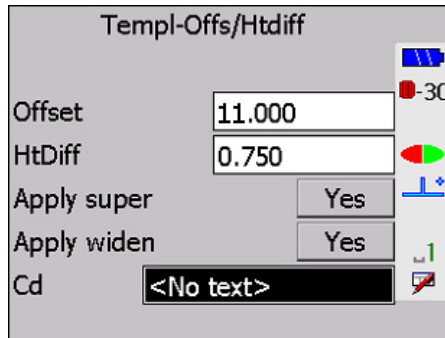


Figure 25: Template elements

### 25.11.1 Template point by offset and height difference

When you select the **Temp-Offs/Htdiff** option, this screen displays:



Use this screen to define a template point by specifying the offset and the height difference relative to the centerline.

Enter appropriate values for the following fields:

**Offset** .....Specifies the distance of the point from the centerline. This offset must not be less than the offsets of any previous points in the template. (A template may not fold back on itself with an overhang.)

You can enter an offset the same as the previous point; this results in a vertical portion of the template. However, only two consecutive template points may have the same offset; you may not have three points one above the other.

**HtDiff**.....Specifies the vertical height difference of the point from the centerline. A positive height difference means the point is above the centerline.

**Apply super** .....Can be set to **Yes** if superelevation should be applied.

**Apply widen** .....Should be set to **Yes** if widening should be applied.

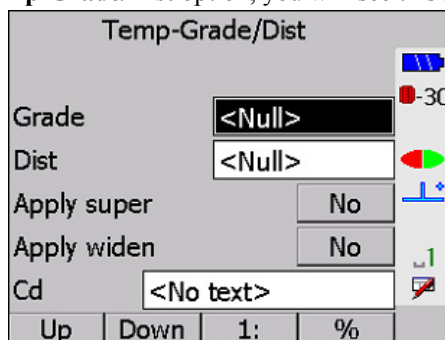
**Cd**.....Is the code to be used for points set out at this point.

Press {←} to accept the screen.

The defined point is joined to the previous template point to form the shape of the template.

### 25.11.2 Template point by grade and distance

When you select the **Temp-Grade/Dist** option, you will see this screen:



This screen defines a template point by a grade and horizontal distance from the previous template point.

**Grade** .....Specifies the grade of the element; it can be specified as vertical up or down by pressing [**Up**] or [**Down**].

[**%**] and [**1:**] can be used to specify whether the grade is entered and displayed as a percentage or a ratio. If the format is percentage, the grade value specifies the slope to the next template point as a percentage. For example, 3% means that the template will rise 0.300 over a distance of 10.0. If the format is ratio, the grade value specifies the slope as a ratio. For example, 1:30 means that the template will rise 0.333 over a distance of 10.0.

**Dist** .....Specifies the horizontal distance of the new template point from the previous template point. It may not be negative; the template shape may not double back on itself. If the grade is specified as either **Up** or **Down** then the distance is taken to be vertical with the horizontal distance being zero.

**Apply super** .....Specifies whether or not the element will be affected by the application of superelevation.

**Apply widen** .....Specifies whether or not the element will be affected by the application of widening.

**Cd** .....Enables a code to be attached to the point that this element defines.

The screen is accepted automatically when you press {←}.

The defined point can be considered to be joined to the previous template point in order to form the shape of the template.

### 25.11.3 Template point by distance and vertical distance

When you select the **Temp-Dist/VDist** option you will see this screen:

The screenshot shows a dialog box titled "Temp-Dist/VDist". It contains the following fields and controls:

- Dist**: A text input field containing "<Null>". To its right is a red circle with "-30" next to it.
- V.Dist**: A text input field containing "<Null>". To its right is a green circle with a red circle above it.
- Apply super**: A button labeled "No" with a blue vertical line and a plus sign to its right.
- Apply widen**: A button labeled "No" with a blue vertical line and a plus sign to its right.
- Cd**: A text input field containing "<No text>". To its right is a red square with a white 'a' and a red diagonal line through it.

This screen defines a template point by distance and height difference relative to the previous template point.

Enter appropriate values for the following fields:

**Dist** .....Specifies the horizontal distance of the point from the previous template point. This distance must not be negative.

**VDist** .....Specifies the vertical height difference of the point from the previous template point. A positive value means the point is above the previous point, a negative value means it is below.

**Apply super** .....Can be set to **Yes** if superelevation should be applied.

**Apply widen** .....Should be set to **Yes** if widening should be applied.

**Cd**.....Is the code to be used for points set out at this point.

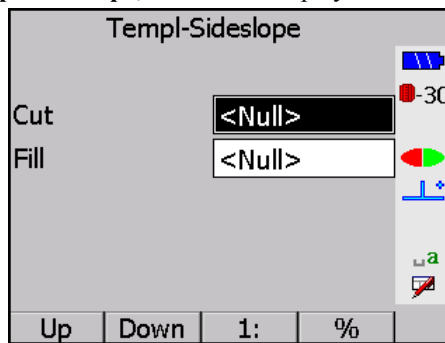
The screen will be accepted automatically when you press {←}.

The defined point can be considered to be joined to the previous template point in order to form the shape of the template.

### 25.11.4 Template sideslope definition

Define as many template points as necessary to form the shape of the template. When you have finished, define sideslopes to join the edge of the template and the existing terrain at a catch point.

When you choose **Templ-Sideslope**, this screen displays:



Define a cut grade and a fill grade in this screen. When you are setting out the road, the SETX determines whether you are in cut or fill and uses the appropriate grade to set out the sideslope.

Define grades like you did in the **Temp-Grade/Dist** template point definition (Section 25.11.2, *Template point by grade and distance*, Page 25-25). However, the numbers are always positive. Cut grades are assumed to rise as they get further from the centerline, and fill grades are assumed to fall.

**Cut** .....This grade will be applied to meet existing terrain when the template is in a cut situation

**Fill** .....This grade will be applied to meet existing terrain when the template is in a fill situation

Press {←} to accept the screen.

## 25.12 Defining Road Cross-Section

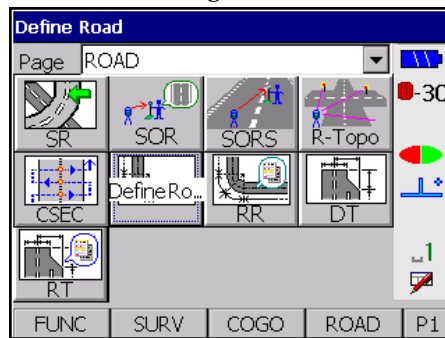
The cross-section of a road is defined by specifying templates to be applied along the horizontal and vertical alignments.

Templates are defined independently of any survey job or road definition. The road cross-section definition allows you to associate one or more templates with a road's horizontal and vertical alignment.

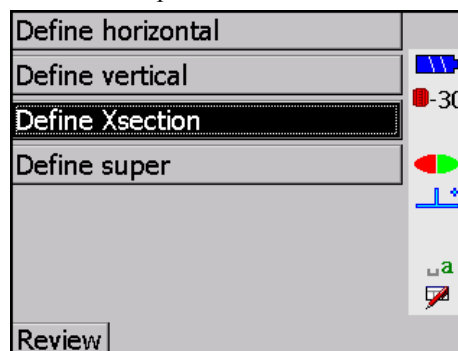
**NOTE** As roads are interpolated between defined cross-sections, you must have a cross-section defined at both the start and the end of a road.

### Steps to define cross-sections

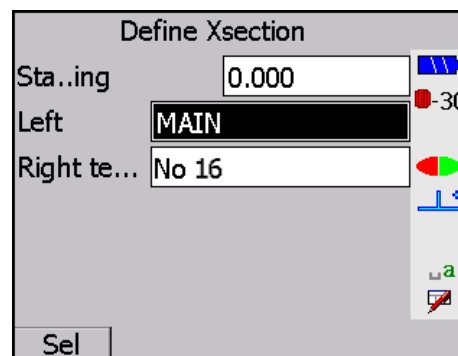
1. Choose **Define Road** from the *Roading* menu.



2. Choose **Define Xsection** from the *Define Road* menu. Use this screen to define the templates that will be used for a portion of the road:



3. Specify the station (chainage) that the templates will be applied from in the *Stationing* field.



4. Specify the name of the template for this cross-section of the road in the left and right template fields. Type the name in the fields or press **[Sel]** to see a list of templates to select from. If you enter the name of a template that does not exist, you are given the option of creating it. You can enter the same name in both fields, which produces a symmetrical cross-section.
5. Press **{←}** to accept the screen.

Once you have defined a cross-section for a road, the *Define Road* menu has two options, **Add Xsection** and **Replace Xsection**.

Specify as many cross-section screens as you wish, using the **Add Xsection** option from the *Define Road* menu. Cross-sections do not have to be defined in order of station (although it is more logical to do so); the SETX sorts them so that they appear in correct



sequence. The simplest procedure is to define one cross-section screen with a station equal to the start station of the road and the same at the end; this applies the same templates all the way down the road.

If you choose the **Replace Xsection** option from the *Define Road* menu, all your existing cross-section definitions (but not your templates) are discarded, allowing you to define new ones.

## 25.13 Roding Calculations

This section describes the calculations performed to calculate positions on the road.

### 25.13.1 Superelevation calculation

The default superelevation applied at any station is null. Values other than the default can only be achieved between the values specified by the **DEFINE SUPER** record. The values of superelevation between the **Start** and **End** stations specified in the **DEFINE SUPER** record are calculated by referring to the **APPLY SUPER** records, and using linear interpolation to calculate the values of superelevation for stationing whose values do not appear explicitly in any **APPLY SUPER** record.

For example, using the values in the printout, Station 57.000 will have values of 3.000% and -3.000% for the left and right superelevation respectively. Interpolation will only occur between specified values. If this cannot be done then the default is given.

The calculations for the left and right hand sides of the road are completely independent of each other.

### 25.13.2 Widening calculation

Calculations for widening are similar to those for superelevation, the main difference being that zero is the default value for widening.

### 25.13.3 Template calculation

Templates are calculated outward from the centerline. They are always calculated at a particular station (chainage) and have applied to them the values of superelevation and widening defined at that station.

Each element of the template is evaluated individually, applying the values of superelevation and widening.

The *normal crossfall of an element on a template* is the grade that is specified in the **Temp-Grade/Dist** definition, or the grade derived from one of the distance based definitions. Similarly, the *normal distance of an element* is the distance specified in any of these definitions and is the horizontal distance of the element.

The way that superelevation is applied to the elements of a template is dependent on where in the template the element is. The first element in a template that can have superelevation applied to it will have its grade altered to be the same as the value of superelevation. Subsequent elements on the template that can have superelevation applied have their grades calculated by adding on to them the difference in grade that the first element undergoes.

The calculation process of the grade is shown by the following decision chart:

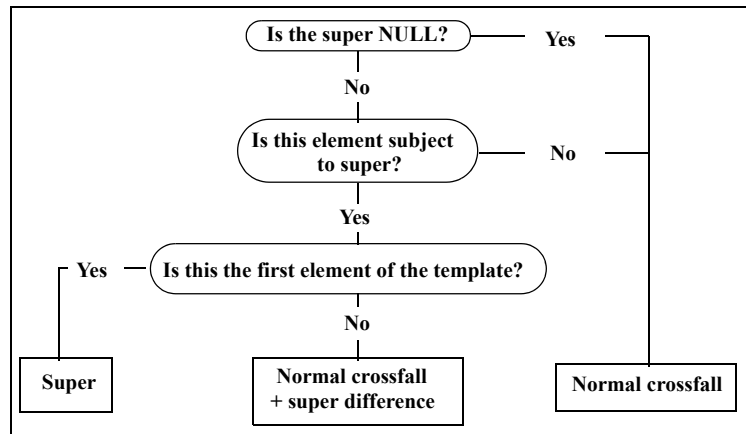


Figure 26: Calculation process decision chart

Once the grade of the element is determined, the horizontal distance is calculated. The horizontal distance is the normal distance plus widening if the element is subject to widening. If the element is widened then the widening occurs by extending the element at its calculated grade. All grade calculations are carried out using grades expressed as percentages, even though these values may be entered and displayed as ratios.

---

**NOTE** Calculating a template using the default values of superelevation and widening will give the same results as would be given if all elements of the template were defined to have neither applied.

---

#### 25.13.4 Pivot calculation

The pivot point is the fixed point in terms of which the cross-sections are calculated when superelevation is applied. If the pivot point is defined as “center,” the centerline is held. Should the pivot point be defined as “left” or “right,” the pivot calculation will find the last element of the template on that side of the road which can be subject to superelevation and uses the end of that element as the pivot point.

The position of the pivot point relative to the centerline is calculated without superelevation being applied and held fixed. After superelevation has been applied to the cross-section, the whole superelevated cross-section is raised or lowered until it is anchored on the pivot point.

#### 25.13.5 Cross-section calculation

The cross-section at a given station (chainage) is calculated by reference to the cross-section definition and to the templates to which it refers. Interpolation between the templates in adjacent cross-section records occurs. Interpolation is based on the end of each corresponding element of the two templates concerned.

For the cross-section to be calculated, there must be a **XSEC** record defined both before and after the station being calculated. The cross-section can then be made up one element at a time by evaluating the same element in both templates and interpolating between them.

This interpolation is based on the differences in horizontal and vertical distances of the ends of the individual elements.

The templates are calculated using the values of superelevation and widening, which are defined at the station whose cross-section is being evaluated.

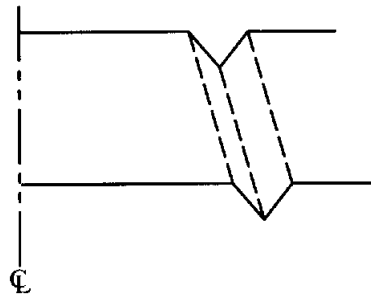


Figure 27: Cross-section calculation example

### 25.14 Roding Example

This section gives an example of SETX roding illustrating the use of all the definitions available.

This example consists of a single right-hand transitional curve. It has superelevation applied and widening and also has the added complication that over most of its length it is getting wider on its left side but not its right side. Superelevation is applied to the first two elements of both templates. Widening is applied to the first element of both templates.

The superelevation and widening diagrams used are shown, as are the two templates used.

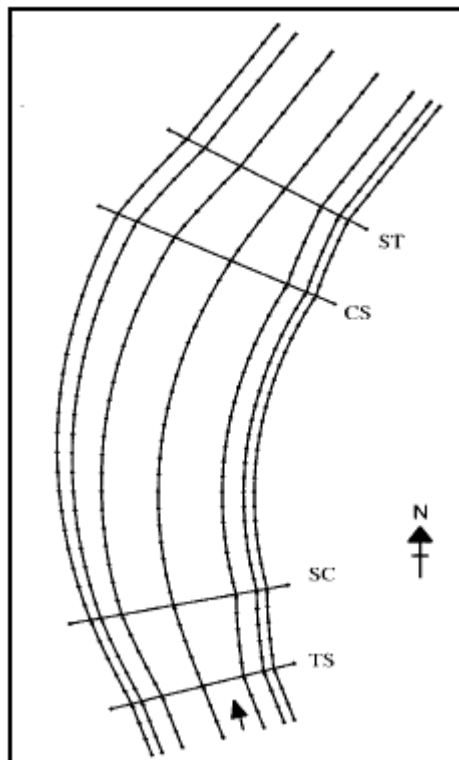
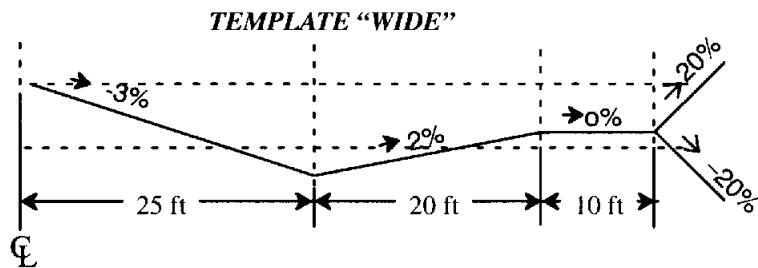
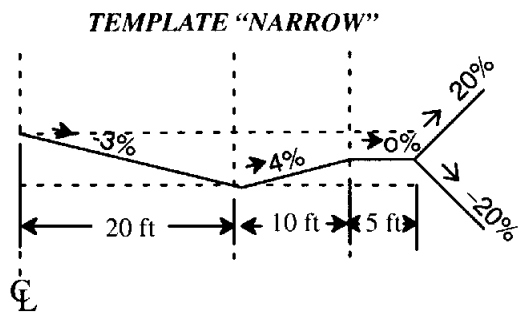
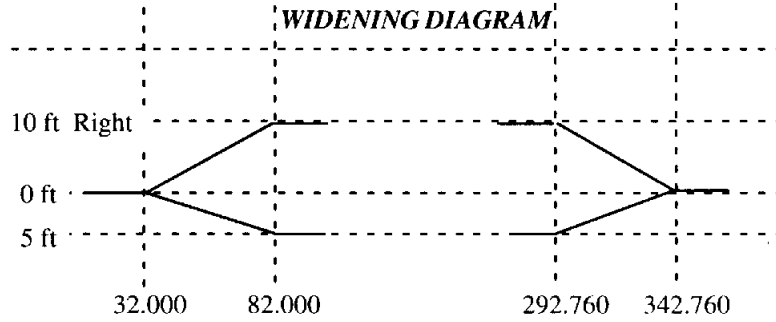
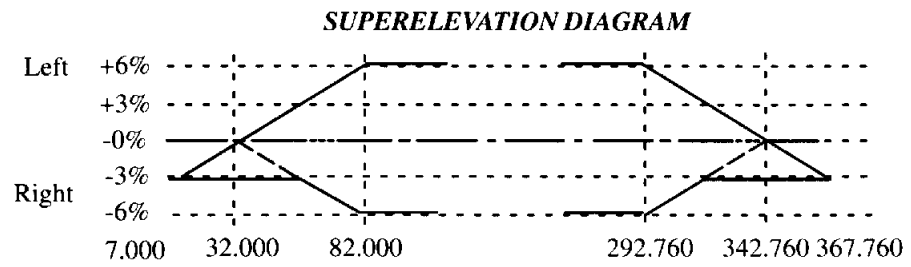


Figure 28: Example road horizontal alignment



SDR33 V04-04.20		10-Apr-96 08:48	
	Angle Degrees	Dist Feet	Press Inch Hg
	Temp Farenht	Coord N-E-Elev	
ROAD KI	ID MANUAL ROAD		
SCALE	S.F. 1.00000000		
NOTE TS	09-Apr-92 10:11		
HORZ ALIGN	Start stn 0.000	End stn 422.760	Azimuth 342-43'00"
	North 10324.430	East 84342.540	
HORZ STRAIGHT	Sta..ing 0.000	Azimuth 342-43'00"	Dist 32.000
HORZ SPIRAL	Sta..ing 32.000	Dist 50.000	Radius 300.000
HORZ ARC	Sta..ing 82.000	Dist 210.760	Radius 300.000
HORZ SPIRAL	Sta..ing 292.760	Dist 50.000	Radius 300.000
HORZ STRAIGHT	Sta..ing 342.760	Azimuth 32-31'05"	Dist 80.000
VERT ALIGN	Sta..ing 0.000	Elev 33.000	
VERT POINT	Sta..ing 500.000	Elev 33.000	
X SECTION	Sta..ing 0.000	Left temp NARROW	Right temp NARROW
X SECTION	Sta..ing 82.000	Left temp NARROW	Right temp NARROW
X SECTION	Sta..ing 292.760	Left temp WIDE	Right temp NARROW
X SECTION	Sta..ing 500.000	Left temp WIDE	Right temp NARROW
DEFINE SUPER	Start stn 7.000	End stn 367.760	
APPLY SUPER	Sta..ing 7.000	L super %-3.000	R super %-3.000
	L widen 0.000	R widen 0.000	Pivot Center
APPLY SUPER	Sta..ing 32.000	L super	R super
	L widen 0.000	R widen 0.000	Pivot Center
APPLY SUPER	Sta..ing 57.000	L super	R super %-3.000
	L widen	R widen	Pivot Center
APPLY SUPER	Sta..ing 82.000	L super %6.000	R super %-6.000
	L widen 5.000	R widen 10.000	Pivot Center
APPLY SUPER	Sta..ing 292.760	L super %6.000	R super %6.000
	L widen 5.000	R widen 10.000	Pivot Center
APPLY SUPER	Sta..ing 317.760	L super	R super %-3.000
	L widen	R widen	Pivot Center
APPLY SUPER	Sta..ing 342.760	L super	R super
	L widen 0.000	R widen 0.000	Pivot Center
APPLY SUPER	Sta..ing 367.760	L super %-3.000	R super %-3.000
	L widen 0.000	R widen 0.000	Pivot Center
TEMPLATE KI	ID NARROW		
NOTE TS	09-Apr-92 10:15		
TEMP ELEMENT	Grade %-3.000	H.dist 20.000	V.dist -0.600
	Offset 20.000	HtDiff -0.600	Apply super Yes
	Apply widen Yes	Cd HIGHWAY	
TEMP ELEMENT	Grade %4.000	H.dist 10.000	V.dist 0.400
	Offset 30.000	HtDiff -0.200	Apply super Yes
	Apply widen No	Cd EDGE OF ROAD	
TEMP ELEMENT	Grade Horizontal	H.dist 5.000	V.dist 0.000
	Offset 35.000	HtDiff -0.200	Apply super No
	Apply widen No	Cd SIDEWALK	

TEMP-SIDESLOPE	Cut %20.000	Fill %20.000	
TEMPLATE KI	ID WIDE		
NOTE TS	09-Apr-92 10:17		
TEMP ELEMENT	Grade %-3.000	H.dist 25.000	V.dist -0.750
	Offset 25.000	HtDiff -0.750	Apply super Yes
	Apply widen Yes	Cd HIGHWAY	
TEMP ELEMENT	Grade %2.000	H.dist 20.000	V.dist 0.400
	Offset 45.000	HtDiff -0.350	Apply super Yes
	Apply widen No	Cd EDGE OF ROAD	
TEMP ELEMENT	Grade Horizontal	H.dist 10.000	V.dist 0.000
	Offset 55.000	HtDiff -0.350	Apply super No
	Apply widen No	Cd SIDEWALK	
TEMP-SIDESLOPE	Cut %20.000	Fill %20.000	

## 25.15 Setting Up Road Station

Whenever **Road Topo**, **Set Out Road**, or **Set Out Road Surface** are selected, a road station must be set up:

The station setup is similar to standard topography; however, you can specify the station point or the backsight point relative to the road definition. The **Set up on** field is toggled between the following:

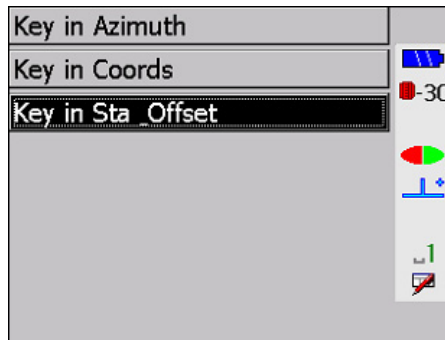
- Coords** .....Enters the station details in exactly the same way as for a normal station
- Stn Offset** .....Sets your instrument on a point relative to the road definition with unknown coordinates

When you enter a point ID into the **Stn** field, the following displays:

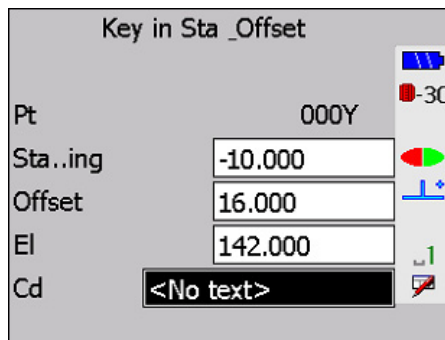
The fields on this screen are the same as those described in Chapter 9, *Setting up station and backsight*, except for the **Sta..ing** and **Offset** fields. The **Set up on** settings will be reflected by displaying *N* and *E* values or **Sta..ing** and **Offset**. Pressing {←} will store a road station record (**RSTN**) and return to the **Confirm orientation** screen.

```
ROAD STN RO 8001   Sta..ing 57.000   Offset -61.340
North 10361.907   East 84266.834   Elev 35.640
Road MANUAL ROAD Theo ht 5.650   Cd End of existing
```

If a backsight point is entered for which an azimuth is not found, you are asked to supply a backsight as displayed below:



The *Key in azimuth* and *Key in coords* options are the same as for normal station setup. The *Key in Stn & Offset* option allows you to specify a point relative to the road definition as displayed below:



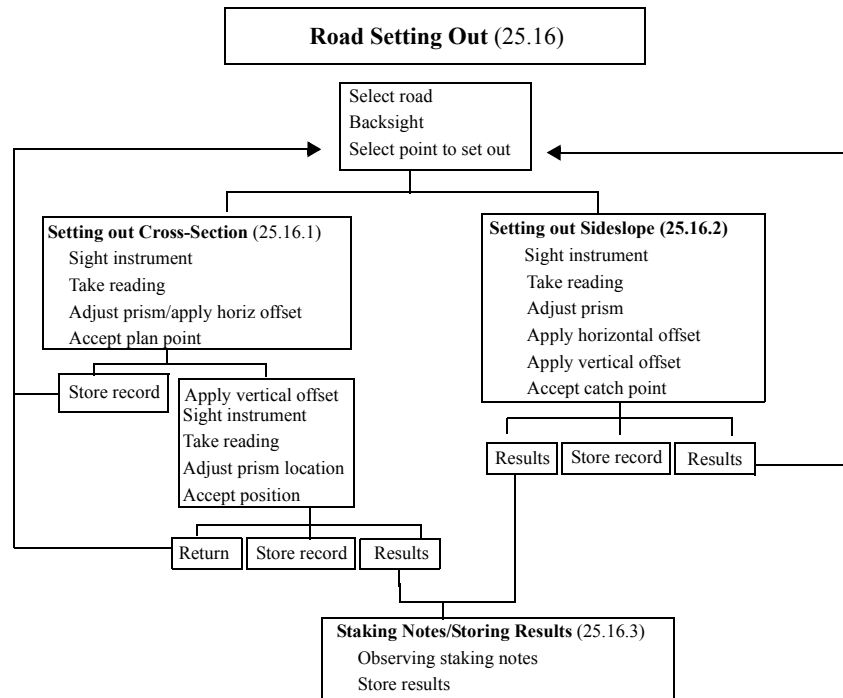
Press {←} to accept this screen; a road position record is stored and the backsight reading is taken in the normal way.

```
ROAD POS KI 8002 Sta..ing 32.000 Offset 0.000
                North 10354.985 East 84333.033 Elev 36.130
                Cd CL
```

**NOTE** For uncoordinated roads, the station position must be specified by station and offset. The backsight may not be specified by coordinates.

## 25.16 Setting Out Roads

The SETX roading program is designed for setting out a road once it has been defined. You can set out any point along the road by specifying its station and offset. The following diagram shows the available options and the processes of setting out specific points:



1. **Select road.** Select the *Set Out Road* option from the *Roading* menu. If a road has not yet been selected a list of roads available for setting out is displayed:

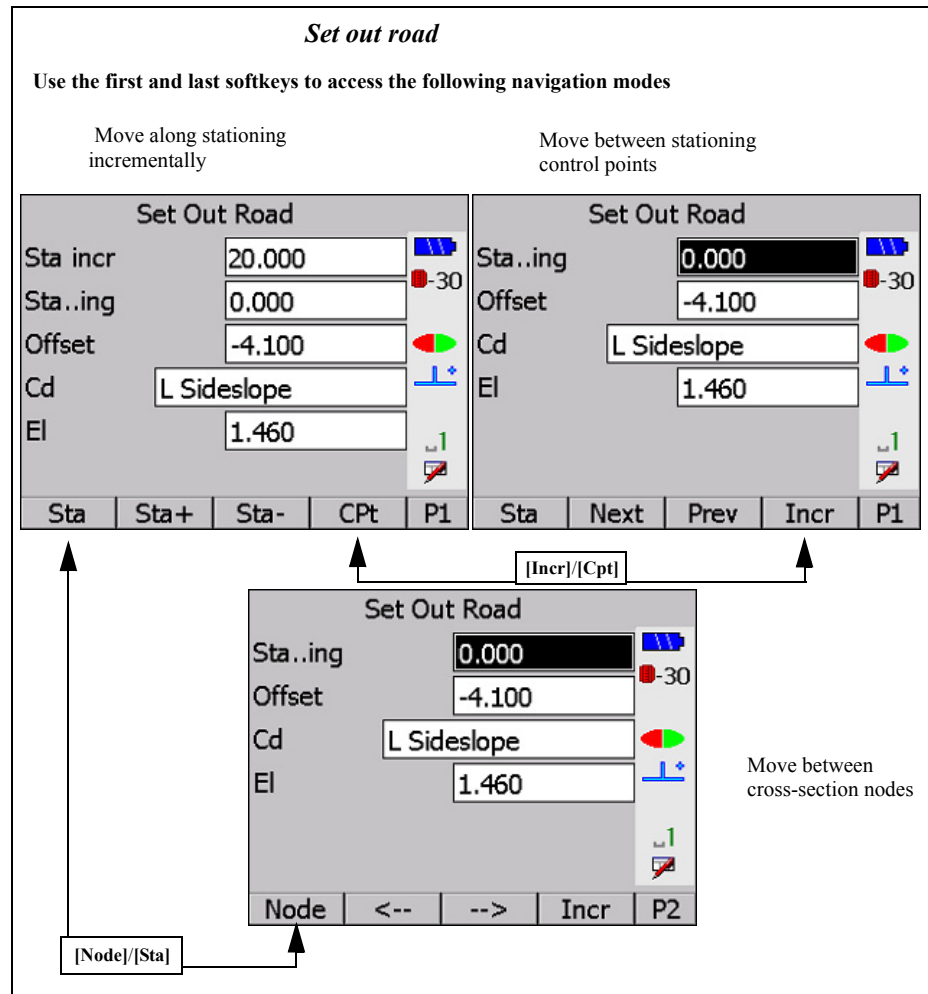


Highlight the road you want to select, then press {←}.

2. **Backsight.** Take backsight reading or confirm orientation.



3. **Identify and select point to set out.** The *Set Out Road* screen is displayed.



This screen allows you to select a point to set out. You may navigate to the desired point by using the softkeys. Three methods of navigating are available:

- Moving along the stationing incrementally by a set amount (**[Incr]** at right) using **[Sta+]** and **[Sta-]**
- Moving along the stationing between control points (**[Cpt]** at right) using **[Next]** and **[Prev]**.
- Moving between nodes on the cross-section (**[Node]** at left) using **[←]** and **[→]**.

The softkeys perform the following functions:

**[Sta]/[Node]** .....Toggles between the modes of moving along stationing or of moving between nodes on the cross-section. This softkey reflects the current mode. To change mode, press this softkey.

**[Incr]/[Cpt]**.....Toggles between the modes of moving along stationing. This softkey reflects the current mode. To change modes, press this softkey.

**[Sta+]/[Sta-]** .....(in *Incr* mode) Increases or decreases the stationing by a set amount, determined by the *Sta incr* field.

[Next]/[Prev].....(in *Cpt mode*) Increases or decreases the stationing between control points.

A control point is the start or end of any straight, arc, spiral, vertical curve, or the high or low point of a vertical curve. The intersection points of the vertical curves also are control points.

[→] .....(in *Node mode*) Increases the offset to the next point in the template. An increase is a move to the right (viewed looking down the road in the direction of increasing stationing).

[←] .....(in *Node mode*) Decreases the offset to the previous point in the template.

The fields on the *Set Out Road* screen are as follows:

Set Out Road				
Sta incr	20.000			
Sta ..ing	0.000			
Offset	-4.100			
Cd	L Sideslope			
El	1.460			
Sta	Sta+	Sta-	Cpt	P1

**Sta incr**.....(available only in *Incr mode*) Enables you to input the amount by which the stationing will increment or decrement using [Sta+] or [Sta-].

**Stationing**.....(information only) Displays the current stationing. This may not be less than the start station of the road or greater than the end station.

**Offset** .....Enables you to directly enter a fixed offset. Once you have entered a value into this field, the offset will not change until [←] or [→] is pressed or a value is entered into the code field.

**Cd**.....Displays the code as entered in the template definition if the point specified is the end point of that element. It will display the following under certain conditions:

- **L Sideslope** specifies the endpoint of the left sideslope element (the left catch point).
- **R Sideslope** specifies the endpoint of the right sideslope element (the right catch point).
- **Undef** offset occurs where a value is entered into the *Offset* field for which there is no design elevation, such as off the edge of the road.
- **Offset** occurs when a value is entered into the *Offset* field which is not the end point of an element of the template.

**Elevation**.....Automatically calculates the elevation on the road at the specified station and offset. However, you may override this value by entering your own elevation.

**Horz o/s**.....Specifies an extra horizontal offset that is to be applied to the point. Use this field to set out stakes for the edge of the road; for example, to add a safety margin to the edge of the road.

This extra offset is different from the offset in the station/offset combination because the *Horz o/s* is applied horizontally (see the following diagram):

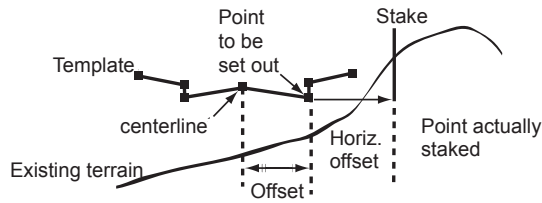


Figure 29: Staking out the template

**NOTE** The horizontal offset is always applied normal to the centerline. If positive, it is applied to the right. If negative, it is applied to the left.

Press **{FUNC CTRL} + {←}** to set out current point. The type of point to be set out will determine what steps are to be followed:

- Points with fixed offsets, as defined within the template or defined by a supplied offset, are discussed in Section 25.16.1, *Setting Out Cross-section*, Page 25-39.
- Catch points, as determined by the sideslope and its intersection with existing terrain (labeled as **R Sideslope** or **L Sideslope**), are discussed in Section 25.16.2, *Setting out sideslopes*, Page 25-42.

### 25.16.1 Setting Out Cross-section

The procedure for setting out cross-sections is simplified due to the known, or fixed, offset from the center line. A horizontal and/or vertical offset can additionally be applied to the fixed offset.

#### Steps for setting out cross-sections

1. **Sight instrument.** The SETX displays all the information required to set out the point:

Aim horiz circle		
Aim H.obs	136°00'16"	
Aim V.obs	41°11'09"	-30
H.dist	7.000	
H.obs	57°10'11"	
V.obs	90°22'16"	1
dH.o	78°50'05"	
Azimuth	0°00'00"	
V.Distance	5.000	
S.Distance	8.630	
Cd	Center	
Cnfg		Store

The previous screen shows you the necessary horizontal and vertical angles to observe, and the desired slope distance to the point. It also shows you the reduced horizontal and vertical distances and the azimuth for your information.

Align your instrument to the horizontal angle shown. The SETX is put into countdown mode automatically to help you. Rotate the instrument until the countdown reaches zero, then direct the prism pole in line.

2. **Take reading.** When ready, press the **{READ}** key to initiate the first reading.
3. **Adjust prism/apply horizontal offset location.** A guidance screen displays to direct the prism to the target point by providing corrections to the last reading. A horizontal offset may be applied by entering a value in the **Horiz O/S** field.

Right	6.996	
In	3.492	
Fill	8.025	
Aim H.obs	136°00'16"	
Aim V.obs	41°11'09"	
H.obs	89°38'25"	
V.obs	90°20'33"	
Horz o/s	<input type="text" value="0.000"/>	
<div style="display: flex; justify-content: space-between; width: 100%;"> <span>Cnfg</span> <span>Store</span> <span>Target</span> </div>		

- Left/Right** .....(information only) Displays the distance to move left or right to get on line (from the instrument operator's point of view).
- In/Out** .....(information only) Shows you the distance to move in (toward the instrument) or out (away from the instrument) to get the prism on the target point.
- Fill/Cut**.....(information only) Shows you the amount of cut or fill that the position represents relative to the design point. Remember that the observed point currently is the physical point at the bottom of the prism pole.
- Aim H.obs**.....Shows you the horizontal angle that you should be observing on your instrument. This changes if you change the **Horz o/s** field.
- Aim V.obs**.....Displays the vertical angle that should be observed.
- H.obs** .....(information only) Indicates the horizontal observation angle
- V.obs**.....(information only) Indicates the vertical observation angle
- S.Dist**.....(information only) Indicates the slope distance
- Horz o/s**.....Shows the horizontal offset adjustment that you entered earlier. If modified, all other fields are adjusted accordingly.

Use the **{READ}** key or **[Target]** to take as many observations to the prism as needed to locate the point. After each observation, the **Left/Right** and **In/Out** fields are updated to reflect the latest position of the prism relative to the point to be set out.

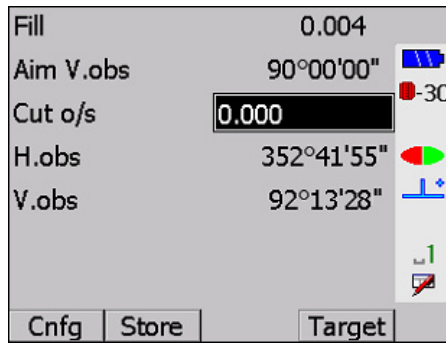
4. **Accept plan point.** Once you have located the plan view position of the point, you can continue with one of the following steps:
  - Store a record and return to the **Set Out Road** screen. Pressing **[Rpos]** will store a RPOS record, containing the station and offset (and coordinates if known) on the final observed point. A NOTE record containing the cut/fill and differences in northing and easting from the design point also is stored. When completed, SETX will return to the **Set Out Road** screen.

**NOTE** If a horizontal offset was used, the offset point is taken as the design point.

- Apply a vertical offset. To apply a vertical offset, press {←} and continue with the next section. To access the **Store Result** screen, a vertical offset or zero must be applied.

**Applying a vertical offset**

1. **Sight instrument on target point.** A guidance screen displays to direct the prism to the target point.



Align your instrument to the horizontal angle shown. The SETX is put into countdown mode automatically to help you. Rotate the instrument until the countdown reaches zero, then direct the prism pole in line.

**Fill/Cut** .....(information only) Shows you the amount of cut or fill that the position represents relative to the design point. Remember that the observed point currently is the physical point at the bottom of the prism pole.

**Aim V.obs** .....Displays the vertical angle that should be observed.

**Cut o/s** .....Is useful for staking a cut or fill different from the design elevation. For example, if the exact design elevation is underground, you may enter a cut offset of 1.0. The **Aim V.obs** field changes to guide your instrument aim to the point on the stake that will produce a cut value of 1.000.

**H.obs** .....(information only) Indicates the horizontal observation angle.

**V.obs** .....(information only) Indicates the vertical observation angle.

2. **Take reading.** When ready, press the {READ} key to initiate the first reading.
3. **Adjust prism location.** The guidance screen display information to help direct the prism to the target point. You can use the {READ} key or [Target] to take as many observations to the prism as needed to locate the point.
4. **Accept point.** Once a satisfactory elevation has been set out, you can choose one of the following options:
  - Store a record and return the **Set Out Road** screen. Pressing [Rpos] will store a roading position record (RPOS), containing the station and offset (and coordinates if known) on the final observed point. A NOTE record containing the cut/fill and differences in northing and easting from the design point also is stored. When completed, SETX will return to the **Set Out Road** screen.
  - Store results. Pressing {←} will take you to the **Store Result** screen (see Section 25.16.3, *Staking notes/storing results*, Page 25-44)

## 25.16.2 Setting out sideslopes

The procedure for setting out a left or right sideslope (the *Cd* field will indicate **L Sideslope** or **R Sideslope**) is different from setting out a point with a know, or fixed, offset from the center line. The SETX cannot determine the offset to the toe of the sideslope because it does not have a model of the underlying terrain. The SETX, therefore, allows any point on the sideslope to be located and set out using an iterative process of taking observations along the sideslope and, using the observation as a model of the underlying terrain, provides direction to the calculated toe from the current point.

### Steps for setting out a sideslope

1. **Sight instrument.** The SETX cannot yet give an indication of where to aim your instrument; it does not yet know anything about the terrain in the vicinity of the sideslope.

You will be prompted to take a reading as shown below:

Stn	1	
BS pt	1100	
H.obs	39°24'12"	
V.obs	103°51'00"	
Sideslope setout		
Cnfg	OFS	Angle P1

This reading will be used by the SETX to determine whether the sideslope is in cut or in fill; therefore, the prism should be located near the anticipated catch point.

2. **Take reading.** When ready, press the {READ} key to initiate the first reading.

Sideslope setout		
Left	5.050	
In	4.010	
ΔSta	0.444	
Offset	3.985	
Cnfg	Target	

3. **Adjust prism location.** A guidance screen displays to direct the prism to the target point by providing corrections to the last reading. An assumption is made that the terrain in the vicinity of the sideslope is at the elevation of the current point.

Fill	16.453	
Sta crn	14.666	
Xsect crn	1.066	
Sideslope at	6.223	
Design slope	Cut	
Grade	%80.000	
Cnfg	Store	Target

- Fill/Cut** .....(*information only*) Displays the difference in elevation of the current prism location and the design elevation of the sideslope at the current offset.
- Sta crn** .....(*information only*) Shows how to correct the current prism location to sight it on the sideslope line or cross-section.
- Xsect crn** .....(*information only*) Displays the necessary correction to the current prism location along the sideslope line or cross-section to sight the toe of the slope.
- Sideslope at** .....(*information only*) Displays the horizontal distance from the beginning of the sideslope to the current prism location.
- Design slope** .....Shows which design slope (cut or fill) is being used in the calculations; you may change it at any time.
- Grade**.....Shows the grade that is being used in the calculations; you may change it at any time

**NOTE** Changes to the **Design slope** and **Grade** will be in effect until the user returns to the **Set out Road** screen or changes the station by returning to the **Stn Setup** screen.

The **Horz o/s** field does not appear. The horizontal offset is not applied until the position on the sideslope to be set out has been determined.

**NOTE** The toe of the sideslope is the point at which the **Cut/Fill** is zero and the **Stn crn** field is zero.

You may adjust your prism location according to the corrections on the previous screen. As many readings as is necessary now may be taken by pressing the **{READ}** key or **[Target]**, using the values displayed to assist in determining where to move.

4. **Apply horizontal offset.** You may apply a horizontal offset as described in Section 25.16.1, *Setting Out Cross-section*, Page 25-39 or press **{←}** to accept a zero offset and continue.
5. **Apply vertical offset.** You may apply a vertical offset as described in *Applying a vertical offset*, Page 25-41, or press **{←}** to accept a zero offset and continue.
6. **Accept catch point.** When you have either found the toe of the sideslope or have determined to set out some other point on the sideslope, you can proceed with one of the following options:
  - Store a record and return the **Set Out Road** screen. Pressing **[Rpos]** will store a RPOS record, containing the station and offset (and coordinates if known) on the final observed point. A NOTE record with the cut/fill and differences in northing and easting from the design point also is stored. When completed, SETX will return to the **Set Out Road** screen.
  - Store results. Pressing **{←}** will take you to the **Store Result** screen.

### 25.16.3 Staking notes/storing results

After completing the set out steps for a cross-section or a sideslope, the **Store results** screen gives you the opportunity to access the staking notes report and/or to store the results before returning to the **Set out Road** screen. The following screen displays:

Store Result	
Cd	L Sideslope
Pt	1033
ΔSta	-0.449
ΔOffset	0.000
Fill	7.078
RPos RChk Rpt Optns P1	

The softkey functions are described in the following sections. The fields in the **Store result** screen display the following information:

- Cd**.....Displays the code as entered in the template definition if the point specified is the end point of that element. You can modify this field.
- Pt**.....Displays the point to be used for storing results. You can modify this field.
- ΔSta**.....(*information only*) Displays the stationing difference between the point set out and the design point.
- ΔOffset**.....(*information only*) Displays the offset difference between the point set out and the design point.
- Fill/Cut**.....(*information only*) Displays the vertical difference between the point set out and the design point.

#### 25.16.3.1 Staking notes

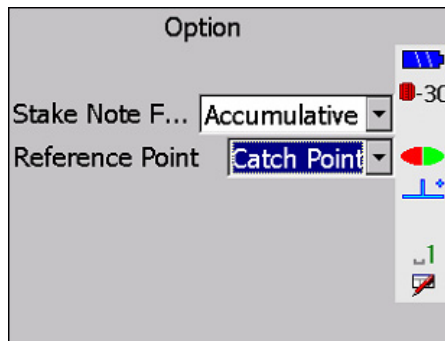
Access to a staking notes report is provided from the **Store Result** screen via **[Rpt]**. The format of the staking notes can be changed with **[Optns]**.

- [Rpt]**.....Enables access to a series of staking notes for each node on the cross-section.
- [Optns]**.....Enables the user to select the format in which the staking notes are displayed. Two formats are available:
- **Incremental** - provides staking notes to each node on the cross-section in respect to its adjacent, outer node.

Option	
Stake Note F...	Incremental
RPos RChk Rpt Optns P1	



- **Accumulative** - provides staking notes to each node on the cross-section in respect to a single reference point. That reference point can be the catch point (toe of the sideslope) or an offset of the catch point.



Additional options are available when the stake note form is **Accumulative** as shown below.

The **Reference Point** may be defined as one of the following:

- **Catch Point** - Each node will be defined with respect to the catch point or the point on the sideslope that was set out.
- **Offset** - Each node will be defined with respect to the catch point horizontal offset, if one was supplied. If a horizontal offset is not used, it will default to the catch point

**Incremental**

Once you press [Rpt], the staking notes are displayed according to the format defined via [Optns].

Consider a template with nodes representing the center, bottom of curb, top of curb, edge of road, and the sideslope. The **Incremental** option gives the slope staking notes for each node with respect to the next outer node as seen on following four screens:

From	Catch Point	
To pt	SIDEWALK	
Sta..ing	0.000	
Fill	19.004	
H.dist	547.647	
Grade	%21.730	
Calc Grade	<Null>	
Store	<--	-->

From	<No text>	
To pt	north	
Sta..ing	0.000	
Fill	0.449	
H.dist	0.000	
Grade	Down (Vert)	
Store	<--	-->

From	north	
To pt	stream	
Sta..ing	0.000	
Fill	2.078	
H.dist	2.000	
Grade	%22.830	
Store	<--	-->

From	stream	
To pt	Center	
Sta..ing	0.000	
Fill	0.449	
H.dist	1.000	
Grade	%11.131	
Store	<--	-->

### Accumulative

The **Accumulative** option gives the slope staking notes of each node with respect to the sideslope node as displayed on the following four screens:

From		Catch Point	
To pt	HIGHWAY		
Sta..ing	0.000		-30
Cut	4.700		
H.dist	547.014		
Grade	Horizontal		
Calc Grade	<Null>		
Store	<--	-->	

From		Catch Point	
To pt	north		
Sta..ing	0.000		-30
Fill	0.014		
H.dist	547.014		
Grade	Horizontal		
Calc Grade	<Null>		
Store	<--	-->	

From		Catch Point	
To pt	stream		
Sta..ing	0.000		-30
Fill	0.044		
H.dist	549.014		
Grade	Horizontal		
Calc Grade	<Null>		
Store	<--	-->	

From		Catch Point	
To pt	Center		
Sta..ing	0.000		-30
Fill	0.014		
H.dist	550.014		
Grade	Horizontal		
Calc Grade	<Null>		
Store	<--	-->	

If the reference point was set to offset, each node would be defined with respect to the catch point offset (if supplied).

Staking notes for individual nodes can be stored to the database, as displayed on the staking notes report screens, by pressing **[Store]**. You can access the various nodes by using **[←]** and **[→]**. Pressing **{ESC}** will return you to the **Store Result** screen.

#### 25.16.3.2 Storing results

The **Store Result** screen allows you to return to the **Set Out Road** screen with or without storing the results. You can change either or both the point name and code if necessary.

Store Result			
Cd	L Sideslope		
Pt	1033		-30
Δ Sta	51.449		
Δ Offset	0.000		
Fill	7.078		
RPos	RChk	Rpt	Optns P1

Store Result			
Cd	L Sideslope		
Pt	1033		-30
Δ Sta	51.449		
Δ Offset	0.000		
Fill	7.078		
No		P2	

The options for leaving the **Store Result** screen are as follows.

- Press **[Rpos]** to store a roading position record (**RPOS**) record and return to the **Set Out Road** screen. An **RPOS** shows the northing, easting, elevation, station and offset of the point that was set out.

The following example shows the type of data that will be stored in the database with an **RPOS** record.

```
ROAD POS RO AUTO1001 Sta..ing 81.983 Offset -35.000
                    North 10395.564 East 84285.594 Elev 29.509
                    Cd EDGE OF ROAD

NOTE RO              Fill 2.091          d.North -0.038 d.East -0.250
```

- Press **[Rchk]** to store a roading check record (**RCHK**) and return to the *Set Out Road* screen. An RCHK record shows the differences of station, offset and elevation from the design point.

The following example shows the type of data that will be stored in the database with an RCHK record.

```
ROAD CHK RO AUTO1002 Sta..ing 82.000 d.Chn -0.017
                    Offset -35.000 d.Offset 0.252 Elev 29.509
                    d.Elev -2.091
                    Cd EDGE OF ROAD

NOTE RO              Fill 2.091          d.North -0.038 d.East -
```

**NOTE** For either type of record, an additional note is stored, giving the cut/fill and the differences in northing and easting.

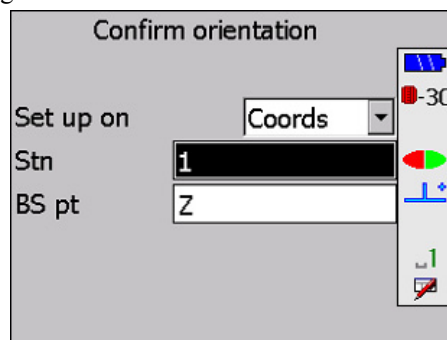
- If you want to return to setting out, press **{ESC}**. You will be returned to the *Aim Horiz Circle* screen. This might be necessary if the prism pole is inadvertently moved during the setting out of the elevation.
- Access the second page of softkeys and press **[No]** to return to the *Set Out Road* screen without storing any results.

Upon returning to the *Set Out Road* screen, you will be prompted for the next point to set out.

## 25.17 Using Road Topography

The road topography program allows you to take a number of readings to points and to apply station (chainage) and offset to them. Setting up for road topo is identical to setting up for setting out a road.

After you have successfully set up your station, you will be asked to take a reading to the point to apply stationing to:



Once you have taken the reading you will see the following screen:

Cd	<No text>	
Pt	1010	
Sta..ing	0.000	-30
Offset	3.070	
N	-5.673	
E	-0.710	
EI	-1.774	

The SETX has now calculated the station and offset of the point on the selected road. You may now change the *Cd* field or the *Pt* field if you wish. Store this as a road position record (**RPOS**) by pressing {←}. If you do not wish to store this record press {ESC}. You will be returned to the *Take reading* screen and may now take another reading.

A shortcut method is provided if you wish to take a number of readings and store the results for each one. Rather than pressing {←} to store the road position record (**RPOS**), press the {READ} key; this will store the record and immediately initiate another reading, returning you to the *Apply Stationing* screen.

```
NOTE RT          Road topo MANUAL ROAD
OBS F1 8001-AUTO1004
S.dist 30.542    V.obs 99-21'55"  H.obs 234-23'55" Code ROCK
ROAD POS RT AUTO1004 Sta..ing 81.989  Offset -69.225
                   North 10388.101  East 84251.935  Elev 30.220
                   Cd ROCK
```

## 25.18 Setting Out Road Surface

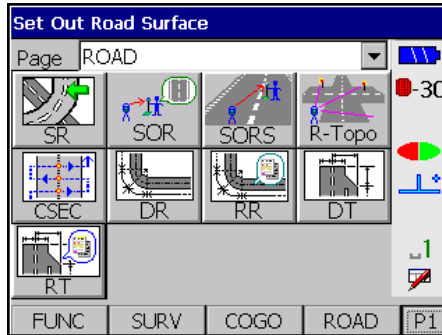
This program allows you to set out the cut or fill of any point on a surface. The surface is defined as a normal alignment road. Simply take a reading, and the cut/fill value is displayed. You can then set the design elevation if required.

**NOTE** Horizontal setting out (left/right, in/out) is not applicable here, because a surface rather than a point is being set out.

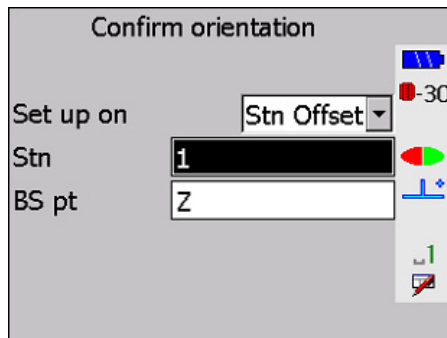
1. Define a road by keying it in or loading from a computer via the PC's serial communications program.

**NOTE** Refer to documentation for the serial communications program for instructions on how to transfer data.

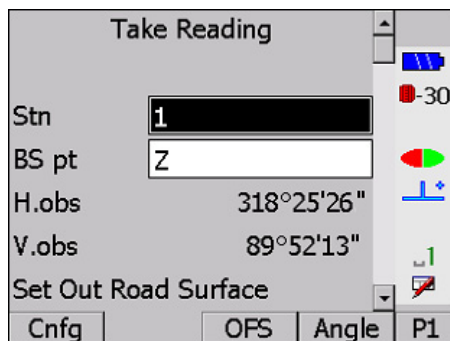
- Run the *Set Out Road Surface* program and select the appropriate road.



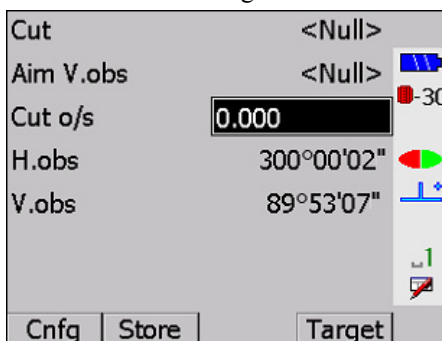
- Set up your station and backsight.



- Take a reading to any point on the road surface.



- The station and offset is calculated, and the road definition is used to calculate the design elevation. The usual vertical setting out screen will be displayed.



At this point you can store the result or set out the design elevation. Further readings are assumed to be to the same point, as the elevation is set out. Press the following softkeys or hardware keys to initiate the described action:

- {←} .....Accesses the result screen
- {ESC} .....Exits setting out road surface
- {READ} .....Takes another reading to the same point without entering code, point number, or target height
- [Target] .....(softkey) Takes a reading with a new target height
- [Cnfg] .....(softkey) Accesses the *Configure reading* screen (see Section 3.5.4, *Configure reading*, Page 3-6)
- [Store] .....(softkey) Stores an (RPOS) record, containing the station, offset, and coordinates of the point

Store Result	
Cd	Undef offset
Pt	1074
Sta .ing	0.000
Offset	0.000
Fill	0.000
<div style="display: flex; justify-content: space-between;"> <span>RPos</span> <span>RChk</span> <span>No</span> </div>	

The  $\Delta Sta$  and  $\Delta Offset$  fields show the distance that the prism pole has moved since the first reading to the current point. Usually this will be small, and confirms that the prism has not moved during the elevation staking procedure. However, this can also be used to set the stake away from the actual point, perhaps out of the way of heavy machinery.

Once the result record has been stored, you may take a reading to the next point on the surface (Step 4).

The station and offset is calculated by an "apply station" algorithm, which may take several seconds on a road with many elements.

If the point observed is not on the surface, you will see a Null cut/fill value.

# Chapter 26

## Cross-Section Survey

### In this chapter

- Using the cross-section survey program to survey cross-sections of roads or existing ground details

The purpose of the Cross-Section Survey program is to survey cross-sections of roads or other linear features. The SETX automatically calculates the offsets from an observation designated as the center line point.

This program enables you to survey the cross-sections in one of two ways:

- Walk the minimum distances (see Figure 30)
- Survey from the centerline outward (see Figure 31, Page 26-1)

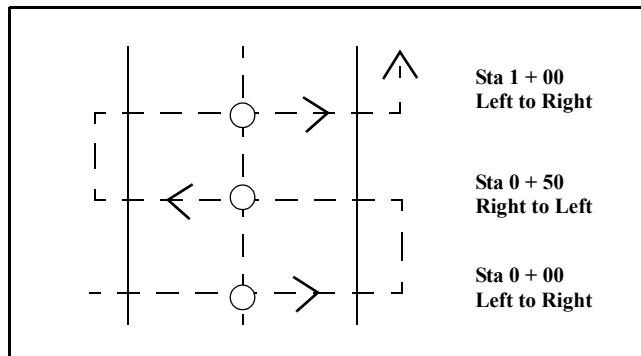


Figure 30: Survey cross-sections by walking the minimum distances

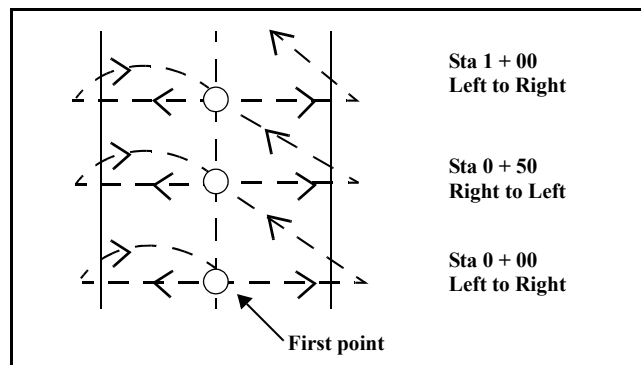
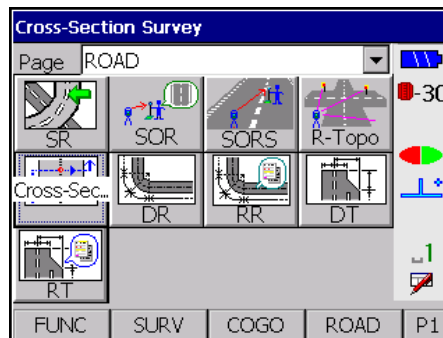


Figure 31: Survey cross-sections from the centerline out

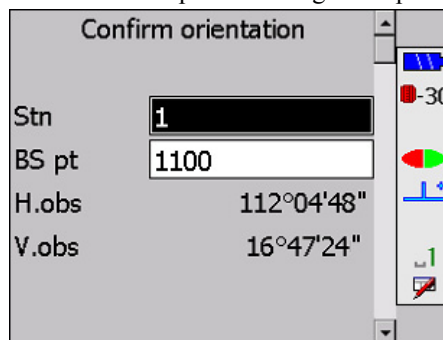
The *Cross-section survey* option is similar to the *Topography* option. If you have read Chapter 8, **Topography Observations**, you will quickly grasp this chapter.

### Steps for using *Cross-Section Survey*

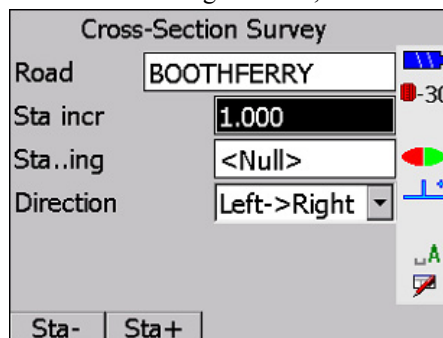
1. Select **Cross-Section Survey** from the *Roading* menu.



2. Begin with the standard station setup and backsight setup.



3. Once you complete station and backsight details, the SETX displays this screen:



Enter the name of the road where you are taking cross-sections in the **Road** field. The road name can be up to 16 characters long. Specifying a different road name in the **Road** field after observing some sections allows you to take cross-sections of subsequent roads.

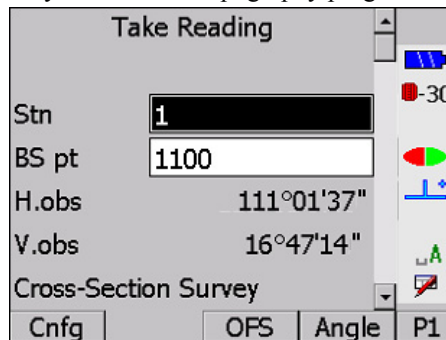
4. Enter the station (chainage) value in the **Stationing** field for the first cross-section. Use the format XXXX.XXX, and the number will be displayed in the selected roading format in the *Units* screen accessed from the *Functions* menu. For example, 1000.000 displays as 10+00.000.

The **Sta incr** field and [Sta-] and [Sta+] offer a quick means to increase or decrease the station value. This is useful if you are surveying cross-sections at even intervals. Pressing [Sta+] adds the value in **Sta incr** to the station value to get a new station value.



Once you have completed at least one cross-section, you may choose not to specify the station value for subsequent cross-sections. If you do not specify the station value, the SETX uses the horizontal distance between the new cross-section's centerline point and that of the last section as the station increment (This has the implicit assumption that the centerline is a straight line between the two points).

5. Use the **Direction** field to specify the survey direction of the cross-section. Choose from **Left->Right**, **Right->Left**, **Left**, or **Right** using the left and right arrow keys. When set to **Right** or **Left**, the direction does not toggle with each reading set.
6. Press {←} and begin surveying the cross-section. Operation during surveying is similar to the methods you use in the topography program.



Each observation is stored as a roading position record in the following formats:

Table 19: Observation Formats

Format	Description
Road	RO
Pt	1001
Station	0+00.000
Offset	0.000
North	4070.711
East	5063.123
Elev	129.425
Cd	Curb

Survey your first point on the cross-section. Your first noncenterline point surveyed must be to the left of the centerline if you specified **Left to right** in the **Direction** field.

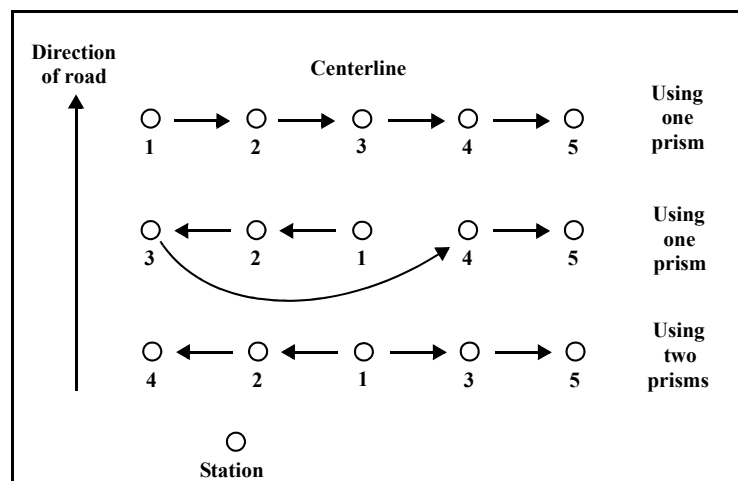


Figure 32: Direction specified left to right

If you specified **Right to left** in the *Direction* field, your first noncenterline observation must be to the right of the centerline.

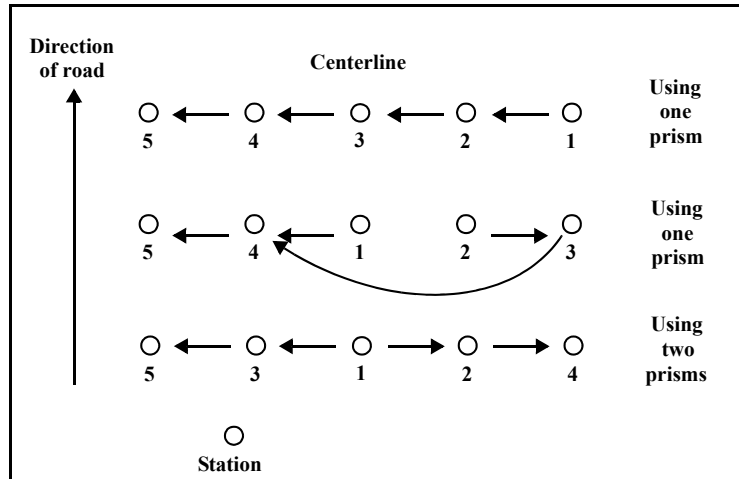


Figure 33: Direction specified right to left

You can begin on, or to the left of, the centerline and proceed to the right if you specified **Right** in the *Direction* field. However, the rodman does not reverse direction after each cross section; all cross sections begin on or to the left of centerline and proceed right.

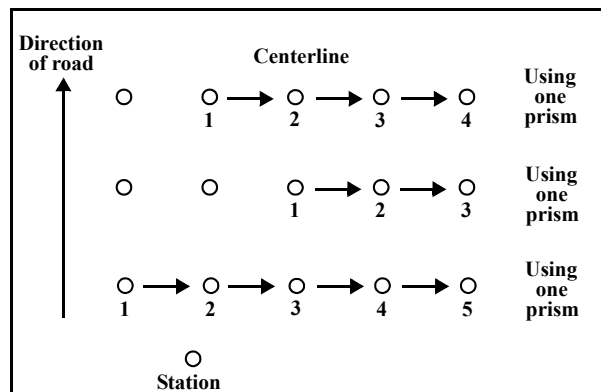


Figure 34: Direction specified right

If you specified **Left** in the *Direction* field, you can start on or to the right of the centerline and proceed left. However, the rodman does not reverse direction after each cross section; all cross sections begin on or to the right of centerline and proceed left.

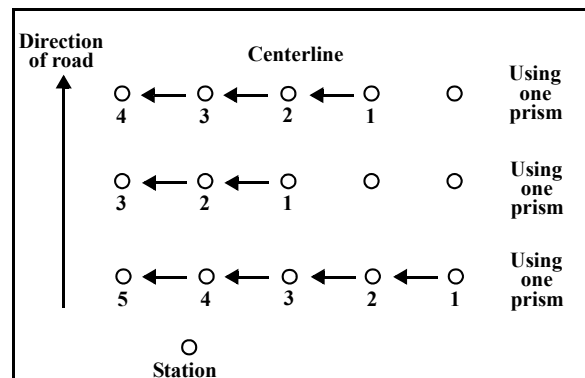
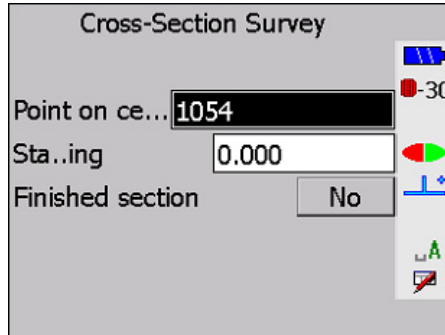


Figure 35: Direction specified left

When taking observations to the cross-section points, the SETX needs some way of deciding whether the last point surveyed was significant (a centerline point, or the last point to be surveyed in the cross-section). After each measurement you must either press {←} or {READ} to continue. If you press {FUNC CTRL} + {←}, the SETX “knows” the last measurement was significant, and the following screen appears. Pressing {READ} instructs the SETX to use the last measurement as a cross-section point and carry on to take the next reading.



If you press {FUNC CTRL} + {←} by mistake, you can press {ESC} to continue taking readings.

If you have not already defined the centerline point, the SETX decides that this is why you have pressed {FUNC CTRL} + {←} and sets the centerline point to be the last surveyed point. Pressing {FUNC CTRL} + {←} confirms this to be the case, and you are returned to taking cross-section measurements.

If you have already specified the centerline point, the SETX decides that you want to leave this cross-section by pressing {FUNC CTRL} + {←}. Accordingly, it sets the **Finished Section** field to be **Yes**. Pressing {FUNC CTRL} + {←} now confirms that you want to finish this cross-section survey and returns to the initial screen where you can specify the new station value.

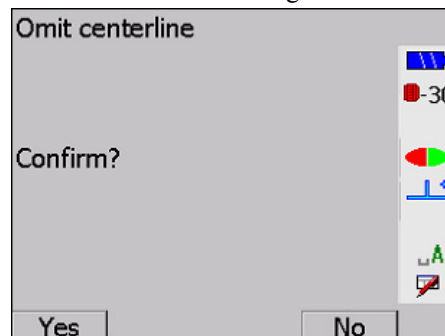
**NOTE** You may override the SETX's assumptions by specifying the desired values in place of those furnished by the SETX.

This methodology allows you the flexibility of starting at the centerline point or from one side. It also ensures identification of the centerline point.

- When observations are saved, they initially have a Null offset. Press {←} or {ESC} to exit from the current section. At this time the SETX calculates the offsets for each surveyed cross-section and updates the database records.

Offsets to the left of the centerline are stored as negative values and offsets to the right have positive values. The centerline has an offset of 0.00.

If you press {ESC} when no centerline reading has been taken, the SDR warns:



If you confirm that you do not want to take the centerline reading, all the points on this section will have Null offsets.

8. Press **{ESC}** a second time (after you have pressed it to exit the current cross-section), and you can change observation stations.

# Chapter 27

# Communications

**In this chapter:**

- Setting communications parameters
- Specifying output and CSV parameters
- Converting files
- Transmitting data to a computer
- Receiving computer data
- Printing data

This chapter gives you instructions and settings for transferring data using the **Communication** option on the **Function** menu. For example, you can send and receive survey information to and from a PC, and print data in a formatted report.

By using a PC's serial communications program, you can transfer data files between the PC and the SETX memory, and convert SDR files into file formats that are compatible with commonly-used CAD packages.

For example, in North America, the serial communication program is typically **HyperTerminal**, located on the **Start** menu at **[Programs] - [Accessories] - [Communications]**. Refer to your PC's documentation for more information on using this program.

## 27.1 Setting Communication Parameters

All of the SETX's direct communications to the memory use a combined communications and external power supply cable. Use this cable to directly connect to a PC or serial printer.

Communication can also be performed using the SETX's onboard Bluetooth wireless technology and SFX Dial-up Program.

For details, see "11. CONNECTING TO EXTERNAL DEVICES" in the Operator's Manual for your total station.

If you are using a generic serial communications program to communicate with the SETX memory, make sure you set communications parameters in that program and the SETX to the following:

**Table 20: Communication Parameters**

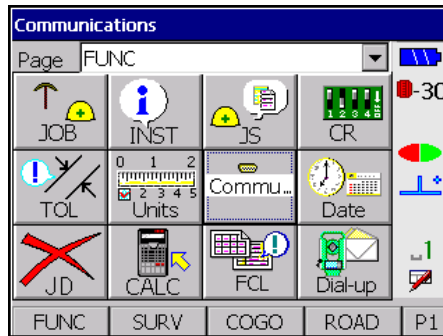
Parameter	Setting
Baud rate	Consistent between both ends
Flow Control	Xon/Xoff
Data bit	8
Stop bits	1
Parity	None
Parity check	Off
Carrier detect	Off

**NOTE** For instructions specific to using a serial communications program, refer to your PC's documentation.

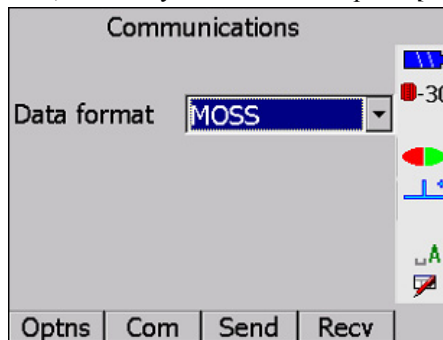
**Steps for Setting SETX communication parameters**

The communications parameters chosen for your PC must match those of the SETX. To change the communication parameters in the SETX, complete these steps:

1. Select **Communications** from the *Functions* menu.

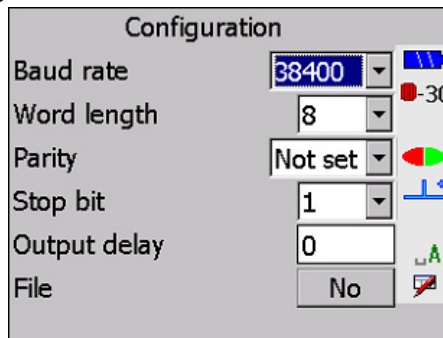


2. In the *Data format* field, select any data format and press [Com].



**NOTE** Setting the communications parameters for one output format will change the parameters for other output formats.

3. The SETX will display the communications parameters screen. Use this screen to set the parameters for your communications session.



Highlight a field, then press {◀} or {▶} to change it.

**Baud rate**.....Specifies the speed that characters are transmitted through the serial line. The baud rate is to the number of bits sent per second; typically 10 bits are transmitted for each byte or character. For example, 9600 baud means 960 bytes per second. Available baud rates are: **1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.**

---

**NOTE** The same baud rate must be selected on both the SETX and the PC to which it is connected.

---

- Word length**.....Specifies the number of data bits in each character transmitted or received. The available options are **7** and **8**.
- Parity** .....Specifies the type of parity bit added to each character when sending or checked on each character when receiving. The available options are **Not set**, **Odd** and **Even**. The parity bit is sent in addition to the specified number of data bits.
- Stop bit**.....Specifies the number of stop bits transmitted after each character. The options are **1** and **2**.
- Output delay**.....Gives support for serial printers with little or no buffering. When you enter number other than 0, the output will pause for the number of milliseconds specified before sending each byte. For example, 10 pauses the SETX for 10 milliseconds before it sends each character in the output file.
- File** .....Allows the selected JOB to be printed to/read from file in the specified format.

4. Press {←} to save your settings.

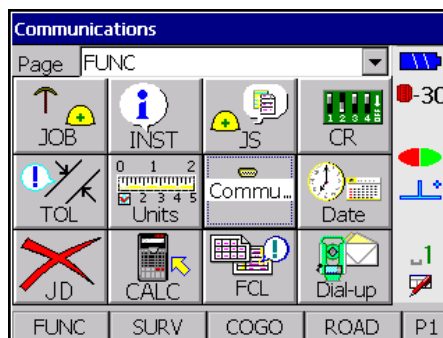
## 27.2 Specifying the output format of observations

Records in the SDR database can be output with the same formats in which they can be viewed (see Section 5.5, *Reviewing Observation Records*, Page 5-4).

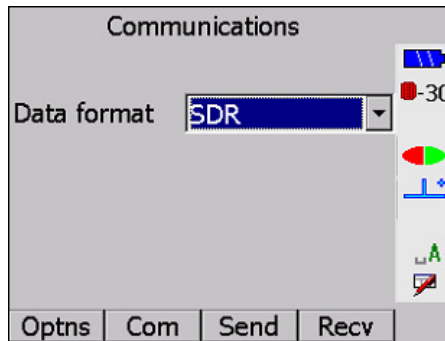
### Steps for specifying data formats

Complete the following procedure to specify an output format:

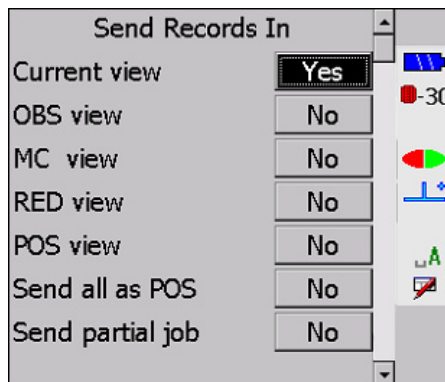
1. On the SETX, select **Communications** from the *Functions* menu.



- Set the **Data Format** field to **SDR**.



- Use [**Optns**] to specify the view for output. When you press this softkey the SETX displays:



- Select any of the following options to designate transfer procedures:
  - Individual views** - Set the views you want to **Yes** (current, OBS, MC, RED or POS). The current view is the view with which you selected to store the record; it is the first view you see in the database. If you set more than one view to **Yes**, the SETX will output more than one record for each observation record in the database. For example, if there is an observation record stored in RAW view, and the options are set so that current view is **Yes** and POS view is **Yes**, the SETX will transmit a raw observation record followed by a position record.
  - Send all as POS** - Setting the **Send all as POS** option to **Yes** allows you to output all job data in the **Mem to card** options: Printed output or COMMS output. Only the **POS** records in the selected job(s) will be output. These output files contain the latest **POS** record for all points obtained in the selected job(s). This differs from the output obtained by setting the **POS** view to **Yes**, where station (**STN**) records, back bearing (**BKB**) records, and so on, are still sent, but all the observation (**OBS** or **MC**) and reduced (**RED**) records are output as **POS** records.
  - Send partial job** - You can use the **Send partial job** option to indicate that you wish to send a portion of a job. If you set this option to **Yes**, you will be given the opportunity to send only part of a job. When you press any key, you automatically enter data review (as if you had pressed {**FUNC CTRL**} + {**0**}). Move through the job data to the position to start sending the data. When you press {**←**}, the currently highlighted record and all records after it will be output.
- Press {**←**}.

### 27.3 Specifying CSV file formats

If you want to import and export CSV files with the SETX, make sure the file follows the CSV format guidelines. You can use spreadsheet or any other program to create these files.

- The CSV file format must consist of an ANSI text file with one point per line:



---

```
[PointID] ,North,East [,Height [, Code]] CRLF
```

- The fields of the CSV file can be separated by comma, semicolon, or tab characters. Each line of the CSV file must end with a carriage return and line feed.
- The decimal separator for numeric values in the CSV file must be a period.
- Each line of the CSV file must have a **Point ID** field. The field may be blank, but must still be followed by a delimiter.
- Each line of the CSV file must have a **North** coordinate field as the second or third field, depending on the selected coordinate order. The **North** coordinate field may not be blank.
- Each line of the CSV file must have an **East** coordinate field as its third or second field, depending on the selected coordinate order. The **East** coordinate field may not be blank.
- Each line of the CSV file may have a **Height** coordinate field as its fourth field. The **Height** coordinate field may be blank, and must be present if the **Feature Code** field is present.
- Each line of the CSV file may have a **Feature Code** field as its fifth field. This field may be blank.

## 27.4 Converting Files

You can convert SDR files to different file formats that can be used with outside software programs, such as CAD packages. For example, you can use ProLINK to convert files. Refer to ProLINK documentation for more information.

## 27.5 Direct Communications - Transferring Data Files

Once you connect the cables between the SETX and a PC, you can use the PC's serial communications program to access the **Functions** menu on the SETX. This way, you can directly send and receive the data files between the instrument and the PC.

---

**NOTE** Refer to your PC's documentation for instructions specific to using a serial communications program.

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### 27.5.1 Sending data to a PC

The following procedure explains how to establish communication between the devices so that you can receive SDR files from the SETX.

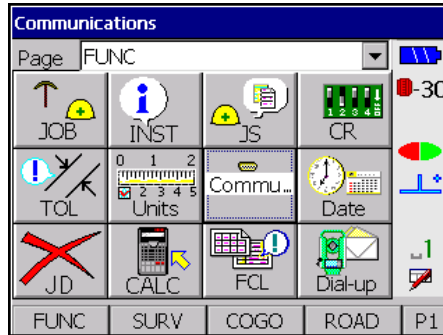
1. Connect the SETX to the PC.
2. On the PC, start the serial communications program and make sure the PC is set to the same baud rate and parity as the SETX; otherwise you cannot receive files from the SETX. You will see a message indicating the program is waiting for input.

---

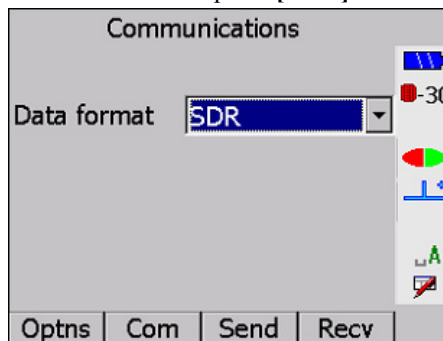
**NOTE** For more information, see Section 27.1, *Setting Communication Parameters*, Page 27-1.

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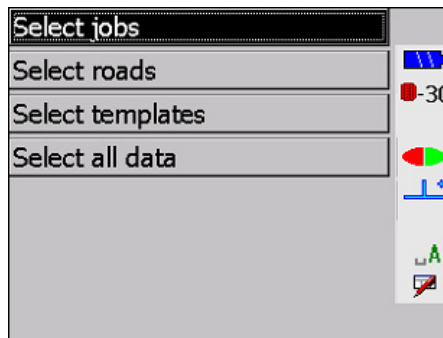
3. On the SETX, select **Communications** from the **Functions** menu.



4. Set the **Data Format** field to **SDR** and press [Send].



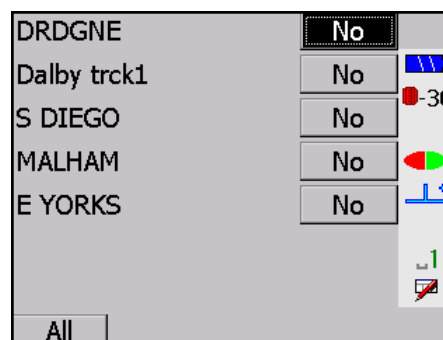
5. The SETX will display its standard job selection screen.



Choose **Select jobs**, **Select roads** or **Select templates** to select individual jobs, roads or templates. Press {←}.}

To send all jobs or data in your SETX, choose either **Select all data** or **Select jobs** and then press [All].

6. In the selection screen, set the option field(s) next to each item you wish to send to **Yes**.



7. Make sure the PC can receive data, then press {←}.

The SETX sends the selected jobs to the PC. The SETX will display a screen that shows how many records are being sent, while the PC's communications program displays a screen that shows how many files were received.

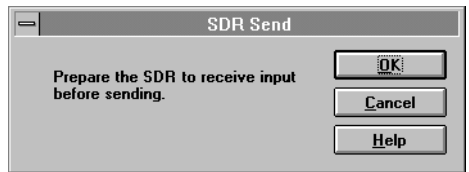
8. When the transfer completes, click **OK** in the PC's communication's program and press {ESC} on the SETX.

### 27.5.2 Receiving data from a PC

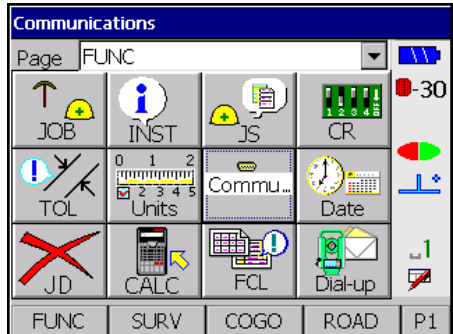
The following procedure explains how to establish communication between the devices so that you can send SDR files from a PC to the SETX.

1. Connect the SETX to the PC.
2. On the PC, start the serial communications program and make sure the PC is set to the same baud rate and parity as the SETX; otherwise you cannot transfer data. You will see a message indicating that the instrument should be ready to receive data.

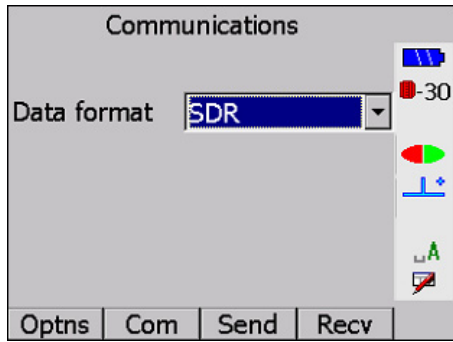
**NOTE** For more information, see Section 27.1, *Setting Communication Parameters*, Page 27-1.



3. On the SETX, select **Communications** from the *Functions* menu.



4. Set the *Data format* field to **SDR**.



5. Press [Recv]. The SETX will display a message, **Waiting for input...**

6. In the serial communications program on the PC, click **OK** or press **{←}**.

The PC will send the selected jobs to the SETX. The SETX will display a screen that shows how many records were received, while the communications program will indicate the file's transfer progress.

7. When the transfer completes, click **OK** in the communications program and press **{ESC}** on the SETX.

### 27.5.3 Assessing transmission problems

When transmitting data, the SETX responds to both hardware and software flow control. The receiving computer may periodically use either or both of these techniques.

You may see either the **Xon/Xoff Detected** (software control) or **CTS/RTS Detected** (hardware control) messages appear on the SETX's display.

If these messages do not disappear within a few seconds, the receiving computer may have stopped transmitting.

- Press **{ESC}** on the SETX to resume transmission.
- To abort transmission and start over (perhaps at a lower baud rate), press **{ESC}** again.

# Chapter 28

## SDR Database

### In this chapter

- Database conventions
- Database records
- Database messages

The SETX stores all observations, notes, and calculated results in an SDR database. This database is a list of records of different types, stored in chronological order. For example, each job's database starts with a **JOB** record that defines the job's name and continues with records stored in the order they were generated.

You have a complete record of your activities in the field. The only exception to chronological storage is the note record; you can insert a note record at any point in the database.

It is not possible to alter data once it has been stored except for code fields and note records. Since these two entries are not used for calculations, you can edit them.

The SETX has about 30 different record types that describe data such as station setup details, backsight orientation, target heights, observational measurements, and many others.

### 28.1 Searching During Calculation

Whenever the coordinates of a point are required, the SETX performs an intelligent search of the database. This search is described in Chapter 6, **Coordinate Search Logic**. Take the time to read this short chapter; you will find the search rules have important and useful implications.







### 28.2 Understanding SDR Database Records

This section describes the use of records in the database and the fields within each record.

Each record has a *derivation* code, a two-character code describing how the record was generated and which part of the SDR software generated the record. The derivation code is sometimes blank. Special derivation codes descriptions are included in the following discussion of records.







#### Apply super

This record defines superelevation at a particular station on the road.

Apply super		
Sta.ing	70.000	
L super	Horizontal	 -30
R super	Horizontal	
L widen	0.000	
R widen	0.000	
Pivot	Center	







**Atmos**

Atmospheric record. The two fields in this record define the temperature and pressure at the time of record generation. These values are used when atmospheric corrections are applied to observations. This record is generated after the station record only if you're applying atmospheric corrections.

Atmos	TP	
Pressure	1013.0	
Temperature	15.00	
		
		
		
		







**Bkb**

Back-bearing record. This defines the orientation correction for the current instrument setup. Fields list source point, target point, horizontal observation value from the instrument, and its corresponding azimuth. The orientation correction is the difference between the last two fields.

Bkb	TP	
Stn	1	
Pt	1100	
Azimuth	51°20'24"	
H.obs	81°57'28"	
		
		







**Circular VC**

This record is part of a road's vertical alignment; it defines a circular vertical curve (arc).

Circular VC		
Sta..ing	220.000	
EI	265.000	
Radius	300.000	
		
		
		







**Col**

Collimation record. Fields define the vertical and horizontal angle correction required to compensate for collimation error in the current instrument.

Collimation		CL
H.obs	0°10'09"	  -30
V.obs	-0°00'33"	  +
		 











**Define super**

This record specifies the limits of superelevation application.

Define super		
Start Sta	70.000	  -30
End Sta	776.000	  +
		 











**Horz align**

This record marks the start of a road's horizontal alignment definition. The end station field is filled in automatically by the SETX.

Horz align		
Start Sta	0.000	  -30
Azimuth	35°00'00"	  +
N	2651.000	 
E	3514.000	 
End Sta	51.000	 






**Horz arc**

This record is part of a road's horizontal alignment; it defines an arc.

Horz arc		
Sta..ing	10.000	  -30
Dist	210.760	  +
Radius	300.000	 
Azimuth	47°00'00"	 
		 







**Horz point**

This record is part of the road's horizontal alignment and specifies the coordinates of a point the alignment passes through.

Horz point		
Sta..ing	31.760	
N	3114.000	 -30
E	3155.000	
Azimuth	296°20'15"	
H.dist	688.479	







**Horz spiral**

This record is part of a road's horizontal alignment; it defines a portion of a spiral.

Horz spiral		
Sta..ing	99.239	
Dist	50.000	 -30
Radius	300.000	
		
		
		

**Horz straight**







This record is part of a road's horizontal alignment; it defines a straight section.

Horz straight		
Sta..ing	0.000	
Azimuth	55°01'00"	 -30
Dist	100.000	
		
		
		









**Instr**

Instrument record. The fields describe the type of instrument, and various instrument parameters. See Section 3.4.1.2, *Selecting instrument type*, page 3-14, for field descriptions.

Instrument		SET 2-way
EDM desc	SET3X	
EDM S/N	000000	
V.obs	Zenith	
		
		
		

**Job**

Job record. This record type appears once at the start of a job. It defines the name of the job, the type of point name (4-digit numeric or 14-character alphanumeric), and which corrections the SETX should apply.

Job		E YORKS
Point Id	Numeric (4)	
Record elev	Yes	
Atmos crn	No	
C and R crn	No	
Refract const	0.14	
Sea level crn	No	

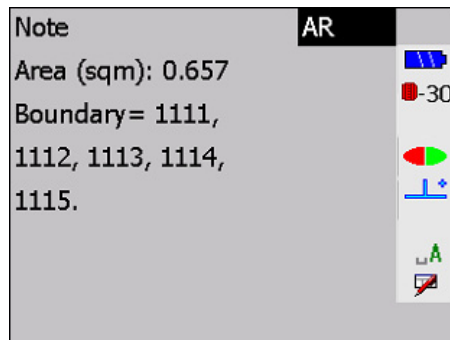
**Note**

Note record. This record type can appear anywhere in a job and contains a 60-character description that you entered with the keyboard. It is for informative purposes only and does not affect calculations. The contents of a note may be edited at any time, as described in Section 5.4, *Editing Notes and Codes*, Page 5-3.

Note		TS
Mar-11-06 01:17		
		
		
		
		
		

**Note AR**

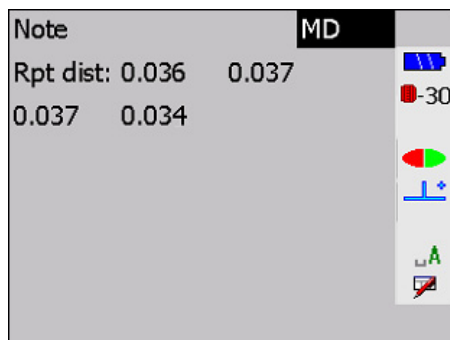
Note record showing area calculation.

**Note CP**

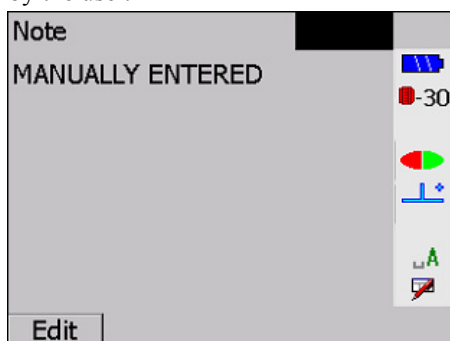
Note record showing correction parameters. Possible corrections are atmospheric, curvature and refraction, and sea level. Correction parameters are stored as part of the job record; this separate record is generated when a job with a 4-digit numeric point name is *printed or transmitted*.

**Note MD**

Note record showing the individual distance measurements from a multidistance observation is made using set collection. It is followed by an OBS record containing the average distance.

**Note NM**

Notes manually entered by the user.

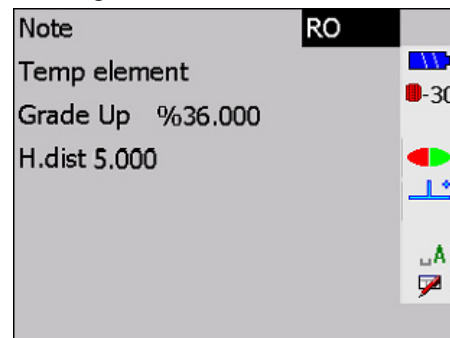


**Note OS**

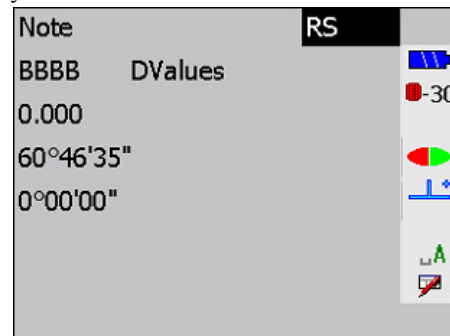
Note record generated by an offset observation. It contains the raw observation details and offset direction. It is generated before the observation record that contains measurements adjusted for the offset.

**Note RO**

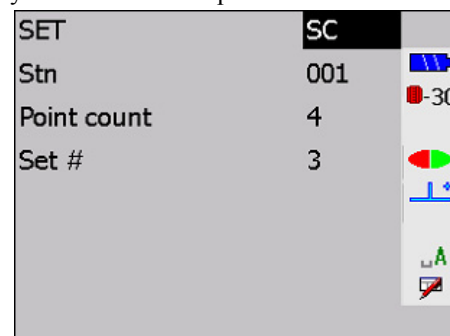
Note record generated in roading.

**Note RS**

Note record generated by the resection calculation.

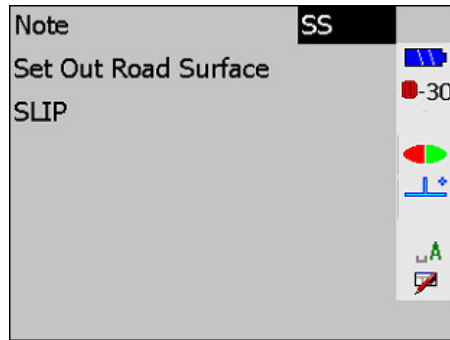
**SET**

Note record generated by the set collection procedure.

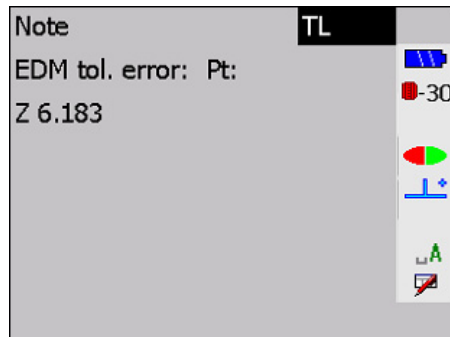


**Note Set Out Road Surface**

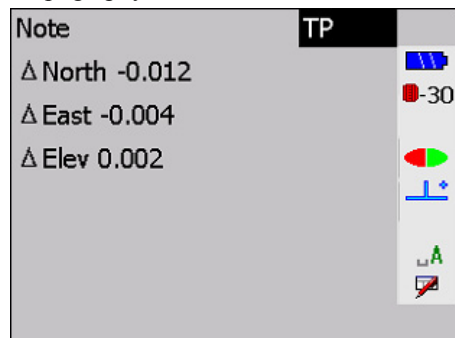
Note record generated when setting out road surface.

**Note TL**

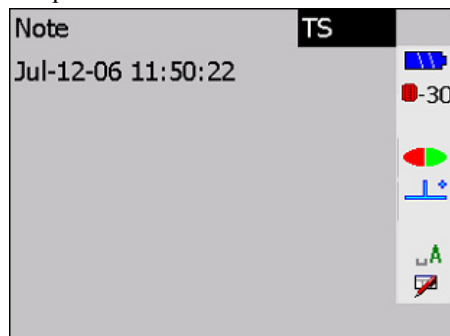
Note record generated whenever a tolerance error message is displayed, and the error is accepted.

**Note TP**

Note record generated in topography.

**Note TS**

Note record with a timestamp. It contains the date and time of the note creation.



**Note TV**

Note record generated by the traverse calculations. It lists information about how the calculation was performed.

Note	TV	
Δ Ang -25°25'17"		
Δ Dist 79.136		-30
Precision 5		

**Obs F1**

Observation record measured on instrument face one. This record contains a source point name, target point name, horizontal observation, vertical observation, slope distance, and descriptive code. The vertical observation (zenith or horizontal) depends on the type specified in the most recent instrument record. This record appears in review as **F1** but prints and transmits as an observation (**OBS**) record with an **F1** derivation code.

OBS	F1	
Stn	001	
Pt	1079	-30
H.obs	81°46'01"	
V.obs	88°10'05"	
S.Distance	10.256	
Cd	1100	
Edit	MC	Red Pos

**Obs F2**







Observation record measured on instrument face two. See **Obs F1** (above).

OBS	F2	
Stn	001	
Pt	1075	-30
H.obs	233°27'43"	
V.obs	271°53'36"	
S.Distance	10.106	
Cd	1100	
Edit	MC	Red Pos

**Obs MC**

Measured and corrected observation record. It defines a point-to-point vector from one point to another. This distance has had environmental corrections applied, such as target and instrument height, and atmospheric or other corrections. Fields include source point

name, azimuth, vertical angle (zenith), slope distance, and a descriptive code. These records appear in review as type **MC** but print and transmit as observation (**OBS**) records with an **MC** derivation code.







OBS	MC	
Stn	001	
Pt	0014	 -30
Azimuth	<Null>	
V.ang	102°50'02"	
S.Distance	20.600	
Cd	Z	
<input type="button" value="Edit"/> <input type="button" value="Red"/> <input type="button" value="Pos"/>		

### Offset

The Offset record contains the value used for the offset.






### Parabolic VC

This record is part of a road's vertical alignment; it defines a parabolic vertical curve.

Parabolic VC		
Sta .ing	30.000	
EI	125.000	 -30
Length	100.000	
  		

### Pos

Position record. This record contains a point name, the point's coordinates, and a descriptive code.

POS	K1	
Pt	SL99	
N	2555.000	 -30
E	2346.200	
EI	324.210	
Cd	<No text>	
<input type="button" value="Edit"/>		







**Rchk**

Road check. This record defines a point on a road by station and offset, not coordinates. It also contains fields showing the difference between the station and offset set out and the design point's station and offset.

Road chk	RO	
Pt	1038	
Sta...ing	44.000	
ΔSta	3.545	
Offset	-4.148	
ΔOffset	0.000	
EI	0.254	
ΔElev	-0.785	
Cd	L Sideslope	
<input type="button" value="Edit"/>		







**RED**

Reduced record. These fields define a point-to-point vector. Source point name, target point name, azimuth, horizontal distance, vertical distance, and a descriptive code are listed. An observation record in reduced (**RED**) view looks the same as a **RED** record.

RED	TP	
Stn	1	
Pt	1088	
Azimuth	353°34'56"	
H.dist	3.722	
V.Distance	0.098	
Cd	Z	
<input type="button" value="Edit"/>	<input type="button" value="Obs"/>	<input type="button" value="MC"/>
<input type="button" value="Pos"/>		






**Rd**

This record marks the start of a road definition. It contains the name of the road.

Road		
ID	SLIP	
		
		
		
		
		

**Road pos**

Road position. Like a position record, this record defines the position of a point but also includes the station and offset of the point relative to the current road definition.

Road pos	RT	
Pt	1079	
Sta..ing	2.678	
Offset	3.515	
N	0.046	
E	0.252	
EI	0.018	
Cd	Z	
<input type="button" value="Edit"/>		







**Road stn**

Road station. This record defines the position on which the instrument was set up (similar to a station record). In addition to the standard station fields, it lists the station and offset of the point relative to the current road definition.

Road stn	RO	
Stn	0	
N	0.455	
E	-4.148	
EI	1.254	
Sta..ing	0.000	
Offset	0.000	
Road	SLIP	
Theo ht	1.100	
Cd	Slip temp	
<input type="button" value="Edit"/>		

**Scale**







Scale factor record. The field specifies a plane scale factor. Only one scale factor record is generated per job.

Scale		
S.F.	1.00000000	
		
		
		
		
		









**SET**

Set of observations record. Fields indicate the start of a group of observations measured using the set collection procedure. The fields in the record define the station point name, set identification number (unique for the station), and a count of observations. Another field in this record is the word *BAD*, which you can use to indicate an inaccurate set of data.

SET	SC	
Stn	001	
Point count	4	 -30
Set #	3	 
		 







**Stn**

Station record. This contains a point name, point coordinates, height of the instrument set up on the point, and a descriptive code. A station record is entered in the database whenever you set up on a different point.

Stn	TP	
Stn	1093	
N	0.024	 -30
E	0.085	
EI	0.555	
Theo ht	1.500	
Cd	PST	
Edit		







**Target**

Target height record. This record specifies the height of the target pole (defined as the distance from the point on the ground to the center of the prism).

Target ht	1.200	
		
		 -30
		
		
		 







**Temp**

This record marks the start of the definition of a road cross-sectional template. The template definition is independent of any specific road.

Template		
ID	MAIN TMP	  -30    







**Temp element**

This record is part of a road template, it defines a point on the cross-section.

Temp element		
Grade	%75.000	  -30    
H.dist	0.800	
V.Distance	0.600	
Offset	4.100	
HtDiff	1.460	
Apply super	No	
Apply widen	No	
Cd	<No text>	







**Temp-Sideslope**

This record is part of a road template; it defines the grades for sideslopes at the edge of the road.

Templ-Sideslope		
Cut	%80.000	  -30    
Fill	1.760	







**Vert align**

This record marks the start of a road's vertical alignment definition.

Vert align		
Sta...ing	10.000	
El	65.970	
		
		
		
		







**Vert point**

This record is part of a road's vertical alignment and specifies the station and elevation of a point that the alignment passes through.

Vert point		
Sta...ing	605.000	
El	21.000	
		
		
		
		

**X section**

This record is part of a road definition; it defines which cross-sectional templates to use from a particular station along the road.

X section		
Sta...ing	11.110	
Lt. Template	MAIN TMP	
Rt Template	MAIN TMP	
		
		
		

## 28.3 Understanding Database Messages

Some common database messages include the following:

**Input accepted**

This message appears when a new record is stored and is accompanied by a musical tone sequence.

**Memory nearly full**

This message displays when there is room left for about 15 observation records. You should finish the observations from your current station setup and then delete old or unnecessary data.

**NOTE** Survey jobs must be printed or transmitted before they are deleted.

---

**Memory is full**

This message displays when the memory is full, and you cannot continue SETX operation. The SETX automatically returns you to the front screen of the program; the only operations you can perform are printing, transmitting and deleting of jobs, roads, or templates.

# Chapter 29

# Observational Calculations

### In this chapter

- Instrument, environmental, and job-related corrections
- Geometric reductions
- Miscellaneous calculations

This chapter presents the formulas and constants used by the SETX for calculations. In addition to this information, it is also important to understand the principles described in Chapter 6, **Coordinate Search Logic**, because these principles can affect the outcome of coordinate calculations.

## 29.1 Correction Categories and Order of Application

The SETX performs several corrections to readings as it converts them from the information on the instrument's screen to a **POS** record. These corrections can be grouped into two general categories:

- Instrument, environmental and job-related corrections
- Geometric corrections

Instrument corrections include equipment configuration, Face1/Face2 observations, collimation and prism constant. Environmental corrections include pressure and temperature corrections. Job-related corrections include orientation, instrument height reduction, and target height reduction.

Geometric corrections include such things as curvature and refraction, slope reduction, sea level, and projection.

The SETX always applies corrections in a specific sequence as it converts a raw observation to coordinates. The instrument, environmental, and job-related corrections are applied first, followed by the geometric corrections.

This sequence is shown in Figure 36.

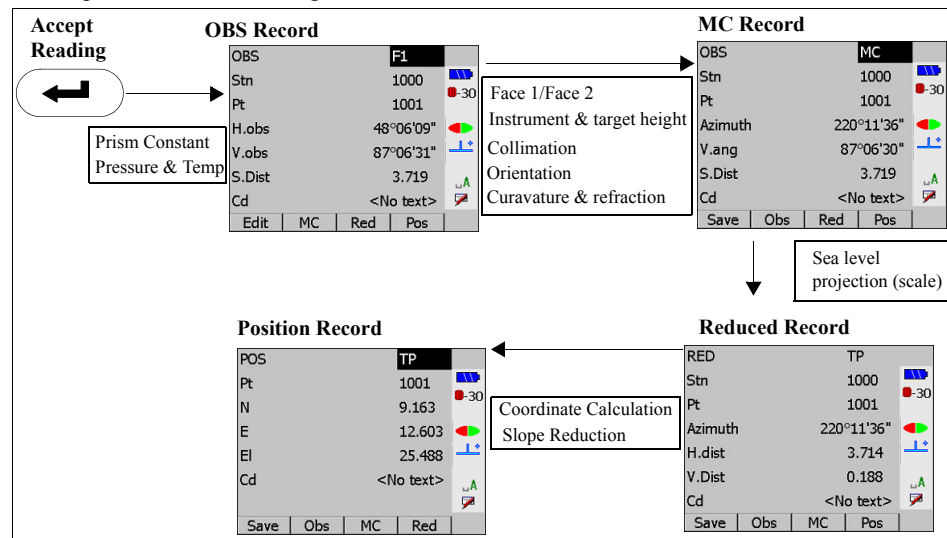


Figure 36: Corrections sequence

The SETX applies the prism constant and atmospheric parts per million (PPM) corrections before the reading is displayed on the SETX screen. This reading can be from the instrument or it could be manually input from the keyboard.

The SETX applies six different corrections when it converts an **OBS** record to a measured and corrected (**MC**) record. The order is face one/face two, instrument and target height, collimation, orientation, arc curvature, and refraction.

The SETX corrects for sea level, projection and scale when converting an MC record to an reduced (**RED**) record. The final step in arriving at coordinates (**POS** record) is a mathematical coordinate calculation.

The equipment configuration for the following discussion of corrections is shown in Figure 37, Page 29-2. In this configuration, the EDM is distinct from the theodolite, and the prism is distinct from the theodolite target.

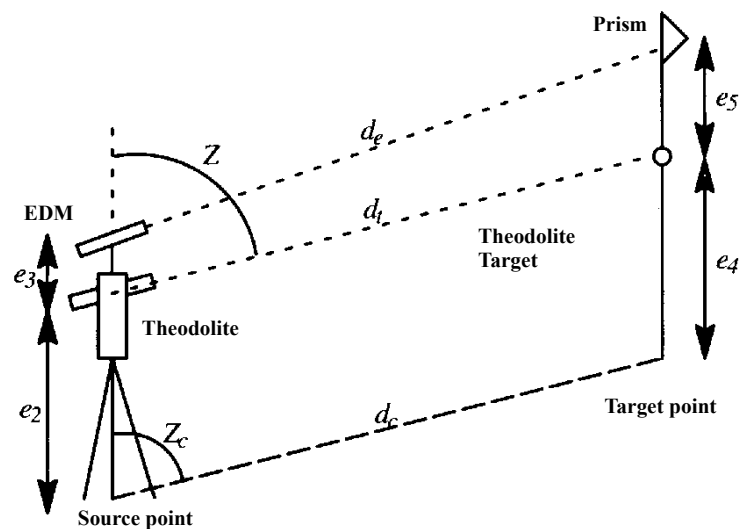


Figure 37: An instrument configuration

$e_1$	Prism constant	$d_e$	EDM slope distance
$e_2$	Theodolite height	$d_t$	Theodolite slope distance
$e_3$	EDM offset	$d_c$	Slope distance, source to target point
$e_4$	Theodolite target	$Z$	Theodolite vertical angle
$e_5$	EDM reflector offset	$Z_c$	Corrected vertical angle

Using the SETX with a simple prism on a pole, the EDM and theodolite are coincident; the prism and theodolite target are also coincident. In other words,

$$\begin{aligned} e_3 &= 0 \\ e_5 &= 0 \\ d_e &= d_t \end{aligned}$$

## 29.2 Instruments, Environmental and Job-Related Corrections

This category of corrections includes the following:

- Prism constant corrections
- Pressure and temperature corrections
- Face one/face two corrections
- Instrument and target height reductions
- Collimation corrections
- Orientation corrections

### 29.2.1 Prism constant correction

This correction is applied to all slope distances:

$$S_2 = S_1 + e_1$$

<b>S<sub>1</sub></b>	=	Measured slope distance
<b>e<sub>1</sub></b>	=	Prism constant
<b>S<sub>2</sub></b>	=	Resulting slope distance

---

**NOTE** Prism constants are usually negative.

---

### 29.2.2 Pressure and temperature correction

Pressure and temperature corrections are not applied in Program mode.

### 29.2.3 Face 1/Face 2 corrections

The vertical angle measurement (defined in the instrument record's *V. obs* field) is converted to an equivalent zenith angle. The derivation of the raw observation is determined as follows:

- If the vertical observation is in the range 0° to 180°, the derivation is **F1** (face one). If it is in the range 180° to 360°, the derivation is **F2** (face two).
- If the vertical angle observation is not present, the derivation is assumed to be **F1**.
- If the vertical observation falls outside the range 0° to 180°, it is converted to an equivalent angle within the range.
- If the derivation code is **F2**, it is assumed the telescope was reversed, so 180° is added to the horizontal observation for horizontal angle calculations.

### 29.2.4 Instrument and target height reduction

Corrections for instrument and target heights are applied to uncorrected measurements of vertical angle and slope distance. In the next equations, these variables represent the following:

<b>e<sub>z</sub></b>	=	Theodolite height
<b>e<sub>4</sub></b>	=	Theodolite target height
<b>d<sub>t</sub></b>	=	Theodolite slope distance

The vertical angle from the source point to the target point ( $Z_c$ ) is given by:

$$Z_c = \tan^{-1} \frac{d_t \sin Z}{d_t \cos Z + e_2 - e_4}$$

The slope distance from source point to target point ( $d_c$ ) is given by:

$$d_c = \frac{d_t \sin Z}{\sin Z_c}$$

### 29.2.5 Collimation correction

The instrument collimation error, determined from the collimation program, is applied in the following manner:

$$\begin{array}{ll} \textit{Face one:} & a_2 = a_1 + V_c \quad b_2 = b_1 + H_c \\ \textit{Face two:} & a_2 = a_1 - V_c \quad b_2 = b_1 - H_c \end{array}$$

<b>a<sub>1</sub></b>	=	Measured vertical angle
<b>a<sub>2</sub></b>	=	Corrected vertical angle
<b>b<sub>1</sub></b>	=	Measured horizontal angle
<b>b<sub>2</sub></b>	=	Corrected horizontal angle
<b>H<sub>c</sub></b>	=	Horizontal collimation correction
<b>V<sub>c</sub></b>	=	Vertical collimation correction

### 29.2.6 Orientation correction

If you have completed the normal procedure for establishing a backsight, an orientation correction is applied to the horizontal angle observation:

<b>A</b>	=	Azimuth of the observation
<b>H</b>	=	Horizontal angle (circle reading) of the observation
<b>BKB<sub>azmth</sub></b>	=	Azimuth field of the applicable backbearing record
<b>BKB<sub>h.obs</sub></b>	=	Horizontal angle observation (circle reading) field of the applicable backbearing record

$$A = H + \text{BKB}_{\text{azmth}} - \text{BKB}_{\text{h.obs}}$$



### 29.3 Geometric Reductions

The following geometrical reductions and corrections may be applied to observations by the SETX.

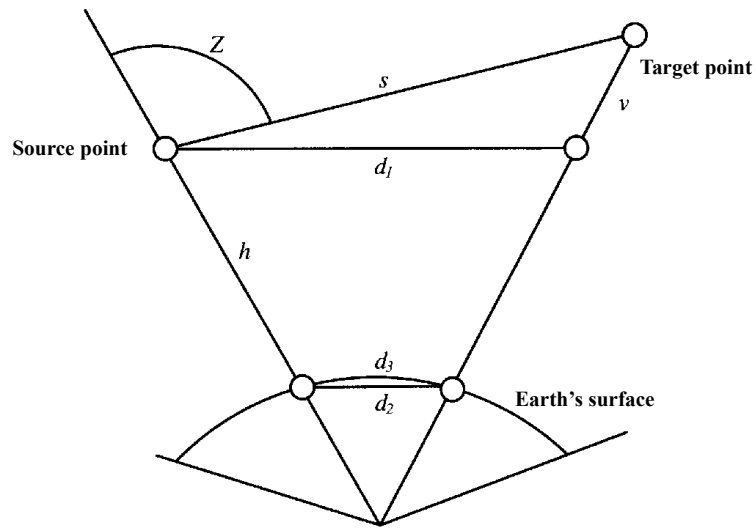


Figure 38: A reference figure for some of the reductions

<b>Z</b>	=	Zenith angle
<b>v</b>	=	Vertical distance
<b>h</b>	=	Elevation of source point
<b>s</b>	=	Slope distance
<b>d<sub>1</sub></b>	=	Horizontal distance at elevation of source point
<b>d<sub>2</sub></b>	=	Sea level chord
<b>d<sub>3</sub></b>	=	Spheroidal arc
<b>d<sub>4</sub></b>	=	Projected distance (not shown)

#### 29.3.1 Curvature and refraction correction

The following correction is applied to vertical angles if the curvature and refraction correction field (**C and R crn**) is set to **Yes** during job creation.

$$a_3 = a_2 - \frac{(1-k)S_3}{2R} \times \frac{180}{\pi}$$

<b>k</b>	=	Coefficient of terrestrial refraction (either 0.14 or 0.20 as selected when the job was created)
<b>R</b>	=	Approximate spheroid radius of 6,370,000 (meters)
<b>S<sub>3</sub></b>	=	Slope distance from Section 29.2.2, <i>Pressure and temperature correction</i> , Page 29-3
<b>a<sub>2</sub></b>	=	Vertical angle from Section 29.2.5, <i>Collimation correction</i> , Page 29-4
<b>a<sub>3</sub></b>	=	Corrected vertical angle (units=degrees)

#### 29.3.2 Sea level correction

If the sea level correction field is **Yes** during job creation, the horizontal distance at the source point's elevation is reduced to the sea level chord (**d<sub>2</sub>**) using the mean height of the

vector:

<b>d<sub>1</sub></b>	=	Horizontal distance at the elevation of the source point
<b>h<sub>1</sub></b>	=	Elevation of the source point
<b>h<sub>t</sub></b>	=	Elevation of the target point
<b>R</b>	=	Radius of the spheroid

$$d_2 = d_1 - \left[ \frac{(h_1 + h_t)d_1}{2R} \right]$$

Reduction of the sea level chord ( $d_2$ ) to the spheroidal arc ( $d_3$ ) involves a correction of the following:

$$\frac{d_2^3}{24R^2}$$

<b>R</b>	=	Radius of the spheroid
----------	---	------------------------

This correction exceeds 1mm only on distances greater than 9.9km. Consequently, the correction term is ignored and the spheroidal arc is taken to be the sea level chord:

$$d_3 = d_2$$

### 29.3.3 Projection correction

The correction of the spheroidal arc ( $d_3$ ) to a projected distance ( $d_4$ ) depends on the projection used. Because the locally used projection is not known by the SETX, a simple scale factor is used. The value of the scale factor is specified during job creation. For short and medium distance EDM work, this provides sufficient accuracy. The projection correction is as follows:

<b>sf</b>	=	Scale factor in the current scale record
-----------	---	--

$$d_4 = d_3 + sf$$

### 29.3.4 Slope reduction

Refer to Figure 38 to better understand this reduction. The horizontal and vertical components ( $d_1$  and  $v$ ) of an observation are found from the vertical angle (zenith distance) and slope distances by the following:

<b>d<sub>1</sub></b>	=	Ssin(Z)
<b>v<sub>1</sub></b>	=	Scos(Z)
<b>Z</b>	=	Zenith angle
<b>S</b>	=	Slope distance

## 29.4 Other Formulas

The two formulas covered in this section include:

- Coordinate calculation
- Inverse calculation

### 29.4.1 Coordinate calculation

Coordinate calculation is the last step in converting an **OBS** record to coordinates, a **POS** record. The coordinates of a target point are calculated from observed measurements and the coordinates of the source point:

$$N_2 = N_1 + d_4 \cos(A)$$

$$E_2 = E_1 + d_4 \sin(A)$$

$$Z_2 = Z_1 + v_4$$

The results are null if the source point coordinates are unknown.

<b><math>N_1, E_1 \&amp; Z_1</math></b>	=	coordinates of the source point
<b><math>N_2, E_2 \&amp; Z_2</math></b>	=	coordinates of the target
<b><math>d_4</math></b>	=	projected distance between the two points
<b><math>A</math></b>	=	azimuth
<b><math>v_2</math></b>	=	vertical distance

### 29.4.2 Inverse calculation

The distances and angles associated with a line between two points are calculated from the coordinates of those points as follows:

$$v = Z_2 - Z_1$$

$$A = \tan^{-1} \left[ \frac{E_2 - E_1}{N_2 - N_1} \right]$$

$$a = \tan^{-1} \left[ \frac{h}{v} \right]$$

$$h = \sqrt{(N_2 - N_1)^2 + (E_2 - E_1)^2}$$

$$S = \sqrt{\frac{((h^2 + v^2)R) / \left(R - \frac{Z_1 + Z_2}{2}\right)}{sf}}$$

<b><math>N_1, E_1</math> &amp; <math>Z_1</math></b>	=	coordinates of the source point
<b><math>N_2, E_2</math> &amp; <math>Z_2</math></b>	=	coordinates of the target point
<b>v</b>	=	vertical distance from source to target point
<b>A</b>	=	azimuth of the line
<b>a</b>	=	zenith angle of the line
<b>h</b>	=	elevation of the source point
<b>S</b>	=	slope distance at the height of the station with slope reduction, sea level correction, and projection correction applied in reverse
<b>R</b>	=	radius of the spheroid
<b>sf</b>	=	scale factor

**Already a polygon**

Points cannot be appended to a traverse list that already specifies a polygon.

**Already exists**

The azimuth, azimuth and distance, or observation keyed in already exists.

Ansermet < 2 No Redundancy caution

**Area too large**

The area you attempted to subdivide is larger than the original polygon.

**Bad record order**

An invalid SDR file has been detected during comms input.

**BS azimuth not found**

An azimuth to the backsight point cannot be found. Key in the azimuth or coordinates for the backsight.

**BS bearing not found**

A bearing to the backsight point cannot be found. Key in the bearing or coordinates for the backsight.

**BS must be included**

You must include the backsight point when entering the list of points for set collection.

**BS not required**

The backsight point does not need to be entered during set collection by direction.

**Cancel input**

You canceled comms input.

**Cancel output**

You canceled comms output.

**Checksum error**

A checksum error occurred during comms input, or while loading a language file.

**Code fields too long**

The code fields may not total more than 16 characters, including a space between each field.

**Code too long**

The selected feature code will not fit into the remaining space.

**Communications error**

A general communications error has occurred. Examine your cabling, connections, and switches. Also check that the baud rates and parities are consistent between the SETX and the other instrument or computer.

**Computation of position not successful**

Add more target points in positioning program. Too few target points were included from which to compute the unknown station position. Additional, non-identical target points should be added.

**Curve overlap**

The vertical curve overlaps with the previous one.

**Diverging azimuths**

An intersection was attempted but failed because the azimuths did not converge.

**EDM error**

The instrument failed to take a distance reading.

**EDM tol. error**

The distance is not within the specified tolerance.

**Empty list**

An attempt was made to set out a road or review a template, but the job contains no roads or templates.

**Error receiving**

An error occurred during comms input.

**FC creation failed**

Creation of a file for feature coding failed. This message may imply that memory is nearly full.

**H.obs tol. error**

The horizontal angle is not within the specified tolerance.

**Illegal Shape**

The specified polygon in area calculation has crossing vertices.

**Input interrupted**

Loading of a language file was interrupted.

**Input not allowed**

Input is not allowed in this field.

**Instr read aborted**

You canceled an instrument reading.

**Internal math error**

An internal math error occurred.

**Invalid input**

The data in the field is invalid.

**Invalid OBS in set**

A comms input set contains a POS, RED, or MC instead of an OBS.

**Invalid set**

A comms input set has an invalid structure.

**Invalid:same as stn**

The point must be the same as the current station.

**Invalid:same coords**

Two points can not have the same coordinates in a polygon (Areas program). An illegal shape results.

**Invalid:same points**

The source and destination points must be different.

**Job limit exceeded**

The maximum number of jobs already exists.

**Limitation of target points exceeded**

The maximum number of target points has been exceeded. Computation of unknown station position will still be computed if possible.

**Linear**

The three points selected to define a plane in Building face survey are colinear, and do not uniquely define a plane.

**Mem nearly full**

This message appears when the remaining space will allow less than 15 observations.

**Memory is full**

The RAM disk is full. You should output and then delete unnecessary jobs to create more memory space.

**Missing BS obs**

In the occupied stations list in traverse, no backsight observation from the new station to the previous station exists.

**Missing dist/ang to (point)**

The traverse has degenerated due to lack of a distance or horizontal angle from one station to the next.

**Missing FS Obs**

In the occupied stations list in traverse, no observation to this point from the previous station exists.

**Must be on boundary**

On a fixedpoint subdivision, the fixed point **MUST** be on a vertex of the polygon.

**Name already exists**

The job name entered already exists.

**Need 1 foresight**

You must include at least one foresight point in the list of points for set collection.

**Need 2 resection obs**

Resection needs at least two observations.

**No current job**

The comms input has no job record, and a job is not open to which to add it.

**No Elev in this Job**

The Remote elevation program requires a job with Record Elev set to **Yes** when it was created.

**No fixed close coords**

The traverse was unable to close on any fixed coordinates.

**No instr response**

The instrument is not responding.

**No more obs to point in set**

No more observations were made to the point in the current set (from the current station).

**No more points in set**

No more points were observed in the current set (from the current station).

**No more points to review**

No more points were observed in sets from the current station.

**No more sets to review**

No more sets were recorded for the current station.

**No sets exist for station**

No sets were recorded for the given station.

**No solution**

The requested intersection calculation has no solution.



**North/East is null**

The Northing or Easting field of the given coordinate is null.

**Not connected**

The comms port could not be opened, no connection was made.

**Not on traverse**

Not enough information exists at two independent stations to form a traverse route.

**Null elevation**

A point was selected to define a building face plane that does not have an elevation (the elevation is Null).

**Null position**

A point was selected to define a building face plane that does not have a northing or easting value (the northing or easting is Null).

An attempt was made to set out a point with a null Northing or Easting, or a POS record could not be stored because it was null.

**Null not allowed**

A value must be entered in this field.

**Offset too small**

You cannot define templates that fold back.

**Parallel Azimuths**

An intersection failed because the specified azimuths were parallel.

**Point exists**

Coordinates for the point already exist.

**Print or send first**

Before a job can be deleted from the SETX's memory, it must be printed or output via the comms connection.

**Pt already on route**

The station is already on the traverse list and is not the first station.

**RAM disk error**

An error occurred while writing to or reading from the RAM disk.

**Road empty**

The road selected for setting out, road topo or road set out surface has no horizontal alignment defined.

**Search failed**

The point does not exist.

**Station North/East is null**

The Northing or Easting (or both) of the given station is (are) null.

**Station Not Found**

In the list of occupied stations in traverse, the station does not exist in the database.

**Super overlap**

The superelevation that you are trying to define overlaps with an existing superelevation definition.

**There are no entries**

You cannot delete, print out or output jobs when none exist.

**Tilt error**

A reading failed because the SETX reported a tilt error.

**Timeout**

A timeout occurred during communications. Check your cable connections and switches. If timeout occurred after successful initiation of communications, make sure the connected device is handling flow control correct. Using a lower baud rate may solve the problem.

**Too few points**

At least three points must be specified before the polygon area will be calculated.

**Too large**

The value entered is too large for its intended use.

**Too many files**

Too many files have been created in a directory.

**Too many points**

An attempt was made to enter too many points into the list of preentered points in set collection.

**Too many sets**

More than 50 sets were recorded from the current station. Some of these (the most recent ones) will NOT be used to produce averaged MC records.

**Too many sets to review**

A maximum of 50 sets may be reviewed for a given station at any moment in time.

**Traverse is full**

The traverse occupied stations list has exceeded 250 stations.

**Too small**

The value entered is too small for its intended use.

**Undef Station**

The station specified for setting out is outside the horizontal alignment.

**Unequal scales**

The scale factor of the road definition and the current job are not the same.

**Unknown Point**

The specified point was not found (its coordinates were not specified in the current job).

**Unknown template**

A template used in the road definition selected for setting out is not known.

**V.obs tol. error**

The vertical angle is not within the specified tolerance.

**Wrong face**

The SETX expected an observation on one face (from a total station), but the observation was made on the other face.

**Xoff detected**

Comms output has paused because an Xoff character was received.

**Zero not allowed**

Zero is not a valid value for this field.

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