Electronic Field Book®

SDR33

Reference Manual

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Welcome

Welcome to SDR® software, Sokkia's complete field surveying solution. This introduction will give you a tour of SDR functionality and this reference manual, including:

- A brief introduction to the SDR
- Contents and organization of the manual
- Manual conventions
- How to get support for your Sokkia SDR

SDR software is compatible with the complete range of Sokkia instruments, including total stations, levels, and GPS receivers, and supports many non-Sokkia instruments as well. The SDR increases efficiency of your instrument for traversing, topographic surveys, setting out, and leveling.

The SDR software contains a full range of surveying applications that use electronically transmitted data from various Sokkia instruments to quickly obtain desired results. These applications range from topography, coordinate geometry functions, and roading capabilities. Data collection can be accomplished with topography, resection, positioning and remote elevation. Coordinate geometry functions include Set Out Coords, Lines and Arcs as well as Areas, Intersections and Transformations.

Advanced roading options in the SDR33 enable you to define horizontal and vertical road alignments, or load the alignments from a computer. You can then set out the road by station and offset, including catch points. The SDR33 supports tangents, circular arcs, and spiral curves in the horizontal definition and straight grades and parabolic curves in the vertical definition.

Using this Reference Manual

This reference manual explains how to unpack, set up, use, maintain, service and store your new SDR33.

It may be tempting to try the SDR33 with little instruction. If you do, it is recommended you practice first in a parking lot or backyard before you attempt a large, complex job. Reading about your SDR will lead to better understanding of how your new partner can work for you and eliminate unnecessary frustration.

This reference manual is organized in the order you probably will use the information. However, you may want to read the chapters in a different order. The SDR manual has been divided into sections to make it easier to find information about related functions.

The following section summaries and the table of contents are your road map to SDR information. If you are a new SDR33 user, you may want to read Section 1 before using your SDR33. If you are an experienced user, you may want to read a particular section or chapter for information about a specific option.

Section 1, *Getting to Know Your SDR,* is designed as an introduction to the SDR33. Understanding this section will aid you in using your SDR33 and provide basic instruction on SDR functionality. This section also includes information about customizing your SDR33 to meet specific survey needs or desired workflows.

Section 2, *Performing Surveys***,** gives you the basic information to start a survey job. This section walks you through starting a job, specifying job settings, setting up an instrument, determining Configure Reading parameters and establishing tolerances. Additional chapters instruct you in setting up a station and backsight, taking a reading, observing offsets and using the Resection and Professional Positioning options.

Section 3, *Coordinate Systems,* provides an overview of coordinate system calibrations and procedures on how to work with selectable coordinate systems when preparing survey jobs.

Section 4, *Topography* is a basic introduction to Topography and Remote Elevation. This section will explain the basics about topography and its relation to the SDR33. The Remote Elevation chapter shows you how to take observations of points that you cannot access directly.

Section 5, *Traverse***,** demonstrates how you can use the SDR33 to perform and adjust a traverse. The SDR33 can perform a single collection traverse or use observation sets to increase a traverse's accuracy. Several special cases you may experience when working with traverses are also detailed in this section.

Section 6, *Construction Stake Out***,** gives you step by step instructions for setting out coordinates, lines and arcs.

Section 7, *Roading***,** explains how to create a road, use a template, the differences between string and alignment roads and their corresponding elements. Setting out roads and road surfaces is detailed in separate chapters as well as road topography.

Section 8, *Additional Survey Processes***,** explores additional topics including Cross-section Surveying, Taping from Baselines, Point Projections and Building Face Surveys. Each chapter contains detailed instructions on using the option including processes that can make your surveys more efficient and accurate.

Section 9, *Leveling***,** is a basic introduction to the SDR33 Leveling program.

Section 10, *Coordinate Geometry*, shows you how to use the COGO functions to solve difficult surveying problems. The Transformation chapter explains how to use Helmert and linear transformations to correct survey data.

Section 11, *SDR Fundamentals,* details specific information about the SDR database, describes how to transfer data with the Communications option and instructs how to use the keyboard to manually enter coordinates, azimuths and elevations. SDR

Fundamentals also includes information about creating and using feature codes and attributes, operating the pop-up calculator, and measuring collimation error.

Section 12, *Appendices***,** is your complete reference guide to instrument settings, system messages and observation calculations. The **Database Records** Appendix lists all of the SDR database records and associated fields. You can also find an appendix about running a user program on the SDR33. Definitions for unfamiliar terms can be found in the **Glossary**.

Understanding Documentation Conventions

The following conventions are used in this manual:

Keys you are to press are enclosed in angle brackets, for example, **<Func>** and <↑>. If you are to press multiple keys to initiate an action, the combination will be shown with a plus sign between the keystrokes; for example, **<Func>** + **<**↑**>**.

A menu bar selection followed by a menu selection is shown in boldface in the format ***Menu bar item /*** **Menu item**, like this example, ***FUNC /*** **Job**.

The term “total station” refers to the Sokkia set series of electronic tacheometers.

The term “Electronic Field Book” refers to the Sokkia (or Sokkisha / Lietz) SDR2, SDR20, SDR22, SDR24, SDR31 or SDR33 models of electronic survey data collectors.

Typefaces

Typefaces and icons are used in this manual as follows:

Main Menu ... Indicates field identifiers, menu options, unit names, variables, and functions.

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>**

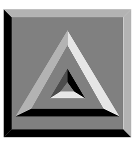
`Print`........... Represents reports or output to a printer.

✉ Indicates that adjoining text explains previous text.

Icons

Icons are used in this manual to represent the following:

Indicates adjoining text is either a printed report or text from a disk file.



Indicates important information or warning information concerning adjoining text.

Accessing Technical Support

Technical support is available from your distributor. You also may contact the appropriate Sokkia subsidiaries listed below. Sokkia and Point, Inc., welcome written communications regarding products. Use the address on the back of the title page of this manual.

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1

Getting to Know Your SDR®

This section is an introduction to the SDR. Understanding this section will aid you in using your SDR and provide basic instruction on SDR functionality. This section also includes information about customizing your SDR to meet specific survey needs or desired workflows.

Software Overview

- *Pre-Survey Operations*
- *Performing Survey Operations*
- *Post-Survey Operations*

SDR33 Hardware

- *Turning the SDR33 On*
- *Turning the SDR33 On*
- *Performing a Warm Boot*
- *Performing a Cold Boot*
- *Accessing the Batteries*
- *Storing the SDR33*
- *Servicing the SDR33*
- *Performing within Environment*

Basic Operations

- *Reviewing the Welcome and Home Screens*
- *Using the Keyboard*
- *Understanding the SDR Menu Structure*
- *Customizing the SDR Software*
- *Entering Data*
- *Understanding System Messages*

System Management

- *Reviewing Hardware, System and Configuration Settings*
- *Setting the Date and Time*
- *Selecting a Default Language*
- *Upgrading Software, Languages and Functionality*

Chapter 1 Software Overview

The SDR® Electronic Field Book® is designed with you in mind. All options use the standard SDR33 functionality making surveying simple and efficient.

SDR functionality is designed to make survey data collection and management efficient. It increases productivity of your instrument for topographic surveys, setting out and Cogo operations. It is also a convenient link to Sokkia Software, office-based mapping and design programs, and other software packages.

1.1 Pre-Survey Operations

Successful surveys begin with set up operations. The SDR33 leads you through each step of the setup process quickly and easily.

Project Management

All projects are managed within the context of a job which is stored in the SDR database. Settings are remembered from job to job, so it is unnecessary to set them for each new job. If you are performing an initial traverse operation and then returning for detail pick up, there is no need to switch between jobs.

Station Setup

Before taking a reading, you are prompted for a station setup and confirmation of a station and backsight. You can supply coordinates by selecting a point previously observed with a total station or by direct keyboard input. Coordinates or azimuth are required, but they do not need to be known.

Coordinate Systems

With the added functionality of selectable coordinate systems, the SDR33 provides a seamless transition between GPS/RTK and total station operations. You can designate coordinate systems during job creation.

Instrument Selection

The SDR33 works with a variety of total stations, levels, and other instruments. You can change instruments as often as necessary.

The settings established in the ***Instrument Setup*** screen are stored with your job file. Whenever you change instruments, the SDR33 will store a new instrument record with the new instrument type and associated settings.

1.2 Performing Survey Operations

After the initial setup, you can immediately begin to perform your survey or set out points.

Taking Readings

The SDR33 provides several options to ensure accurate readings. If you are unable to actually set up on the point to be observed, the SDR33 enables you to perform several different kinds of offsets. To further increase the accuracy of your survey, you can take multiple observations to a point and calculate inherent error and corrected calculations.

Topo

The SDR33's ***Topography*** program enables you to collect data on physical elements within an area.The ***Topography*** program can be used for a variety of different surveys including boundary surveys, cadastral (plat) surveys, contour surveys, and two and three dimensional surveys.

Set Out

Setting out can be used for a variety of applications. The SDR33 can be used before construction to initially set out a design or you can double check locations against a design during and after construction.

Roading

All options needed to survey, define, and set out a road are contained in the SDR33's ***Roading*** menu. This feature makes roading quick and efficient using standard SDR workflow - sharing similarities with other SDR options.

COGO

The ***COGO*** menu of the SDR33 provides several options to perform coordinate geometry calculations, including inverses, areas and intersections. You can use these tools to calculate distances, azimuths and coordinates separately from traditional SDR33 methods.

Controlling Quality

You have control over the quality of readings by setting survey job tolerances. You can automatically end an observation based on the quality of the solution or choose to manually end the observation.

Through the ***Configure Reading*** screen, you have the advantage of setting work standards from job to job. The system will remember the parameters set during a previous survey.

Full Functionality

The SDR33 delivers multiple options in a single package. With more memory (1 MB NVM), the SDR33 can handle nearly any survey operation under any condition.

Leveling

Digital or manual levels can be used with the SDR33 to perform differential leveling. By using the ***Leveling*** option to collect accurate elevations, you can improve the accuracy of your survey jobs. Elevations recorded from the ***Leveling*** option can be used to correct existing data in the SDR database.

1.3 Post-Survey Operations

Your collected data is ready for immediate transfer to a desktop computer or a printer.

File Format

Data is stored in the industry-standard SDR file format. You can export files directly to any software package that recognizes SDR files.

Output

You can also choose to send SDR jobs to Sokkia's ProLINK desktop software. With ProLINK's Conversion Definition Manager, you can import, convert, edit, reduce, and export a variety of raw data formats. ProLINK's functionality as an intelligent editor for survey data is enhanced by the ability to convert to and from a wide range of file formats.

Chapter 2 SDR33 Hardware

In this chapter

- Hardware
- Turning the SDR33 on and off
- Performing warm and cold boots
- Accessing batteries
- Storing the SDR33
- Servicing the SDR33
- Environmental Conditions

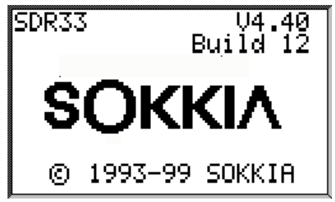
The SDR33 is an Electronic Field Book® with 56 keys and an eight-line, 20-character LCD screen. It contains a V25 microprocessor and 1MB, 2MB or 4MB of CMOS RAM. The operating system is ROM resident Digital Research DR-DOS, compatible with MS-DOS 3.2. The SDR33 is rated at IP54 and can withstand wind-driven rain. However, it cannot be submerged. The SDR33 meets MilSpec 810D and can withstand a 1.2-meter (4 foot) fall to a concrete surface while maintaining reliable operation.

The SDR33 has two external connectors for connection to another device.

- An RJ41 with limited RS232 capability is located at the top of the SDR33. This port is usually connected to an electronic total station for collection of survey data, but it can also be connected to a printer, plotter or personal computer using appropriate adapters.
- The bottom end cap of the SDR33 can be removed to expose a 25-pin connector and external power source connector.

2.1 Turning the SDR33 On

Press the <I> key to turn the SDR33 on. When you first turn the SDR33 on, it will go through a boot sequence. After the SDR33 has finished loading the SDR program, it will display the ***Welcome*** screen.



Press <**OK**> or <**Clear**> to enter the SDR33 software.

If the SDR33 fails to turn on, check the batteries. If the batteries are good, perform a boot to reset the SDR33 - preferably a cold boot. For more information, see the following sections on performing a warm boot and cold boot.

⌧ **Note:** If this is the first time you are turning on the SDR33, or if it has been in storage, perform a cold boot even if the unit turns on.

2.2 Turning the SDR33 Off

Press the gold **<Func>** and <I> keys to turn the SDR33 off.

If the SDR33 fails to respond to key presses, hold the <I> key down for 16 seconds. This will shut down the hardware. Next, perform a warm boot.

If the warm boot was successful, transmit all data as soon as possible to safeguard against further problems. Then perform a cold boot.

2.3 Performing a Warm Boot

A warm boot restarts (or resets) the SDR software without clearing the RAM memory. A warm boot will not erase survey data in the SDR33; however, when conditions permit it, the data should be transferred to a personal computer before rebooting.

To perform a warm boot, turn off the instrument. Hold the gold **<Func>** and **<L>** keys down. While holding them down, press and release the <I> key. Then, release the other keys.

2.4 Performing a Cold Boot

A cold boot clears the RAM memory in the SDR33 and restores default settings. All survey data will be lost. This action is necessary only when a fault in the system cannot be corrected by performing a warm boot.

WARNING: All surveying data and uploaded files in the SDR33 memory ***WILL BE LOST*** after a cold boot. Be sure to transfer it to a personal computer before performing a cold boot.

If you are experiencing problems with your SDR33 and suspect a fault in the program, you should try a **warm** boot (see Section 2.3, *Performing a Warm Boot*, page 2-3) *before* you try a cold boot. A warm boot will not erase surveying data in your SDR33. Whenever possible, transmit your SDR33 data to a personal computer before rebooting.

To perform a cold boot, start with the terminal off. Hold the **<F1>**, **<F4>** and **<Read>** keys down. The **<Read>** key is the bottom right key (with the blue icon) on the keyboard. While still holding all three keys down, press and release the <I> key. Then release the other keys.

2.5 Accessing the Batteries

The SDR33 uses two 9V alkaline batteries or an optional NiCd battery pack for main power and two lithium batteries for backup. Alkaline batteries typically last 48 hours for a 1MB NVM unit. SDR33s with larger memory will consume power a bit more rapidly.

The 48-hour operating life of the 1MB unit was determined using fresh alkaline batteries at room temperature, using the topography program continuously to observe a total station reading every 45 seconds. The SDR33's "continuous" memory feature consumes a small amount of power. Therefore, without supplying external power, the main batteries will eventually deplete even if the SDR33 is not used at all.

The NiCd pack can be charged in place by connecting the charger cable. The removable cover at the bottom of the terminal gives access to the charger socket.

When the SDR33 detects low main battery voltage, a message, "Battery is low," displays on the bottom line of the screen. Also, you will hear a distinctive, descending beep every minute. You may continue using the SDR33, but the batteries should be replaced or recharged as soon as possible.

🖂 **Note**: When the battery is low, the low battery message will flash every four seconds.

If the SDR33 detects that the main battery voltage is so low it cannot function, the unit displays the message, "Battery is dead," and turns off. The batteries must then be replaced or recharged.

✉ **Note**: When you see the message, “Battery is dead,” adequate energy is still available to maintain data. However, do not attempt to “squeeze” more power out of them by letting the SDR33 rest to let the batteries recover and then resume operation. This can destroy data stored in your SDR33. The only safe practice at this stage is to replace the main batteries with fresh batteries before you continue.

The use of carbon zinc batteries is not recommended. Erratic operation and severely shortened battery life will occur.

Rechargeable 9V NiCd batteries are not recommended. Their power capacity is about one-third that of alkaline cells. Furthermore, the circuitry of the SDR33’s 9V adapter tray, designed to prevent accidental charging of 9V alkaline batteries, will prevent charging them in place.

2.5.1 Installing the batteries

The two small batteries (lithium cells) are installed with their crimped end (negative pole) down toward the bottom end of the SDR33. They fit tightly and must be inserted fully, with their surfaces flush with the top of the socket. If not installed correctly a "Backup lithium dead" message will display.

Use caution to ensure that both batteries are oriented properly in the battery tray. If only one is installed or oriented correctly, the SDR33 will still operate, but only for half as long. (Yes! the SDR33 will operate on only one alkaline battery.)

Refer to the icons molded into the battery compartment to determine the battery installation. The shape of the connectors on the battery icons differ according to polarity. The alkaline adaptor should be installed with the free ends of its four spring fingers downwards toward the bottom of the compartment.

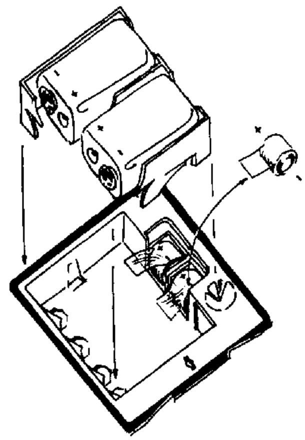


Figure 2-1: Installation of batteries

2.5.2 Removing the batteries

You can remove the batteries to reset the SDR similar to a cold boot. Removing the 9V alkaline batteries (or NiCd pack) while the SDR33 is on will reset the SDR. Removing all the batteries from the SDR may help in cases where the memory contains errors which cause the application to go off on an undesirable vector. You can replace the batteries after 30 seconds. Replacing the batteries before 30 seconds could interrupt the SDR's shut-down procedure and disorient the system.

🖂 **Note**: Removing the batteries with the SDR unit on will result in a loss of data. Make sure to transfer any jobs, roads or templates before removing the batteries. If you are experiencing problems with the SDR after removing all batteries, contact your local Sokkia dealer for assistance.

2.5.3 Backup batteries

Two small lithium batteries are used to power the SDR33 memory when the main batteries are removed. These batteries ensure continuous memory, so all data is safe. The backup batteries contain enough power to back up the memory for 400 hours when the main batteries are completely discharged or removed. The battery designation is CR1/3N or simply 1/3N. They are rated at 3V. Some equivalent designations are Eveready Energizer 2L76 and Duracell DL 1/3N.

When the lithium batteries are completely discharged or incorrectly installed, warning messages appear on the screen. It is important to download your data to a personal computer as soon as possible; ***all data may be lost if the main batteries are discharged completely or are removed*** while the lithiums are dead. A charger or power supply may be used to prevent catastrophic data loss as well.

2.5.4 Charger/Power supply

The charger for the NiCd battery pack can also be used to run the SDR33, with or without batteries. This avoids running the batteries down while performing high-energy tasks such as communication with a personal computer.

2.5.5 Cold weather battery operation

Alkaline batteries dramatically decrease their capacity to power the SDR33 as temperatures fall. At 0° C (32° F), less than 30 hours of service may be expected. At -20° C (-4° F), the service life of the alkaline batteries is less than 10 hours. For operation at these temperature extremes, the NiCd battery is recommended.

If alkaline batteries are used at cold temperatures, do not discard them when the battery dead message is encountered. In warmer temperatures, their remaining rated capacity will still be available for SDR33 operation.

Note: Higher battery drain will occur with use of the backlight and communication. Therefore, the external power supply should be used during communications input or output to conserve battery life.

2.6 Storing the SDR33

If you plan to store the SDR33 for an extended time, first transmit important data from the SDR33, then remove the battery pack and lithium cells.

If you are removing the main battery pack for an extended period, you should also remove the lithium backup batteries. If you do not remove them, they will completely discharge in 400 hours.

Warning: If you remove the lithium batteries after you removed the main batteries, all SDR33 data will be lost.

2.7 Servicing the SDR33

No servicing is required beyond battery service. If your SDR33 develops a fault, transmit any data to your personal computer and reset the SDR33 with a cold boot as described in Section 2.4, *Performing a Cold Boot*, page 2-3. If you cannot transmit data, DO NOT perform a cold boot. Contact the authorized distributor who supplied the unit for advice.

2.8 Performing within Environment

The SDR33 is designed to operate in temperatures in the range -4° F to +122° F (-20° C to +50° C). Humidity must be noncondensing. The SDR33 will withstand wind-driven rain and dust, but it is not designed to be submerged. It can withstand a 4-foot (1.2 meter) drop to a concrete surface.

Chapter 3 Basic Operations

In this chapter

- Reviewing the Home screen
- Special keyboard keys and softkeys
- Menu structure and options
- Customizing SDR software options
- Data entry
- System messages and warnings

Before working with your SDR33 in the field, you may want to review this chapter. This chapter explains several unique keys to access menu options and special functions as well as the menu structure and available options. Also, you can customize your SDR33 for specific tasks by adding or removing options or entire menus. The basic information to help you work with the SDR33 efficiently and effectively is presented in this chapter.

3.1 Reviewing the Welcome and Home Screens

When you initially turn the SDR33 on, it will display the boot sequence, including the ***Welcome*** screen:

The ***Welcome*** screen displays, indicating software version number, the operating software currently loaded and the copyright.

Pressing <**Clear**> or <**OK**> displays the ***Home*** screen. You can return to the ***Home*** screen at any time by repeatedly pressing <**Clear**>. The ***Home*** screen displays several types of information including:

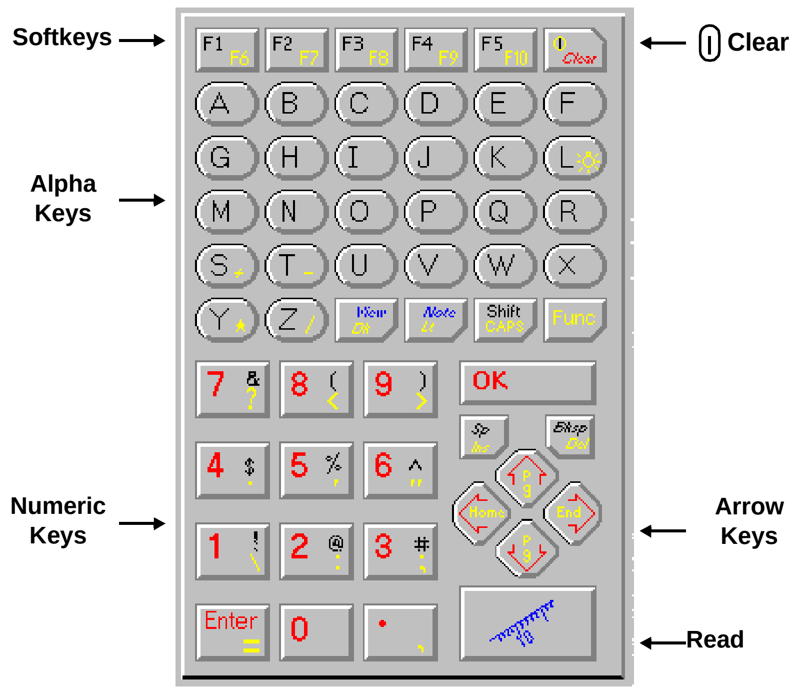
- date
- time
- name of current job (file name)
- current instrument station
- current backsight point
- number of free records remaining

The ***Home*** screen is the starting point of your SDR33 operation. From this screen, you can access any menu of options by selecting one of the five softkeys at the bottom of the screen as described in the next section.

✉ **Note**: If the SDR33 was used in a previous session, it will return to the screen displayed when the SDR33 was turned off.

3.2 Using the Keyboard

The SDR33's 56 button keypad is designed to facilitate your workflow. The keypad is arranged is detailed in the following diagram. Frequently used operating keys are indicated:



The SDR33 has several special keys in addition to key combinations to access special functions and create special characters.

The standard operating keys are as follows:

< Clear> This key turns the SDR33 on and off, and returns the software to the previous screen.

<READ>...... This key records measurement readings from your instrument.

<Shift>......... This key alternates between lowercase to uppercase.

<OK> .... This key accepts and stores all fields displayed on a screen form. (A form is a group of data fields displayed together.)

<↑> and <↓> The vertical arrow keys move the cursor to highlight available fields.

<←> and **<→>**The horizontal arrow keys enables you to select (“toggle between”) options within a field.

3.2.1 Function and character keys

To access special functions or enter special characters, use the <**Func**> or <**Shift**> keys to create key combinations. To enter a key combination, press the **<Func>** or **<Shift>** key first, then the key corresponding to the desired function or character. For example, to turn off the SDR33, press the gold **<Func>** key, then press the **<Clear>** key. The functions available with the gold **<Func>** key are as follows:

<Func>+< I > This key combination turns off the SDR33.

<Func>+<L> This key combination turns the SDR33’s backlight screen on or off.

<**Func>+<SP (Ins)>** This key combination turns insert / overwrite mode on or off.

<Func>+<Bksp (Del)> This key combination deletes the character under the cursor.

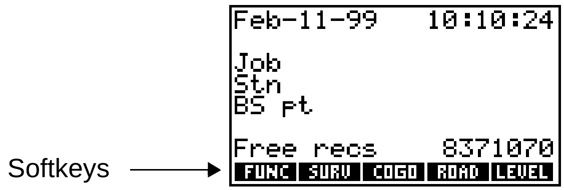
<Func>+<M> This key combination accesses configuration manager, enabling you to select whether a particular menu or a specific menu option is displayed. See Section 3.4, *Customizing the SDR Software*, page 3-11.

<**Func>+<C>** This key combination pops up the calculator. See **Chapter 37, *Calculator*** for more information.

<Func>+<O> This key combination displays all the options available for a field.

3.2.2 Softkeys

The bottom line of the SDR33 screen lists available softkeys. A softkey's function depends on the mode or screen you are in at the time, or settings you have pre-selected. Only the softkeys relevant to your current task appear.



Access the softkeys by pressing the corresponding function key (<**F1**>). The available softkeys will change depending on the functions and options on the SDR33.

3.3 Understanding the SDR Menu Structure

A menu provides a list of SDR33 actions or selections. You can access the menus with softkeys located at the bottom of the *Home* screen or the opening screen of any menu. Press **<Clear>** repeatedly to get to the ***Home*** screen.

The SDR33 has up to five main menus. The availability of each menu depends on which SDR software options installed on your SDR33:

Func.............. This menu is used to set up or start survey jobs, determine job and configuration parameters, remove jobs and communicate between the SDR33 and other devices as well as starting the calculator, setting up feature code lists and upgrading SDR software and languages.

Surv.............. This menu accesses survey programs frequently used in the field for data collection.

Cogo............. This menu allows you to perform coordinate geometry calculations and setting out field work.

Road............ This menu contains programs for road survey, definition and set out (see **Section 7, *Roading***).

Level............ This menu accesses routines for differential leveling (see **Section 9, *Leveling***).

✉ **Note**: The SDR33 requires a job in the system before many routines will function. The ***Create job*** screen will display if there is no current job.

Each menu lists several options that are organized according to specific tasks. The options available in SDR33 are outlined in the following table

Func	Surv	Cogo	Road	Level
Job	Togography	Set Out Coords	Select Road	Leveling
Instrument	Traverse Adjustment	Set Out Line	Set Out Road	Report/Adjust
Job Settings	Resection	Set Out Arc	Set Out Road Surface	Keyboard Input
Configure Reading	Positioning	Resection	Road Topo	
Tolerance	Set collection	Positioning	Cross-Section Survey	
Units	Set Review	Inverse	Define Road	
Communications	Building Face Survey	Areas	Review Road	
Date & Time	Collimation	Intersections	Define Template	
Job Deletion	Remove Elevation	Point Projection	Review Template	
Calculator	Keyboard Input	Taping from Baseline		
Feature Code List		Transformation		
Hardware		Keyboard Input		
Upgrade				
User Program				
Language				

To perform a task with the SDR33, such as determining unit settings or setting out a line, you must access a menu option.

Steps to access or leave a menu option

1. Access the appropriate menu.

2. Highlight an option by moving the highlight bar with the <↑> and <↓> keys or by pressing the letter key corresponding to the option’s first letter. If two or more options start with the same letter, press the letter key more than once to step through the options.

3. Press **<Enter>** to select a highlighted option.

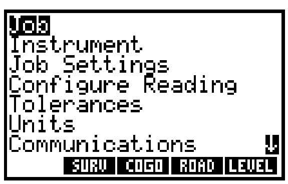
   —OR—

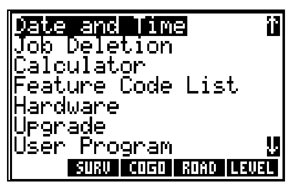
   Press **<Clear>** to leave a menu without selecting any option.

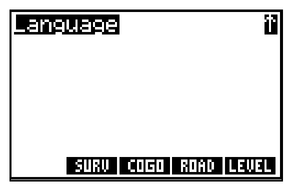
3.3.1 Functions menu

The ***Functions*** menu is used to set up or start survey jobs. It also controls all communications between the SDR33 and any other devices, such as a personal computer.

You can access the ***Functions*** menu with the **<FUNC>** softkey. The ***Functions*** menu contains the following options, which are described in the chapters indicated.





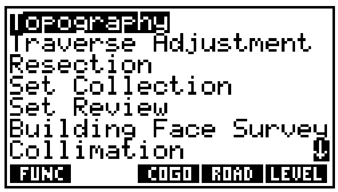


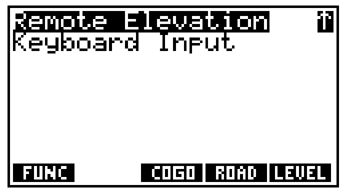
- **Job — Chapter 5, *Working with Survey Jobs***
- **Instrument — Chapter 6, *Setting Up the Survey***
- **Job settings — Chapter 5, *Working with Survey Jobs***
- **Configure reading — Chapter 6, *Setting Up the Survey***
- **Tolerances — Chapter 6, *Setting Up the Survey***
- **Units — Chapter 6, *Setting Up the Survey***

- **Communications — Chapter 34, *Communications***
- **Date and time — Chapter 4, *System Management***
- **Job deletion — Chapter 5, *Working with Survey Jobs***
- **Calculator — Chapter 37, *Calculator***
- **Feature Code List — Chapter 36, *Feature Codes and Attributes***
- **Upgrade — Chapter 4, *System Management***
- **User program — Appendix E, *User Program***
- **Language — Chapter 4, *System Management***

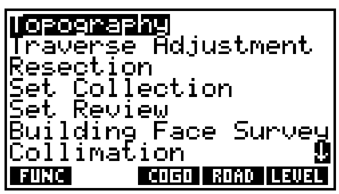
3.3.2 Survey menu

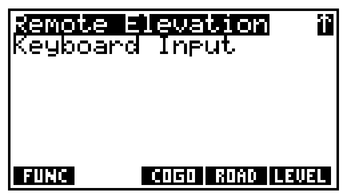
The ***Survey*** menu contains the programs most frequently used in the field for data collection. The other menus for field work is the ***COGO and ROAD*** menus.





Access the ***Survey*** menu with the **<SURV>** softkey. The ***Survey*** menu contains the following options, which are described in the chapters indicated.





- **Topography Chapter 13, *Collecting Topography Observations***
- **Traverse adjustment — Chapter 16, *Traverse Adjustment***
- **Resection — Chapter 9, *Calculating Unknown Stations***
- **Set collection — Chapter 15, *Traverse Collection Methods***
- **Set review — Chapter 15, *Traverse Collection Methods***
- **Building face survey — Chapter 29, *Building Face Survey***

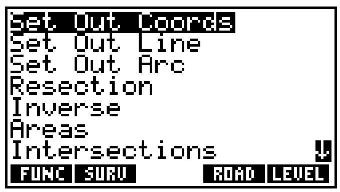
- **Collimation — Chapter 38,** ***Measurement of Collimation Error***
- **Remote elevation — Chapter 14,** ***Observing a Remote Elevation***
- **Keyboard input — Chapter 35,** ***Operating with Keyboard Input***

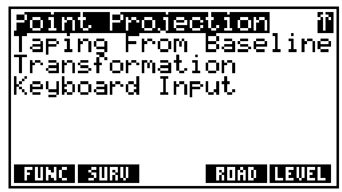
Note: Menu items specific to GPS RTK work are descibed in detail in the ***SDR33 RTK Reference Manual***.

3.3.3 COGO menu

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

Access the ***COGO*** menu with the **<COGO>** softkey. It contains the following options, which are described in the chapters indicated.



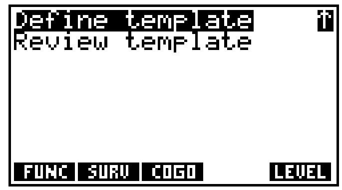


- **Set out coordinates — Chapter 18,** ***Setting Out Design Coordinates***
- **Set out line — Chapter 19,** ***Setting Out a Line***
- **Set out arc — Chapter 20,** ***Setting Out an Arc***
- **Resection — Chapter 9,** ***Calculating Unknown Stations***
- **Inverse — Chapter 31,** ***COGO Options***
- **Areas — Chapter 31,** ***COGO Options***
- **Intersections — Chapter 31,** ***COGO Options***
- **Point projection — Chapter 28,** ***Point Projections***
- **Taping from Baseline — Chapter 27,** ***Taping from Baseline***
- **Transformation — Chapter 32,** ***Transformations***
- **Keyboard input — Chapter 35,** ***Operating with Keyboard Input***

Resection and **Keyboard input** are in this menu and in the ***Survey*** menu, as they are useful in both.

3.3.4 Road menu

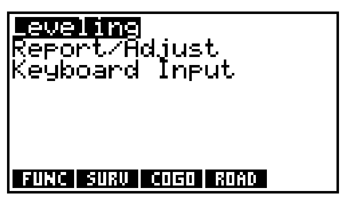
The ***Road*** menu contains programs used in the surveying, definition, and setting out of roads. Access the ***Road*** menu with the **<ROAD>** softkey. It contains the following options, which are described in the chapters indicated:



- **Select road — Chapter 21, *Working with Roads***
- **Set out road — Chapter 23, *Setting Out Roads***
- **Set out road surface — Chapter 24, *Set Out Road Surface***
- **Road topo — Chapter 25, *Road Topography***
- **Cross section survey — Chapter 26, *Cross-Section Survey***
- **Define road — Chapter 22, *Defining Roads***
- **Review road — Chapter 21, *Working with Roads***
- **Define template — Chapter 21, *Working with Roads***
- **Review template — Chapter 21, *Working with Roads***

3.3.5 Leveling menu

The ***Level*** menu provides access to the program required to perform leveling in the field. Access the ***Level*** menu with the **<LEVEL>** soft-key. It contains the following options, which are described in the chapters indicated:



- **Leveling — Chapter 30, *Leveling***
- **Report/Adjust — Chapter 30, *Leveling***
- **Keyboard input — Chapter 35, *Operating with Keyboard Input***

3.4 Customizing the SDR Software

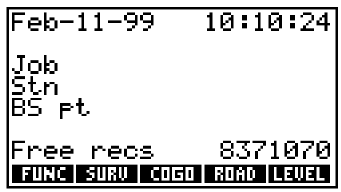
You can customize the SDR33 software for your specific tasks. The ***Configuration Manager*** lets you deactivate menu items to customize the SDR menus to facilitate your specific tasks. The ***Configuration Manager*** can be activated only from the ***Home*** screen. See Section 3.1, *Reviewing the Welcome and Home Screens*, page 3-2 for information.

3.4.1 Customizing menus

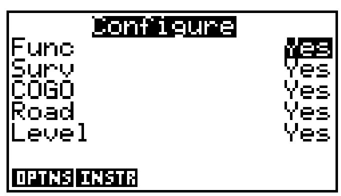
You can use the ***Configuration Manager*** to customize your menu selections by removing or adding specific menus.

Steps to customize menus

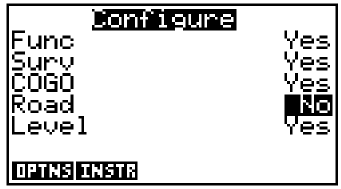
1. Press the **<Clear>** key until the ***Home*** screen displays. The ***Home*** screen displays the currently available menus as softkeys at the bottom of the screen.



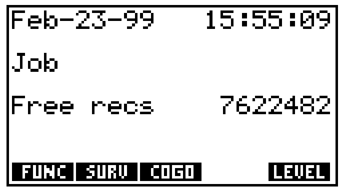
2. Press the **<Func>+<M>** key to start the ***Configuration Manager***. The ***Configure*** screen displays.



3. You can deactivate any of the five main menus from this screen. Press the <↑> or <↓> key to choose a menu, press the <←> or <→> key to toggle it **Yes** or **No**. Press **<OK>** or **<Enter>** to accept and exit the ***Configuration Manager***.



4. When you return to the ***Home*** screen, the deactivated main menu item is no longer displayed and the softkey is unavailable.

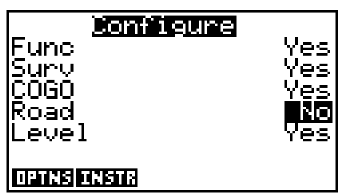


3.4.2 Customizing menu options

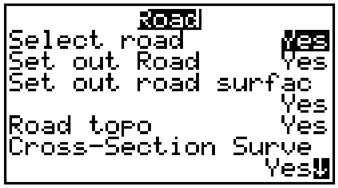
In addition to adding or removing menus, you can specify options within the menu structures. Use the ***Configuration Manager*** to organize your menu options for specific surveys or tasks, improving your workflow.

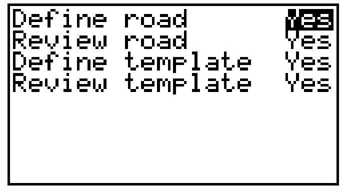
Steps to customize menu options

1. You can also deactivate specific items under a main menu selection. For example, highlight ***Road*** on the ***Configure*** screen and toggle its setting to **Yes** with the <←> or <→> key.



2. Press the **<OPTNS>** softkey. The SDR33 displays all options available under the selected main menu item.





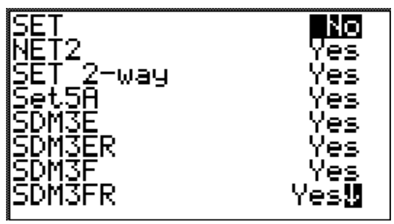
3. Toggle individual items to **No**. Press **<OK>** or **<Enter>** to deactivate the selected items. The deactivated items will not be displayed when the main menu item is chosen.

3.4.3 Customizing instrument selections

You can also shorten the list of selectable instruments using the ***Configuration Manager***. Reducing the list of selectable instruments can aid surveyors in selecting the instrument types and reduce confusion by eliminating a broad spectrum of instrument choices.

Steps to customize instrument selections

1. Press the **<INSTR>** softkey on the ***Configure*** screen to display the first page of all selectable instruments.



2. Toggle individual instrument types to **No**, then press the **<OK>** or **<Enter>** key to deactivate the selected items.

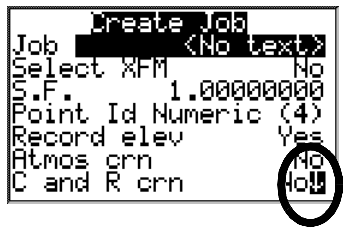
✉ **Note**: The SDR33 will automatically reactivate instruments if you load a job file that previously used an instrument which is now deactivated.

3.4.4 Restoring menus, options and instruments

Use the previously described procedures to activate disabled menus, menu options or instruments. To restore menus, options and instruments, you should select **Yes** instead of **No** next to each item.

3.5 Entering Data

Most screens in the SDR33 allow you to enter information. Information is entered into a specific line (field) on the SDR33 screen. Some fields have options you can select using the arrow keys; other fields require you to enter data..

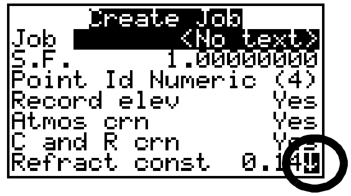


In the ***Create Job*** screen, you can enter a variety of information including:

- job name
- applied XFM file
- scale factor
- point ID format
- record elevation
- curvature and refraction correction
- sea level correction
- plane curvature correction

This screen contains option, numeric and alphanumeric fields. For more information on specific fields and how to enter information in them, see Section 3.5.1, *Field types*, page 3-15.

If the number of fields in a screen exceeds the space limitation on the first page, a second page is used to display the extra fields. The additional fields indicator (up or down arrow) in the right corner of the first and / or last fields signifies that more fields are accessible for that form. To view the additional pages, use the <↓> key on the last field or the <↑> key on the first field.



Steps to enter data

1. Use the <↑> and <↓> keys to move from field to field.

2. Enter data into the appropriate fields. The fields can be accessed in any order. For information on field types (numeric, alphanumeric and option), see Section 3.5.1, *Field types*, page 3-15.

3. Press **<OK>** to accept entered values. If you do **not** want to continue, press **<Clear>**.

4. To edit data, highlight the field. Then make your editing changes or type a new value. The **<Bksp Del>** key backspaces over data and removes it.

3.5.1 Field types

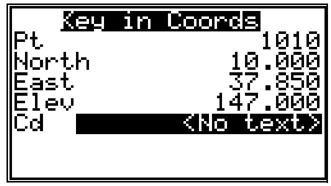
Three types of fields are used when you are reviewing or changing data:

- Numeric
- Alphanumeric
- Option

The type of field will determine how you can modify the data in that field.

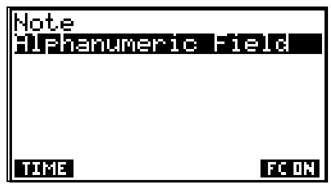
3.5.1.1 Numeric fields

Numeric fields include serial numbers, distance values and other values. Numeric fields accept only the digits 0 through 9, decimal points or a leading minus sign.



3.5.1.2 Alphanumeric fields

Alphanumeric fields include notes, observation codes and other user-entered information. They can contain alphabetic (uppercase and lowercase) characters, numeric characters and special characters (such as +, -).



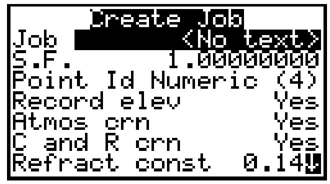
To toggle between upper- and lower-case alpha characters, press **<Shift>**.

3.5.1.3 Option fields

Option fields provide a list of possible selections, such as **Yes** or **No** options. The selections will toggle in the field when the **<←>** or **<→>** key is pressed. The option that is displayed when you move to another field (by pressing <↑>, <↓>, <**Enter**> or **<OK>**) is the entry for that field.

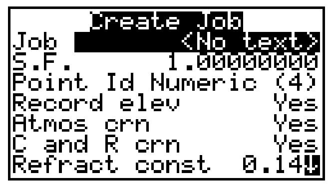
When you are in an option field, you cannot enter any alpha or numeric characters from the keypad. You must choose a selection from the choices provided.

For example, the ***Point ID*** field can be changed from **Alpha (14)** to **Numeric (4)**, by pressing <←> or <→>.



3.5.2 Point IDs

You can identify collected survey points in the SDR33 by names or numbers. When you create a new job, you must decide whether you want to use four-digit point numbers or 14-character point names. This option is selected via the ***Point ID*** field in the ***Create Job*** screen.



The four-digit point numbers are compatible with the SDR2, SDR20, SDR22 and SDR24 Electronic Field Books.

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 SDR alphanumeric point names. Sokkia Software Versions 4.02 and above support this new format.

3.5.3 Angles

Angle fields include horizontal and vertical observation values, azimuths, and so on. If angle units are set to degrees, angle fields are entered in this form:

ddd.mmss

where *ddd* is the number of degrees, *mm* is the number of minutes and *ss* is the number of seconds.

Note: Angles are stored to an accuracy of hundredths of a second but are displayed only to an accuracy of a rounded second.

Once you press **<Enter>**, the field displays in the form:

ddd°mm'ss” (Unless quadrant bearings are used)

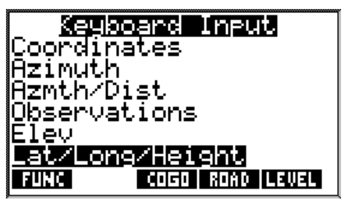
The acceptable value range for most angles is 0° to 359°59'59". The acceptable range for latitude angles is -90° to 90°. The acceptable longitude angle range is from -180° to 180°.

3.5.4 Latitude, Longitude, and Height

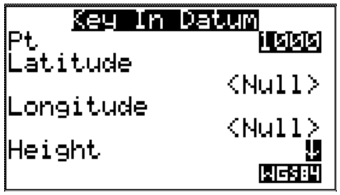
The key in options for local datum latitude, longitude, and height values are combined with the option to key in WGS84 values.

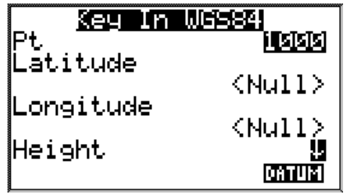
Steps to manually input latitude/longitude height values

1. Select **Lat/Long/Height** from the ***Keyboard Input*** screen.



The ***Key In Datum*** screen will display.





Note: The **<WGS84>** and **<DATUM>** softkeys act as a toggle between the ***Datum*** and ***WGS84*** screens.

Enter Information into the following fields:

Latitude........ Enter a value in this field for latitude (positive north and negative south). For example, to enter 37°25’42.0000N, type **37** + **<.>** + **25** + **<FUNC>** + **<.>** + **42**.

Longitude.... Enter a value in this field for longitude (positive east and negative west).

Height.......... Enter a height value in this field.

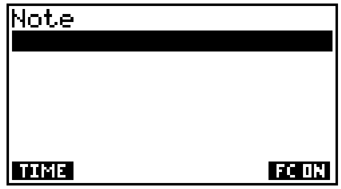
Cd................. Enter a feature code, if desired, in this field.

2. When finished press **<OK>** to store the entered values The SDR33 will store the keyed in values as either a Datum KI or WGS84 KI record. See Section Appendix B, *Database Records*, page Appendix B-1.

3.5.5 Notes

Notes are used to enter additional information about an observation. A note can consist of three lines of 20 characters (including spaces) or a total of 60 characters. 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 **<Note>**. Notes also can be inserted into the database during database review (accessed by **<View>**). The note is inserted before the currently highlighted database record.



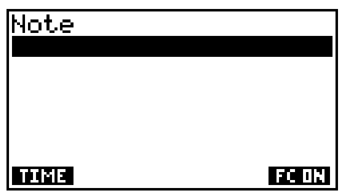
Press the **<TIME>** softkey to manually store the current time and date. The **<TIME>** softkey will not appear when you are creating a job or when you are in the database review mode.

✉ **Note:** You can set an option for an automatic time stamp in the Data and Time screen (see, Section 4.2, *Setting the Date and Time*, page 4-4).

The **<FC ON>/<FC OFF>** softkey is used to turn on or off feature codes when entering Notes.

Steps to enter a note

1. Enter descriptive notes at any time by pressing **<Note>**.



2. Enter the information.

3. To turn on or off the Feature Code Insert option, press the **<FC ON>** softkey or the **<FC OFF>** softkey. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

You will not see the **<FC ON>** or **<FC OFF>** softkeys if the **Code list active** option is set to **No** on the ***Configure Reading*** screen.

✉ **Note**: When the **<FC OFF>** softkey is visible, the feature code insert option is **On**; pressing the **<FC OFF>** softkey turns this option **Off**. The same logic is true for the **<FC ON>** softkey.

---

4. Press **<Enter> or <OK>** to store the note in the database; press **<Clear>** to discard it.

3.5.6 Feature codes within notes

Feature coding is the method of describing each point observed with an alphanumeric code. This feature is convenient if you are using lengthy, repetitive descriptions. For additional information on feature codes, see **Chapter 36, *Feature Codes and Attributes***.

If you want to insert a feature code into a note, press the **<FC ON>** softkey. When you enter a note, the SDR33 will open the feature code library (or stack) if the word occurs in the currently selected stack. If your word is in the feature code stack, select the feature code by scrolling through the library rather than manually entering it.

As you enter codes, if you do not want the SDR33 to select a word from the feature code stack, press the **<FC OFF>** softkey. For example, if you want to enter the letters “TR” and your list has an entry called “Tree”, the **Feature code insert** option will automatically use the “Tree” entry. To enter free-form text, you must turn off the **Feature code insert** option to type in the letters.

3.6 Understanding System Messages

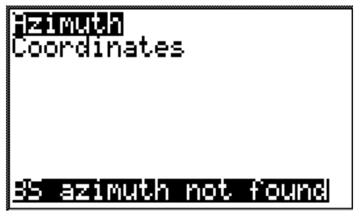
There are two types of system messages, the first displays as a line within the current screen, the other clears the current screen and displays the message. The SDR33 will display a system message if

- the SDR33 cannot continue normal operation
- a required field has not been entered

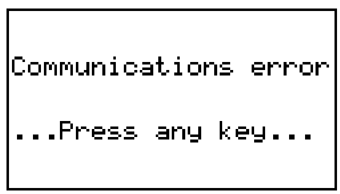
- a tolerance has been exceeded
- an option is not available at this time
- an issue arises that requires user intervention

A system message may display because of a disconnected instrument, ambiguous or meaningless values (such as, the same point name for a station point and an observed point). If possible, correct the cause of the system message before continuing to operate the SDR33.

The first system message displays 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.



The second system message type clears the screen, displays the message, and instructs you to press any key to continue.



See **Appendix C, *System Messages***, for a full list of system messages and explanations.

Chapter 4 System Management

In this chapter

- Reviewing hardware settings
- Setting time and date
- Selecting a language
- Upgrading SDR software

This chapter explains system management tools to aid you in working with the SDR33. Familiarity with this chapter can help you in changing hardware settings, selecting new language options and setting the time and date for your SDR33.

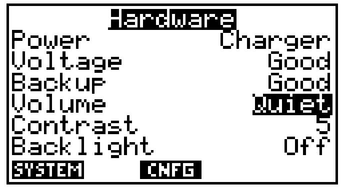
4.1 Reviewing Hardware, System and Configuration Settings

Hardware-related settings may be viewed and modified from the **Hardware** option in the ***Functions*** menu. You can navigate between the ***Hardware***, ***Configuration*** and ***System*** screens using the softkeys.

4.1.1 Hardware settings

Hardware settings include power source, battery level, screen contrast and the volume of key beeps. The ***Hardware*** screen displays six hardware-related items.

> **Note**: To set the time limit that the SDR33 will wait idle before turning off, see Section 4.2, *Setting the Date and Time*, page 4-4.



Power........... (*display only*) This field displays the SDR33's current power source (**Charger** or **Internal**).

Voltage......... (*display only*) This field displays (**Good** or **Bad**) whether the SDR33 is receiving adequate voltage from the power supply.

Backup......... (*display only*) This field indicates if the backup battery is **Good** or **Bad**.

Volume .... Use the <←> or <→> arrow key to adjust the volume of beeps.

Contrast....... Adjust the screen contrast using the <←> or <→> arrow keys from **1** (light) to **7** (dark).

Backlight..... Turn the backlight **on** or **off** with the arrow keys.

> **Note**: Operating the SDR33 with the backlight on will dramatically decrease your battery's life.

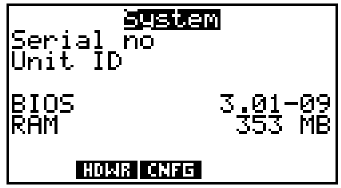
The Hardware screen has two softkeys:

<**SYSTEM**> ...... Pressing this softkey displays system software and operating parameters. See Section 4.1.2, *System settings*, page 4-3.

<**CONFIG**> ...... This softkey displays the Configuration menu. See Section 4.1.3, *Configuration settings*, page 4-3.

4.1.2 System settings

You can access the system settings by pressing the <**SYSTEM**> softkey in the ***Hardware*** screen. The ***System*** screen displays information about the SDR33 unit and the installed memory and BIOS version. This information is used when you update functionality.



Serial #......... (*display only*) This field displays the serial number of your SDR33.

Unit ID .... (*display only*) This field displays the unique identification number for your SDR33. You will need this number when requesting a software upgrade.

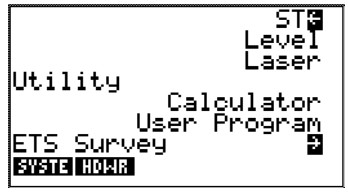
BIOS............ (*display only*) This field displays the current BIOS version in the SDR33.

RAM............ (*display only*) The RAM field displays the amount of **RAM** memory in megabytes (MB). All of this memory is used for data storage.

✉ **Note**: You can navigate among the ***Hardware***, ***Configuration*** and ***System*** screens using the softkeys.

4.1.3 Configuration settings

Pressing the <**CONFIG**> softkey in the ***Hardware*** screen displays the ***Configuration*** screen. To change the configuration settings, you must reinstall the SDR33 software from the original media. You cannot change the configuration settings on the SDR33 itself. For more information on the SDR installation procedure, please refer to your ***SDR33 Installation Guide***.



Market Name .... (*display only*) This field displays localized configuration as established during software installation. This configuration defines units, date and time, language, and available coordinate systems. You must return to the software installer to change this configuration.

Functionality .... (*display only*) The ***Functionality*** field displays the SDR33 functionality currently activated.

Instrument - lists the instrument types currently supported by your SDR33

Utility - lists the options currently enabled on your SDR33

✉ **Note:** The functionality displayed in the ***Configuration*** screen is dependent upon which SDR software options you have installed on your SDR33. For more information on SDR-RTK and SDR-SK software functionality, refer to the appropriate software manuals.You will need your SDR33's unit ID when adding/ upgrading software, see Section 4.1.2, *System settings*, page 4-3.

4.2 Setting the Date and Time

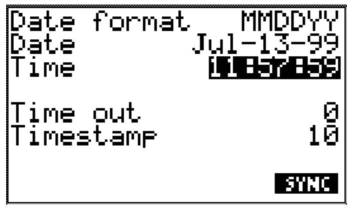
Date and time are maintained automatically by the SDR33. You can review the date and time on the ***Home*** screen and on the ***Date and Time*** screen accessed from the ***Functions*** menu.

From the ***Date and Time*** screen you can establish the length of time you want the SDR33 to stay on when the unit is inactive.

If you have activated the timestamp option for notes, the current time and date will be automatically recorded in manually entered notes. For more information, see Section 3.5.5, *Notes,* page 3-19.

Steps to change the date and time

1. Select **Date and time** from the ***Functions*** menu. The following screen displays.



2. Modify the following fields to reflect the current time and date information.

Date format...... This field controls how the date is displayed in the ***Date*** field. The options are DDMMYY and MMDDYY.

Date.................. The ***Date*** field shows the current date. Enter a new date using the date format selected in the ***Date format*** field setting, if desired.

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 SDR33 generates automatic timestamp records as described below.

Time out........... This field specifies the number of minutes that the SDR33 will wait idle before it turns itself off. For example, if this field is set to 5 and you do not touch the keyboard for 5 minutes, the SDR33 will turn itself off.

Note: A setting of zero is not allowed. The minimum setting is 1 minute; the maximum is 99 minutes. If you wish to turn the SDR33 off immediately, press **<FUNC>** then **<Clear>.**

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 SDR33 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.

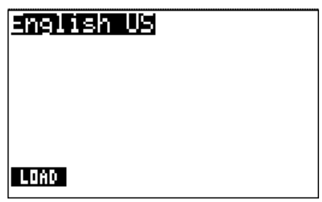
✉ **Note:** If the timestamp interval is set to zero, the SDR33 will not generate timestamps. Timestamps can be inserted into the database using the **<TIME>** softkey when entering a note. (see Section 3.5.5, *Notes*, page 3-19.)

<**Sync**>......... You can synchronize the SDR33 to GPS time by pressing this softkey. See the procedure below to synchronize the SDR33 with the receiver.

3. Press <**OK**> to save the settings, exit the ***Date and Time*** screen, and return to the ***Functions*** menu.

4.3 Selecting a Default Language

The SDR33 can operate in several languages. Available languages vary depending on geographic region. Select **Language** from the ***Functions*** menu to see available languages.



The selected language will be used for all prompts and messages. Highlight your choice and press <**OK**> to save the new language selection. Press **<Clear>** to return to the ***Functions*** menu with the language selection unchanged.

Languages are either in the SDR33 when shipped or installed with the SDR software installation or upgrade. To change a default language, use the **Language** option in the ***Functions*** menu. If the desired language is not currently installed on the SDR33, you will need to use the SDR installation program to load additional languages. For detailed instructions, refer to your SDR33 installation guide.

4.4 Upgrading Software, Languages and Functionality

You can use the **Upgrade** option from the ***Functions*** menu to perform software upgrades, when available. Detailed instructions on how to upgrade are supplied with the upgrade software.

Use the SDR installation software to upgrade functionality, change your SDR software local configuration or install new languages. For more information, refer to your SDR33 installation guide.

Note: The installation procedure in the SDR33 installation guide will only work with 1 MB Non-Volatile Memory (NVM) units with 1 MB of RAM running BIOS version 3.07-01 or better. Contact your Sokkia distributor to for questions on determining NVM and Basic Input Output System (BIOS) compatibility.

2

Performing Surveys

This section includes procedures for starting a job, setting up an instrument, determining Configure Reading parameters and establishing tolerances. Additional chapters instruct you in setting up a station and backsight, taking a reading, observing offsets and using the Resection and Professional Positioning options.

Working with Survey Jobs

- *Creating a New Job*
- *Reviewing Job Statistics and Renaming a Job*
- *Specifying a Control Job*
- *Determining Which Job Is Current*
- *Deleting a Job*
- *Modifying Job Settings*
- *Determining Job Sizes*

Setting Up the Survey

- *Setting up the Instrument*
- *Determining Configure Reading Parameters*
- *Establishing Tolerances*
- *Defining Unit Formats*

Setting Up a Station and Backsight

- *Establishing a New Station and Backsight*
- *Working with Backsights*
- *Determining Unknown Stations*

Taking a Reading

- *Initiating the Observation*
- *Observing Offsets*
- *Averaging Multiple Observations*

Calculating Unknown Stations

- *Using Resection*
- *Using Professional Positioning*

Chapter 5 Working with Survey Jobs

In this chapter

- Creating a new job
- Selecting an existing job
- Changing a job name
- Viewing job statistics
- Designating a control job
- Verifying the current job
- Deleting a job
- Reviewing job settings
- Job file size

Before you can perform a survey, you must create a job file. The SDR33 stores all the information associated with the survey in the job file, including points, Configure Reading parameters, unit settings and other user-defined parameters. You can store multiple jobs on the SDR33, limited only by the amount of memory available.

Some settings, notably instrument type, are remembered from job to job, so it is unnecessary to set them for each new job. You can always review the current settings whenever you are starting a new job to ensure you are using the correct parameters.

You may want to designate a control job during your survey. A control job is a separate job file containing specific points you wish to use in your new file. These points may be station locations, calibration points, known positions or other important locations.

5.1 Creating a New Job

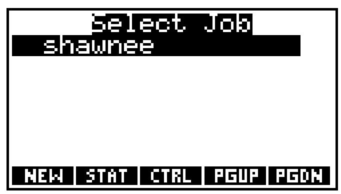
Most operations in the SDR33 require the creation of a job before you proceed. You can create a job at any time, and the SDR33 can store as many jobs as memory allows.

When you create a job, several parameters are established that define how data will be stored during operations within the job. **These parameters cannot be changed at a later time, so you should carefully plan each job.**

Note: When creating a new job, you must decide whether or not a local assumed or projected / ellipsoidal coordinate system will be used. Once selected, this option cannot be changed for a particular job. For more information, see Section 10, *Overview of Coordinate Systems*, page 10-1.

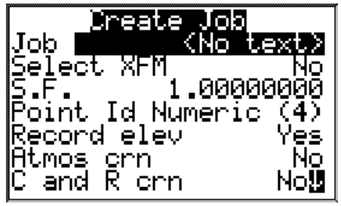
Steps to create a new job

1. Select the **Job** option from the ***Functions*** menu. The ***Select job*** screen displays.



Note: If no jobs are created in the SDR33, the ***Create Job*** screen appears when you select **Job** from the ***Functions*** menu.

2. Press the **<NEW>** softkey to display the ***Create Job*** screen.



3. Enter information in the following fields.

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. Do not use a period (.) within a job name.

Select XFM.. *(cannot be changed later)* This field determines whether coordinate systems will be applied during the survey process. The following three fields will display when this field is set to **YES**.

✉ **Note:** For more information on using coordinate systems, see Section 10, *Overview of Coordinate Systems*, page 10-1.

Point ID .... This field holds specifies the length and type of point names in the job.

Trans............. Select the type of transformation to be used on the job in this field.

Description . (*display only*) This field displays a description of the transformation type selected in the Transformation field.

Zone .... Select the local zone to which the transformation will be applied.

Atmos crn.... *(Applies only to total station measurements)* If atmospheric correction is set to **Yes**, the SDR33 applies an atmospheric correction to observations based on the current temperature and pressure values. Calculation details are given in Appendix D, *Observational Calculations*.

If you set the ***Select XFM*** field to **NO**, the following fields will be displayed:

S.F. (Scale Factor)..........(*Cannot be changed later)* This field holds the plane scale factor of the job. 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 whenevernon-GPS 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.

- **Numeric** (4) — point names contain four digits; compatible with the SDR20 series of data collectors.

- **Alpha** (14) — the 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.)

Record elev....................(*Cannot be changed later*) The SDR33 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**, any corrected records are given a vertical angle of 90°. This forces all subsequent calculations to take place in two-dimensional (horizontal) space.

Atmos crn............. *(Applies only to total station measurements)* If atmospheric correction is set to **Yes**, the SDR33 applies an atmospheric correction to observations based on the current temperature and pressure values. Calculation details are given in Appendix D, *Observational Calculations*.

C and R crn........... *(Applies only to total station measurements)* If curvature and refraction correction are set to **Yes**, the SDR33 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 Appendix D, *Observational Calculations*.

Refract const......... *(Applies only to total station measurements)* 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 .... *(Applies only to total station measurements)* If **sea level correction** is set to **Yes**, the SDR33 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 Appendix D, *Observational Calculations*.

4. Once you have set these job parameters, press **<OK>** or <**Enter**>. The ***Note*** screen displays.

5. Enter your note records. The number of notes you can enter is limited only by available memory. Press **<Enter>** or **<OK>** to accept and store the note records.

Note: To change these options after the job has been created, see Section 4.7, *Job settings*.

5.2 Opening an Existing Job

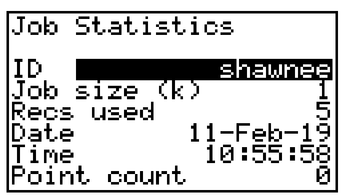
You can add data, transfer a file or set out points from an existing job file at any time by selecting it as the current job. You can even transfer job files from a personal computer back to the SDR33 for continued field work.

Steps to open an existing job

1. Select **Job** from the ***Functions*** menu. The ***Select job*** screen displays.
2. Use the <↑> and <↓> keys to highlight the desired job.
3. When a job name is highlighted, press the **<VIEW>** key to review and verify the job and data.
4. Press **<Clear>** or **<OK>** to return to job selection.
5. Press **<Enter>**. The selected job will become the current job.

5.3 Reviewing Job Statistics and Renaming a Job

You can review current information and rename the current job in the ***Job Statistics*** screen. This screen is accessed from the **Select Job** option of the ***Functions*** menu. The **<STAT>** softkey will display the job statistics for the job currently highlighted on the ***Select Job*** screen.



The ***Job Statistics*** screen contains the following fields:

ID .... This field displays and allows modification of the job name.

✉ **Note:** You can also rename the current job in the Job Settings screen. For more information, see Section 5.7, *Modifying Job Settings*, page 5-11.

Job size (k) ....(*display only*) This field displays the size of the job, in kilobytes, currently occupied in memory.

Recs used ....(*display only*) This field displays the approximate number of records (point positions, observations, notes, etc.) currently stored in the job.

Date and **Time**......(*display only*) These fields display the 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............(*display only*) This field displays the number of points currently stored. A new job will have a point count of 0.

Press **<OK>** or **<Clear>** to return the ***Select job*** screen.

✉ **Note**: You can also rename a job in the ***Job Settings*** screen, accessed from the ***Functions*** menu.

Steps to rename a job

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

2. Highlight the name of the job in the ***Select Job*** screen.

3. Press the <**STAT**> softkey to display the job statistics.

4. The ***ID*** field presents the current name for the job. You can edit this field to enter the new name for the job.

5. Press the **<Enter>** or **<OK>** key to complete the entry and change the job name. The ***Select Job*** screen will display with the new job name.

5.4 Specifying a Control Job

When you are working within a job, you might want to use control points already present in another job. By using a control job, you are working with one job file and using a separate job designated as a control job. The control job can contain specific points, station locations or known positions you wish to use in your current job file. **Only one control job can be specified at any one time.**

You can designate a control job from the **Select job** option in the ***Functions*** menu. The **<CTRL>** softkey allows you to specify a job to act as the control job. Once the control job is set, if you specify a point name that does not exist in the job you are currently working on, the SDR33 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 for use within the job. If the specified point does not exist in either the current or control job, a standard **Search failed** message will be displayed, and you will be given the opportunity to enter the point details.

Control jobs will work even if the current job and control job have different point ID types. The SDR33 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 utilize 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 for use in other jobs.

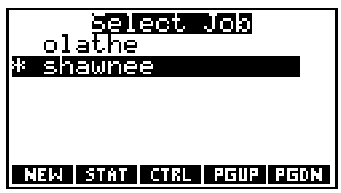
Note: Data stored in a control job is not altered. The SDR33 uses points, station locations, and other control job information for reference only.

Steps to determine a control job

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

2. Use the <↑> and <↓> keys to highlight the name of the job you want to use as a control job.

3. Press the <**CTRL**> softkey. An asterisk (*) will be displayed to the left of the job name designating it as a control job.



   To deselect the job as a control, press the <**CTRL**> softkey again.

Note: You can designate only one control job at a time. If another job was already specified as the control job, it will automatically be deselected whenever you press the <**CTRL**> softkey.

4. Once the control job has been tagged, highlight the job you wish to work with and select <**Enter**> or <**OK**>.

5.5 Determining Which Job Is Current

You can verify the current job several ways in the SDR33:

- by pressing <**Clear**> to access the ***Home*** screen
- by accessing the ***Select Job*** screen from the ***Functions*** menu; the current job is highlighted
- by accessing the ***Job Settings*** screen from the ***Functions*** menu

Any observations or notes made will be stored in the current job.

5.6 Deleting a Job

You can remove any existing job to free up memory but first you must transfer or print the job data. The SDR requires you to transfer or print the job to safeguard your data.

Steps to delete a job

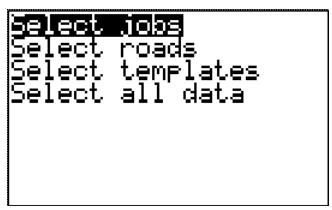
1. Select **Job Deletion** from the ***Functions*** menu.

✉ The ***Job Deletion*** screen is used for the deletion of roads and templates as well as survey jobs, so you need to select the specific file type you wish to remove.

---

2. Use the <↑> and <↓> keys to highlight ***Select jobs***.

3. Press **<Enter>** or <**OK**> to view the available jobs. If no jobs are available, the SDR33 advises you to send or print the jobs first.



Jobs marked **N/A** indicates that the job can not be deleted.

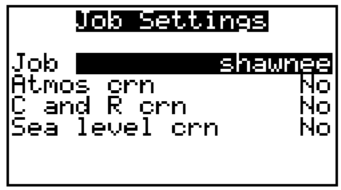
4. Place the cursor on the job you wish to delete. Use the <←> or <→> keys to toggle the setting from **No** to **Yes**.

5. Press **<OK>** to delete any jobs marked **Yes**. When prompted to confirm the deletion, select the **<OK>** softkey.

✉ **Note**: Use the **<ALL>** softkey to select all available.

5.7 Modifying Job Settings

You can review and modify several of the choices made when creating a job. Select **Job Settings** from the ***Functions*** menu to display the ***Job Settings*** screen.



The ***Job Settings*** screen lets you change some of the options selected on the ***Create Job*** screen, including the current job name. You cannot change the point ID type, scale factor or record elevation choices that you selected at job creation. Changes made on the ***Job Settings*** screen do not affect data that has already been collected (with the exception of the ***C and R crn***). These changes affect only subsequent data points.

If any ***Job Settings*** are changed, a Note JS will be saved on the database. This note contains a sequence of four digits.

Note JS record		
Digit in Sequence	**Represents**	**Entry options**
First	Atmospheric Corrections	0 = Off 1 = On
Second	Curvature and Refraction Correction	0 = Off 1 = On

Note JS record		
Digit in Sequence	**Represents**	**Entry options**
Third	Refraction Constant	0 = 0.14 refraction constant 1 = 0.20 refraction constant
Fourth	Sea Level Corrections	0 = Off 0 = On

This Note record is primarily for informational purposes when parameters are changed. Some software packages may use this record for reduction purposes.

5.8 Determining Job Sizes

The size of a job in the SDR33 is, in theory, limited only by the available memory. However, for practical reasons you should split your work into small blocks. The use of the control job helps facilitate this, as you can easily access control coordinates even from a new job.

The SDR33 informs you when the memory is becoming full and when it is completely full. When it is full, transmit one or more jobs and then delete them to free memory space. For more information on transmitting SDR jobs, see Section 34.3, *Transferring Data Files*, page 34-7

Chapter 6 Setting Up the Survey

In this chapter

- Setting up the instrument
- Determining configure reading parameters
- Selecting a coordinate system
- Establishing tolerances
- Defining unit formats

Before you perform survey operations, you will need to establish some settings on the SDR33. For example, you will need to select the instrument type, determine take reading parameters and establish tolerances. You can select a variety of survey settings to aid you in collecting the survey data, ensuring its accuracy and interpreting data in the office.

✉ **Note**: The SDR33 requires a job in the system before many routines will function. The unit will display the ***Create Job*** screen if a job is not currently selected.

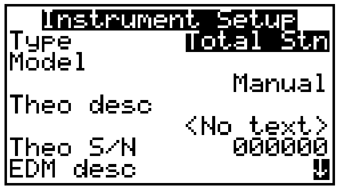
6.1 Setting up the Instrument

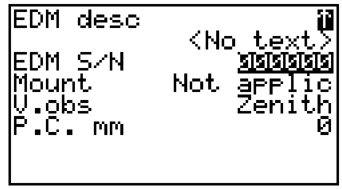
The SDR33 can work with a variety of total stations, levels, GPS receivers, and other instruments. You can change instruments as often as necessary. As you switch instruments, select the new instrument type in the ***Instrument Setup*** screen.

Access the ***Instrument Setup*** screen by selecting **Instrument** from the ***Functions*** menu. The settings established in the ***Instrument Setup*** screen will be stored with your job file. Whenever you change instruments, the SDR33 will store a new instrument record with the new instrument type and associated settings. For more information, see Appendix B, *Database Records*.

6.1.1 Setting up a total station

The SDR33 can work in conjunction with a variety of total station instruments. You should specify the model and specific settings for your total station.





The fields display the following information:

Type............. This field identifies the type of instrument and the subsequent type of measurement the SDR33 should expect. Select from **Total Stn** and **Level**.

Model........... This field provides the model of instrument based on the selected type; the information is stored as part of the instrument record. Select the appropriate model from the available options.

- Manual
- Criterion 300
- Criterion 400
- Nikon A-series
- Nikon D50
- Pentax II / III
- Pentax III / V / PCS
- Geod 400 / 500 / 600
- Wild TC / TCM series
- Advantage
- SET5A
- SET
- Topcon GTS-3
- Topcon GTS300
- Topcon GTS / ET1 / GTS-4
- Wild T1000
- Wild T1000+D1
- Wild T1600
- Wild T1600+D1
- Wild T2000
- Wild T2000+D1
- Wild T1010 / 1610
- Wild T1010 / 1610+D1
- ProSurvey 1000

- SET 2-way
- NET2
- Zeiss Elta 2/3
- Zeiss Elta 46R
- Zeiss Elta RL
- Zeiss Elta 50

Note: If you are using a total station instrument that is not listed, select the Manual option. For more information on specific instruments and associated settings, see Chapter A, *Instrument settings*, page A-1.

Note: Selecting a particular instrument will automatically select the appropriate comms parameters for that instrument. The communications parameters cannot be changed (not even by the comms setup option in the ***Comms*** menu). See Chapter A, *Instrument settings*, page A-1.

Theo desc.... Enter the type of theodolite you are using; this information is stored as part of the instrument record for descriptive purposes alone.

Theo S/N..... Enter the serial number of the theodolite; this information is stored as part of the instrument record for documentation.

EDM desc.... Enter the type of EDM; this information is stored as part of the instrument record.

EDM S/N..... Enter the EDM serial number in use. It is stored as part of the instrument record.

Mount.......... This selector field describes the EDM mounting method. Select from three available options:

- **Not applic -** EDM and theodolite are coaxial
- **Standard -** EDM is standard mounted on the theodolite case
- **Telescope -** EDM is mounted on the theodolite telescope and consequently moves as the vertical angle changes

V.obs .... The vertical observation selector field appears if the instrument has more than one way of measuring its vertical angle.

- **Zenith -** Angles are measured with the upward vertical representing 0°
- **Horiz -** Angles are measured with the horizontal representing 0°

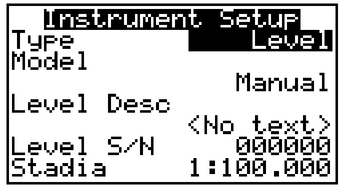
P.C. mm........ The prism constant in millimeters is the optical distance from the plumb line to the reflective surface of the prism. It is always entered in millimeters, regardless of the current distance units. The default value is 0 mm. Although you are not prohibited from using a positive value, a warning displays to verify your intentions.

✉ **Note**: Apply the prism constant in either the SDR33 or the instrument, but not both. For two-way SET instruments, the SDR33 determines the instrument's prism constant automatically. See Appendix B, Instrument settings, for details.

Orient........... The orientation parameter appears only for two-way SETs. When it is set to **Zero** or **Azimuth**, the SDR33 automatically sets the horizontal circle of the SET to either zero or the computed azimuth at the time of backsight reading. For this reason, averaged F1/F2 values are not allowed. The **None** option does not change the horizontal circle of the SET.

6.1.2 Setting up a level

The SDR33 can work in conjunction with a variety of levels. You can specify the model and specific settings for your level.



The fields display the following information:

Type............. This field identifies the type of instrument and subsequent type of measurement the SDR33 should expect. Select from **Total Stn** and **Level**.

Model........... This field provides the model of instrument based on the selected type; the information is stored as part of the instrument record.

- Manual
- NA2000/3000 - Leica NA2000 and NA3000
- Sokkia SDL1/SDL2
- Zeiss DiNi 10/20
- Sokkia SDL30

Note: If you are using a level instrument that is not listed, select the **Manual** option. For more information on specific instruments and associated settings, see Appendix B, *Instrument settings*.

Note: Selecting a particular instrument will automatically select the appropriate communications parameters for use with that instrument. The communications parameters cannot be changed (not even by the communications setup option in the ***Comms*** menu). See Appendix B for setting your instrument to be compatible with the SDR33.

Level Desc... Enter the type of level you are using; this information is stored as part of the instrument record for descriptive purposes alone.

Level S/N..... Enter the serial number of the level; this information is stored as part of the instrument record for documentation.

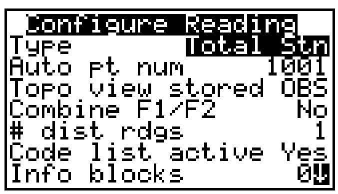
Stadia........... Select the stadia value, **1:100** or **1:300**, when entering 3-wire readings using the **Manual** instrument setting.

6.2 Determining Configure Reading Parameters

The Configure Reading parameters enable you to select settings and preferences that apply to observations taken in the field. These parameters are used in many operations, such as topography, setting out and roading. You can access the ***Configure Reading*** screens by selecting **Configure Reading** from the ***Functions*** menu

6.2.1 Determining configure reading parameters for total stations

The ***Configure Reading*** option allows you to determine specific parameters for observation measurement and recording with your total station.



The fields display the following information:

Type............. If you are working with a total station, select **Total Stn**. This field selection indicates what instrument is attached to the SDR33. Select **Total Stn** or **Level**. For information on selecting a specific model, see Chapter 6.1, *Setting up the Instrument*, *page 6-1*.

Auto pt num .... If you do not enter a point designator, this is the next designator the SDR33 automatically suggests. Once a point designator has been suggested and accepted, the SDR33 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, as described in Chapter 33.1.4, *Reviewing observation records in the database, page 33-4*. This field controls in which view observations are initially displayed using the topography program. Options are as follows:

- OBS raw observation view
- MC measured and corrected view
- RED reduced view
- POS position view

Note: Data is always stored internally in raw form. Topo view stored merely defines the initial view when the record is stored in the database. See also “Specifying the format of observations” for information on the options for outputting data to a printer.

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 average observation record.

 # dist rdgs............. This field specifies the number of distance readings you will take for each point. Values from **0** to **9** are allowed. 0 indicates an angles-only reading is taken.

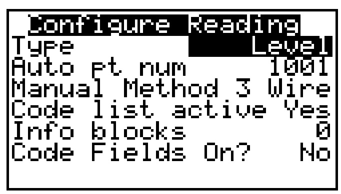
Code list active..... When this field is set to **Yes**, any code field will use the feature code list for quick entry of codes as described in Chapter 6.2.4, *Using Code fields, page 6-11*. When this field is set to **No**, use normal entry of alphanumeric data in the code field.

Info blocks........... This feature provides compatibility with Wild's Info Block style of data entry. Use this field to split your note records into specific fields that contain different types of data (information blocks). For more information, see Chapter 6.2.3, *Using Info blocks, page 6-10*.

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 subfields. For more information, see Chapter 6.2.4, *Using Code fields, page 6-11*.

6.2.2 Configure reading parameters for levels

The ***Configure Reading*** menu enables you to determine specific parameters for observation measurement and recording with your level. The ***Configure Reading*** screen will maintain the last selected settings for the selected instrument, making it easy to switch between instrument types.



The fields display the following information:

Type............. ....Select **Level**. This field selection indicates what instrument is attached to the SDR33. Select **Total Stn** or Level. For information on selecting a specific model, see Chapter 6.1, *Setting up the Instrument, page 6-1*.

Auto pt num ....If you do not enter a point designator, this is the next designator that SDR33 automatically suggests. Once a point designator has been suggested and accepted, the SDR33 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.

Manual Method........This selection field can be toggled between **1-wire** and **3-wire**. Select **1-wire** if you are reading only the center cross hairs. Choose **3-wire** if you are recording top, center and bottom cross hairs.

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 6.2.4, *Using Code fields, page 6-11*. When this field is set to **No**, use normal entry of alphanumeric data in the code field.

Info blocks.. ....This feature provides compatibility with Wild’s Info Block style of data entry. Use this field to split your note records into specific fields that contain different types of data (information blocks). For more information, see Chapter 6.2.3, *Using Info blocks, page 6-10*.

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 subfields. For more information, see Chapter 6.2.4, *Using Code fields, page 6-11*.

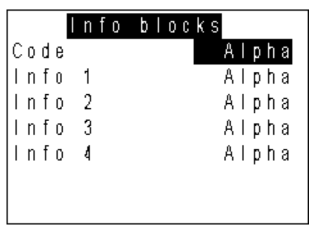
6.2.3 Using Info blocks

The ***Info Block*** field of the ***Configure Reading*** screen allows you to collect information about survey points using Wild's Info Block style of data entry. It should not be confused with the more powerful Attribute definition capability of the SDR33's feature code list.

Note: See Chapter 36, *Feature Codes and Attributes* for information on the SDR33's feature codes capabilities.

Use this field to split your note records into smaller fields containing different types of data (information blocks). Specify the number of extra fields that you want to fill in. The first field is called the **code**; 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 specify the number of information blocks, the following screen displays. Select whether the field should be numerical or alphanumeric by using the <←> or <→> key.



Press <**OK**> to accept the ***Info Blocks*** screen.

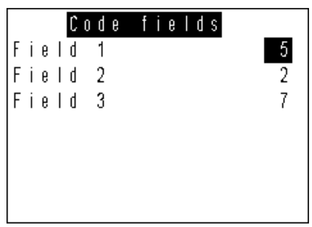
For example, if you specified four info blocks, a note entry might appear as follows:

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 3.2

6.2.4 *Using Code fields*

You can collect feature code information using the Zeiss style of code entry with the ***Code fields*** option in the ***Configure Reading*** screen. This option splits codes into subfields. Enter the number of subfields. The maximum is seven. When you specify a number of code fields greater than one, you can specify the size of each field.



The SDR33 suggests possible default values for the sizes of the fields. The total size of all the subfields must be less than or equal to 16 characters; this number includes a space between each subfield.

During code entry, the <↑> key acts as a tab to move to the beginning of the next subfield within the code field. However, there is no buffer to stop characters in one subfield from overflowing into the next subfield. To edit code fields, highlight the code field and select <→> or <←>.

✉ **Note**: Generally if you are using code fields, disable feature code lists.

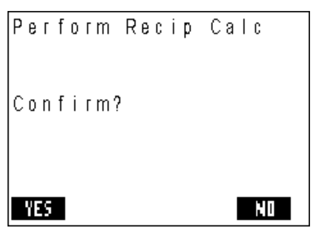
6.2.5 Using Recip Calc

The ***Recip Calc*** field of the Configure Reading screen enables the SDR33 to perform reciprocal vertical calculations automatically This field can also be set to prompt for calculations or to never perform the calculations.

Always......... The SDR33 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. The SDR33 will, in this case, 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 SDR33 will display a prompt. Select <**YES**> if you want the SDR33 to perform a reciprocal calculation. If not, select <**NO**>.



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

6.3 Establishing Tolerances

The SDR automatically checks tolerances and notifies you whenever a tolerance is exceeded, ensuring accurate data collection.

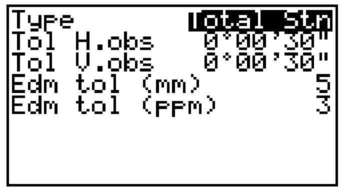
The SDR33 checks observations for consistency within specified tolerances. These tolerances are used throughout the program:

- When you observe an existing point in topography, the SDR33 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 SDR33 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 (3σ).
- 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 happens in topography when the Combine F1/F2 configuration option is enabled and 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 SDR33 will notify you.
- During set collection, each observation is not compared with the other observations to the same point.
- When reviewing sets of data, any observations that are out of tolerance will be marked with an asterisk.

Note: You should specify tolerances for both leveling instruments and total station instruments. These tolerances are stored in the same manner as the reading configuration values and are retrieved automatically when you switch from one type of instrument to another.

6.3.1 Establishing tolerances for total station instruments

You can establish tolerances through the **Tolerances** option of the ***Functions*** menu. The ***Type*** field selection will reflect the current setting in the ***Instrument Setup*** screens.



The fields display the following information:

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 millimeters specifies the EDM error that is independent of the length of line measured.

Note: This field is always in millimeters, even if the current distance units are feet.

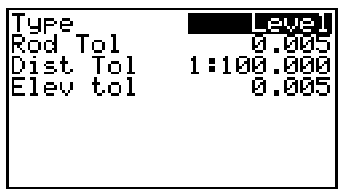
EDM tol (ppm)..... EDM tolerance in parts per million specifies the EDM error proportional to the length of line measured. The EDM tolerance is the sum of the EDM tol (mm) field, plus this field times the length of the line, divided by one million. A tolerance set to zero tells the SDR33 not to check EDM tolerances.

Stn Pos.................. This field is used as a tolerance to determine the quality of the least squares Stn Pos in Professional Positioning. The least squares point standard deviation, multiplied by two, is compared to the value in this field. It is used similarly to determine the LS vs BLAVE qualifier.

HDIST tol (ppm). This tolerance check uses the EDM Field settings and therefore does not posses its own field. The same tolerance procedure used on EDM readings is applied to the distance between an observed position and its expected position. This tolerance checks safeguards against a small angle error (within tolerance) over a long distance propagating into a large position error.

6.3.2 Establishing tolerances for levels

You can establish tolerances for a level through the **Tolerances** option of the ***Functions*** menu.



The fields display the following information:

Type............. This field reflects the current setting in the ***Instrument Setup*** screens.

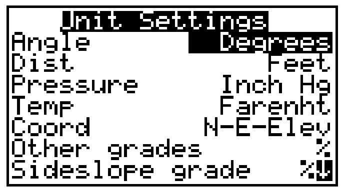
Rod Tol........ Use this field to specify the tolerance in the vertical direction.

Dist Tol........ Use this field to specify the distance tolerance.

Elev Tol........ Use this field to specify the tolerance allowed in elevation angle readings.

6.4 Defining Unit Formats

The SDR33 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 SDR33 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 SDR33 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.

Note: 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, take this factor into account in certain situations such as using state plane coordinate system values.

Pressure .... Pressure units apply to the atmospheric pressure values. Units can be millimeters of mercury (**mm Hg**), inches of mercury (**Inch Hg**) or **millibars**. Conversion factors used are 1 Inch Hg = 25.4 mm Hg and 1,000 mbar = 750 mm Hg.

Temperature .... Temperature units apply to the atmospheric temperature values. Units can be **degrees Fahrenheit** or **degrees Celsius** (Centigrade). The conversion formula used is °C = (°F - 32) / 1.8.

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

N-E-Elv - North, East, Elevation

E-N-Elv - East, North, 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). The options are:

Ratio - for example, 1:10

Percent - for example, 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**.

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

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

Zero Azimuth .... This field determines which direction is used to define the zero azimuth. The options are **north** (default) and **south**.

Chapter 7 Setting Up a Station and Backsight

In this chapter

- Station setup
- Backsight observation
- Deriving station elevation

When you perform surveying tasks (such as taking a reading, setting out and roading), your SDR33 needs information about instrument location, station, and backsight. The initial, and subsequent, instrument location setups are referred to as stations. Setting up a station establishes a base point for the survey. Observing backsight increases the quality of your survey and establishes a known direction for the survey.

When beginning your survey, the SDR33 will prompt you to establish a station and backsight. The initial station record you enter will be used as the base for all subsequent observations. The SDR will use the station and backsight information to calculate future observations.

You can change the station at any time by entering a new point ID in the ***Stn*** field of the ***Confirm Orientation*** screen. If the point ID you entered is not in the currently selected job, the SDR33 will prompt you to enter the new station coordinates.

✉ **Note**: See Chapter 21, *Working with Roads* for setting up a station and backsight for roading programs.

7.1 Establishing a New Station and Backsight

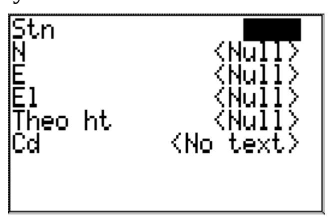
A station and backsight setup is required for most surveying options. The SDR33 will prompt you to create a station if one does not exist. Also, any time you access an option requiring a station and backsight setup, the SDR33 will prompt you to confirm the setup.

✉ **Note**: You do not need to set your station on a known point. If your station is an unknown point, you can use the Resection or Professional Positioning option to determine the location. For more information, see Chapter 9, *Calculating Unknown Stations*.

Steps to set up a station and backsight

1. Connect your instrument to the SDR33 using the supplied serial cable before you initiate an observation. Be sure you have selected the correct total station in the ***Instrument*** menu of your SDR33 (see Section 6.1, *Setting up the Instrument*, page 6-1). Also be sure your surveying instrument is in the proper mode for operation with your SDR33.

2. From the ***Survey*** menu, select **Topography**. The ***Station Setup*** screen will display.



✉ **Note**: You can access the ***Station Setup*** screen by accessing other surveying functions in the ***Survey***, ***COGO, Road*** or ***Level*** menus.

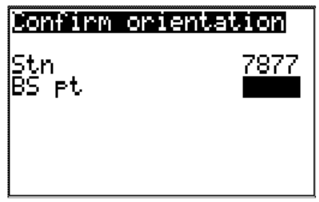
Stn .... This field specifies the station point name. If you enter an existing point ID, the SDR33 fills in the coordinate fields with the point's coordinates; otherwise it sets the coordinate fields to Null (unknown).

North, East, Elev .. These three fields show the point's coordinates. You may change any or all of these values.

Theo Ht................. Enter the theodolite height **-** the instrument's height above the ground point.

Cd .... Enter a descriptive note up to 16 characters, if desired.

3. Press the **<OK>** key to accept the station setup. The ***Confirm Orientation*** screen will display.



4. Enter the backsight point ID in the ***BS pt*** field.

   If the point is unknown, the SDR33 displays two menu options: **Key in coords, Key in azimuth**. You can choose to enter either the backsight coordinates (***Key in coords***) or the azimuth from the current station point to the backsight point (***Key in azimuth***). These two methods are described in Chapter 17, *Keyboard input*.

5. Once the backsight data is entered, the SDR33 prompts you to measure the backsight point. Press **<Read>** to observe the backsight point. Press **<OK>** when the measurement is complete. For more information, see Section 8.1, *Initiating the Observation*, page 8-1.

6. (*optional*) The offset softkeys, <**OFS**>, <**OFS-D**>, <**OS-2D**>, <**ANGLE**>, allow you to observe an offset backsight. For more information on offsets, see Section 8.2, *Observing Offsets*, page 8-3.

7. Press <**OK**> to store and save the station and backsight details. You can then proceed to take readings or press <**Clear**> to return to the ***Survey*** menu.

7.2 Working with Backsights

After establishing a station, the SDR33 will prompt you to observe the station's backsight. Backsights orient the survey to avoid any major directional errors in the survey. A backsight also improves the accuracy of your survey by providing a basis for all future observed angles. The SDR33 generates a back-bearing record (**BKB**). Whenever you change stations, always observe the backsight.

The backsight observation is always in the **OBS** view, even if the **CNFG** option says to store it in **POS** view. (See Section 6.2, *Determining Configure Reading Parameters*, page 6-6, and Section 33.1.4, *Reviewing observation records in the database*, page 33-4 for more information about observation views.) You may, however, change the backsight observation to a **POS**, **RED** or **MC** view using the **<View>** key and the corresponding **<POS>, <RED>, <MC>,** or **<OBS>** softkeys.

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 which will be reflected in the coordinates and will increase in subsequent calculations.

7.2.1 Avoiding backsight

The backsight setup can be avoided, if desired, for testing or training. Press **<Enter>** or **<OK>** when the ***Backsight point field*** is blank to eliminate backsight setup. A confirmation message is displayed.

Press the **<YES>** softkey to avoid the backsight and continue taking topographical observations. Horizontal angles stored are treated as azimuths with no orientation correction applied. This option is enabled until the next station is entered.

7.2.2 Using a backsight to derive station elevation

If you set up your instrument on a station point with an unknown (null) elevation, the SDR33 calculates an elevation for your station if you observe a backsight point with a known elevation. The backsight observation requires a slope distance measurement so the elevation difference between the instrument and backsight target can be calculated. The elevation field in the station record is automatically calculated and changed.

⌧ **Note**: The derivation of station elevation is done only for the first backsight observation; subsequent backsight points' elevations are not used for station elevation determination.

The new station elevation is used for all subsequent calculations involving the station point's coordinates.

⌧ **Note**: See Chapter 21, *Working with Roads* for setting up a station and backsight for roading programs.

7.2.3 Averaging multiple backsights

Just as taking multiple observations in Set collection, you can take multiple backsight observations with the SDR33. Multiple backsights produce more accurate results, improving the reliability of your survey. When more than one known point or azimuth is observed, the back-bearing corrections for each observation are averaged to generate a single back-bearing record. This back-bearing record orients subsequent observations.

7.2.3.1 Multiple backsights in topography

The back-bearing record contains two fields: the 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.

In the case of multiple backsights, the SDR33 generates a back-bearing record with the point number of the most recently observed backsight and the calculated horizontal observation.

✉ **Note**: This horizontal observation is not a value that has originated from the instrument. 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 you are using an instrument that accepts horizontal circle information, such as the SETC, 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 are internally weighted, so observations to a third backsight point will be correctly averaged with the previous two backsight observations.

7.2.3.2 Multiple backsights in other operations

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.

7.3 Determining Unknown Stations

The SDR33 provides two methods for calculating the coordinates of an unknown or free station. Depending on the SDR software installed, your SDR33 will have one of these methods:

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

Positioning ...... The Professional Positioning method uses a balanced last absolute value estimation and mathematical techniques to determine the coordinates of an unknown point and any observational errors.

Refer to Chapter 9, *Calculating Unknown Stations* for information on both of these methods.

Chapter 8 Taking a Reading

In this chapter

- Initiating an observation
- Observing offsets
- Averaging multiple observations

Whenever you observe a point and record data associated with the location you are taking a reading. This chapter explains the basic procedure for taking a reading using any survey function.

If you are unable to actually set up on the point to be observed, the SDR33 allows you to perform several different kinds of offsets. An offset is a different method of recording point information by observing accessible angles and distances related to the point and then calculating them to produce an accurate location.

To increase the accuracy of your survey, you can also take multiple observations to a point and then calculate the inherent error and corrected calculations of a point. Averaging multiple observations can assist you in collecting accurate data without performing complicated math or having to reobserve points.

8.1 Initiating the Observation

Once you have created a job and established the station and backsight, the SDR33 is ready to take a reading. The basic procedure for taking any reading, or observation, with any survey operation follows these steps.

Steps to initiate an observation

1. Connect your instrument to the SDR33 using the supplied serial cable before you initiate an observation. Be sure you have selected the correct total station in the ***Instrument*** menu of your SDR33 (see Section 6.1, *Setting up the Instrument*, page 6-1). Also be sure your surveying instrument is in the proper mode for operation with your SDR33.

2. Select **Topography** (or the appropriate option) from the ***Survey*** menu.

   — OR —

   Initiate a reading by pressing the **<Read>** key. The surveying instrument starts measuring, and the SDR33 displays the observation.

✉ **Note:** If you have not established a station and backsight, the SDR33 will display the Station Setup screen. For more information, see Chapter 7, *Setting Up a Station and Backsight*.

3. The SDR33 will display the observation information.

   H.obs............ This field displays the horizontal distance measurement.

   V.obs .... This field displays the vertical distance observation.

   S.Dist .... This field displays the slope distance.

   Cd .... Enter a descriptive note for the observed point. If the **Code lists active** option in the ***Configuration*** menu is set to **Yes**, feature codes can be selected from this field. (For more information, see Section 36.3, *Using Feature Codes*, page 36-10.)

   Pt................... The ***Point*** name field is the name of the point being observed. Initially, this contains the next automatic point name allocated by the SDR33.

Note: Even though the SDR33 is connected to a surveying instrument, it is still possible to enter values for the ***H.obs, V.obs*** and ***S.Dist*** fields while the instrument is taking a reading. The instrument may overwrite what you have typed, but this facility permits you to enter data for an instrument without an EDM.

4. (*optional*) Use the three softkeys, **<OFS>**, **<OFS-D>** and **<OFS-2D>**, to take offset measurements. For more information, see Section 8.2, *Observing Offsets*, page 8-3.

5. (*optional*) Use the **<ANGLE>** softkey to initiate an angles-only (theodolite mode) reading, and use the **<CNFG>** softkey to access the ***Configuration*** menu (see *Section 6.2*, *Determining Configure Reading Parameters*, page 6-6.)

6. End the observation and store the data by pressing **<OK>**. The SDR33 displays **Input accepted** and returns to the ***Take BS reading*** screen.

Shortcut: Press **<Read>** to store the observation and initiate another reading.

8.2 Observing Offsets

If you are unable to set up directly on the desired point, you can perform an offset. Offsets measure the distances and azimuths to the desired point and use geometrical formulas to derive the desired points. Three types of offset are available for topographical (and other) observations.

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

8.2.1 Angle offset observations

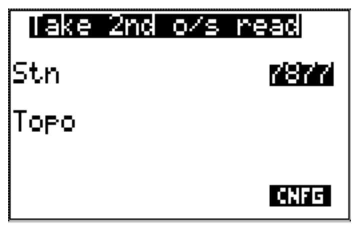
The angle offset observation is made with two readings. The first reading observes the vertical angle and distance and is observed on the prism. To take the second reading, the surveyor rotates the instrument until the target point is in sight. The surveyor then observes the horizontal offset angle. The SDR33 combines both readings into a single angle offset observation record.

Steps to take an angle offset observation

1. From the ***Take reading*** screen, press the **<OFS>** softkey.

2. The SDR33 takes the first reading (from the prism) and displays the results.

3. Press the **<OK>** key to accept the first reading. The SDR33 prompts you to take the second reading.



4. Rotate the surveying instrument until the target point is lined up in the instrument's sight. Press the **<Read>** key to take the second reading.

5. The SDR33 takes the second reading and displays the results.

6. Enter a code in the ***Code*** field and press the **<OK>** key to accept the entire reading. The SDR33 will return to the ***Take reading*** screen.

8.2.2 Single-distance offset

The single-distance offset is made by observing a prism 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 8-1).

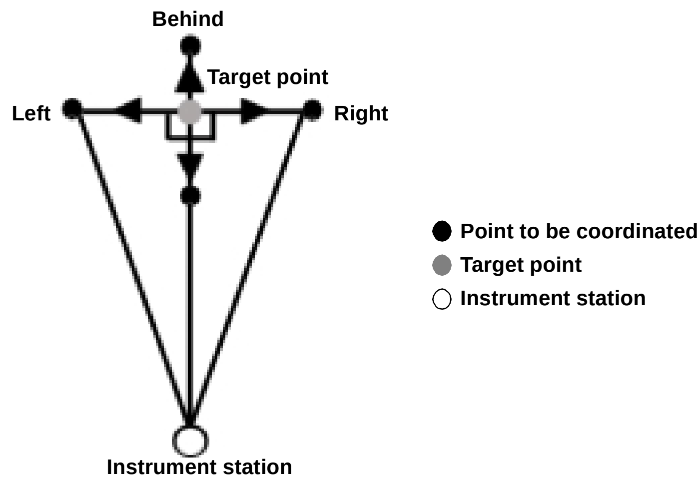


Figure 8-1: Direction to the prism from the target point

Steps to take a single distance offset observation

1. Initiate the single-distance offset observation by pressing the **<OFS-D>** softkey; the surveying instrument measures the angles and distance to the prism.

2. Enter selections for the following fields:

Ofs dist........ This field indicates 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 accept the default value.

Dirn to prism....This field indicates the direction *to the prism from the target point* as viewed by the instrument operator. Assign direction to the prism by using <←> or <→> key to scroll through possible directions (←, →, ↑ or ↓).

Interpret the arrow direction from the perspective of the instrument operator as follows.

- Right arrow — prism is to the right of the target point
- Down arrow — prism is in front of the target point
- Up arrow — prism is behind the target point
- Left arrow — prism is to the left of the target point.

Use the left and right arrow keys to select the correct direction to prism and press <**Enter**>.

3. Once the fields and the measurement are complete, press <**OK**>. The SDR33 calculates the horizontal and vertical angles and slope distance to the target point and stores an observation record. The offset from the prism to the target point is assumed to be horizontal. A Note record (example shown below) is generated showing the original measurements and the offset distance and direction used in the calculation. See Figure 8-2.

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

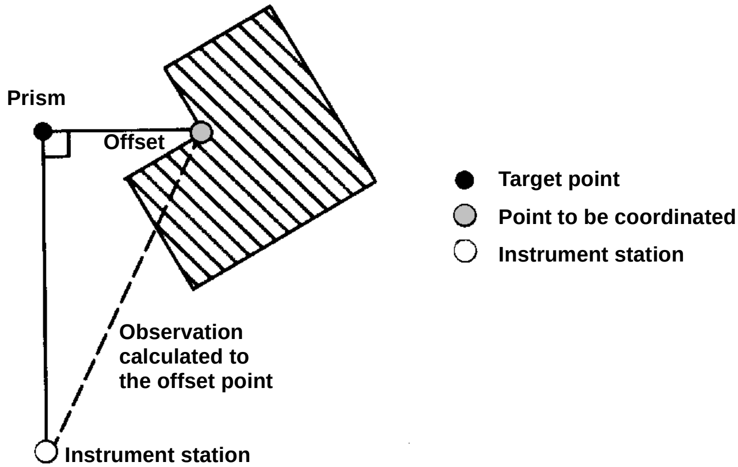


Figure 8-2: Horizontal/vertical angles and slope distance calculation

8.2.3 Two-distance offset observation

The two-distance offset observation is made by using a rod with two prisms attached. The rod extends a known distance past the end of each prism. Both prisms are observed and the SDR33 calculates the vector between them. The vector is then extrapolated the specified distance to find the target point's coordinates.

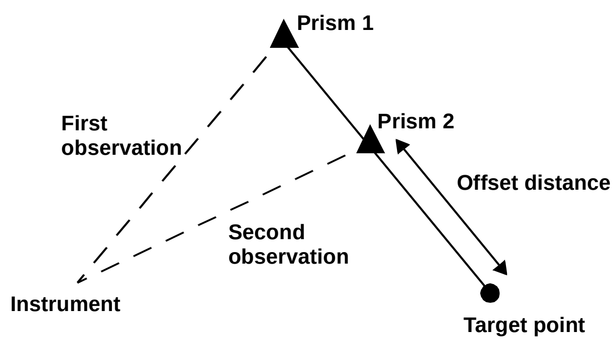


Figure 8-3: Two-distance offset

Steps to take a two distance offset observation

1. Sight on the first prism (furthest from the target point) and initiate the two-distance offset observation by pressing the **<OS-2D>** softkey.

2. Enter an offset distance and a code in the ***Code*** field. Press **<OK>** to accept the first reading.

3. The SDR33 prompts you for the second reading.

4. Sight on the second prism and press **<Read>**. The SDR33 reads the distance and direction to the second prism and displays the following screen.

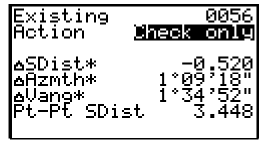
5. Press **<OK>** to accept the entire observation. The SDR33 calculates the positions of the two prisms, extrapolates the vector between them for the offset distance and calculates the observation that a prism directly on the target would have made. This calculated observation is stored in the appropriate view.

WARNING: 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.

8.3 Averaging Multiple Observations

When you use the topography program to observe a previously observed point or a point already known to the SDR33, you are shown the difference between the observation and the observation expected by SDR33 based on its data. For example, you may see a screen where “*” indicates a value that exceeds the tolerances specified in the ***Tolerance*** menu.



The Δ***SDist*** field shows the difference in slope distance AB and the distance AB' (Figure 8-4). The Δ***Azmth*** field shows the difference between the azimuth from A to B and the azimuth to the observed point B'. The Δ***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'.

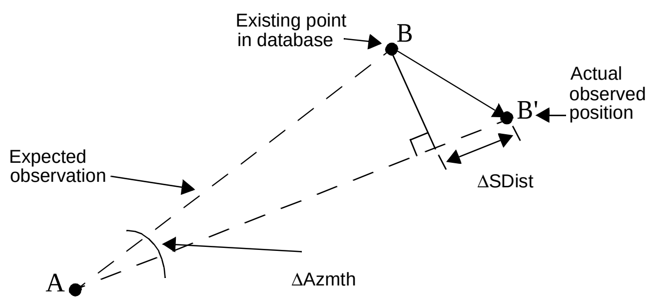


Figure 8-4: Comparing previous data and current observation

Steps to average multiple observations

1. Select the desired option in the **Action** field by pressing the <→>or <←> key. (Some of these options may not be available if they are not relevant.)

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

Store OBS.... This option 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.

Note: This option may be useful to observe a point within a traverse without overwriting an existing POS observation.

Check only.. This option 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.

Rename........ This option enters a different target point name for the observation you just made. If the renamed pt ID already exists in the database, a warning message will display.

Average........ This option averages the new observation with the existing data. The average is generated using one of two methods:

- 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.

Average BS.. This option uses the new observation as the new backsight reading.

2. Press **<OK>** to continue.

3. Press **<Clear>** to ignore the observation.

Chapter 9 Calculating Unknown Stations

In this chapter

- Using resection to calculate unknown stations
- Using resection to calculate an inaccessible station
- Using Professional Positioning to calculate unknown stations

When performing several common operations, you will need to establish a station as the base for subsequent observations. Any time the instrument is moved to a new location, the SDR33 will prompt you to establish a new station.

Stations are not required to be known locations. However, you may need to calculate an unknown station's location in the field. The SDR needs accurate station coordinates for some options, including coordinate geometry, transformations, roading, and set out. You do not need to calculate an unknown station for general surveying options, such as topography, remote elevation, or building face survey.

If your survey contains some known positions, the SDR33 can calculate the position of an unknown point. Depending on the version of SDR software installed, one of the two methods will be available. Both options use known data to compute unknown locations. The two options vary in the mathematical processes used to derive the coordinates.

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

Positioning . The Professional Positioning method uses a balanced last absolute value estimation and mathematical techniques to determine the coordinates of an unknown point and any observational errors.

Both Resection and Professional Positioning use the same technique to observe multiple observations as the Set Collection option. For more detailed information on the Set Collection option, viewing collected set and special set collection cases, see Section 15.2, *Traversing with Set Collection*, page 15-3.

You can calculate multiple unknown stations by repeating the Resection or Professional Positioning process for each station. The SDR33 will store the calculation results in the database, for use in determining future stations, observed coordinates or calculating coordinate geometry functions.

9.1 Using Resection

The Resection program calculates the coordinates of an unknown station by observing a number of known positions from the unknown point. The SDR33 performs a least squares reduction so all data is used and redundant data generates better statistical results. Using the Resection option requires at least one of the following:

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

- three observations with horizontal angles.

The SDR33 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 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°. 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.

9.1.1 Performing a resection

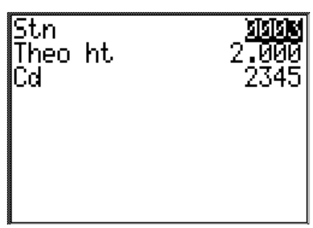
You can use the Resection program to calculate the coordinates of an unknown station. To perform the resection, you will need to observe multiple observations associated with the unknown point. The SDR33 can then calculate the unknown station using a least squares adjustment.

The Resection program uses the same technique to observe multiple observations as the Set Collection option. For more detailed information on the Set Collection option, viewing collected set and special set collection cases, see Section 15.2, *Traversing with Set Collection*, page 15-3.

Steps to perform a resection

1. Select a job and choose **Resection** from the ***Survey*** menu to start the resection program.

2. Enter the point name of the station on which you have set up, the theodolite height and the atmospheric details in the ***Confirm Stn*** screen.



3. Use the **<OPTION>** softkey to access set collection parameters.

```
Method      Direction
Data              HVD
Number of H sets    1
# dist rdgs         1
Face order F1F2/F2F1
Obs order    123..321
Return sight       No
Pre-enter point   Yes
```

Enter information in the following fields:

Method .... This field indicates the sets collection method:

Direction — observing several points using the same instrument orientation

Repetition — observing a single angle between two points several times using different instrument orientations.

Data .... This field controls which observational measurements will be collected together. The options are as follows:

HVD — All measurements are collected in each set of observations.

H,VD — The horizontal angles are collected during one observation. The vertical angle and distance are collected on the next observation.

H,V,D — The horizontal angle, vertical angle, and slope distance are collected in separate observations.

Where: **H** = horizontal angle, **V =** vertical angle, and **D** = slope distance

Number H sets .... This field controls how many sets of horizontal angles are collected.

✉ **Note**: In the case where the data being collected is **HVD**, the **Number of H sets** is also the number of sets of vertical angles. 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, six physical rounds of observations are required (one for each face for each set).

Number of V sets ..... This field appears only if the data being collected is **H**,**VD** or **H,V, D;** this field indicates how many sets of vertical angles are collected.

 # dist rdgs.................. This field controls how many distance observations are made during each observational sighting. Enter a value between 0 and 9.

✉ **Note**: The SDR33 will initiate multiple distance reads only for Sokkia surveying instruments.

Face order.................. This field controls the switching between F1 and F2 during the collection of single as well as multiple sets. Select from the following options:

• F1 only	• F1F2 / F1F2	• F2F1 / F2F1
• F2 only	• F1F2 / F2F1	• F2F1 / F1F2

Selections showing two sets, separated by a slash, indicate both Face 1 and Face 2 will be used.

For example, F1F2 / F2F1 specifies the first set of observations will be made to points beginning with Face 1 and then Face 2 of your instrument. The second set, indicated by / F2F1, you will reobserve the same points beginning with Face 2 and then Face 1 of the instrument.

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.)

Obs order .... This field specifies the order in which the SDR33 prompts you to observe points when collecting individual sets.

Unprompted - ...... The SDR33 will not prompt you at all and observations may be made in any order.

123...123 - .... The SDR33 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

123...321 - .... The SDR33 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

Return sight.......... This field specifies whether you wish to sight again on the first observed point in a set when the end of the set is reached. For example, if points 1, 2 and 3 are observed and a return sight is selected, then the physical observations made would be 1, 2, 3, 1. Any error found in the return sighting is distributed between the other observations.

This field displays only when the set collection method is **direction**.

Preenter points..... This field determines if you enter a list of points that you will observe, prior to observing any points in the set. The SDR33 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 **Yes**, the SDR33 allows you to enter a list of points that you will observe, prior to observing any points in the set.

If this field is set to **No**, you will not be asked for the point names prior to observing the points. The SDR33 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.

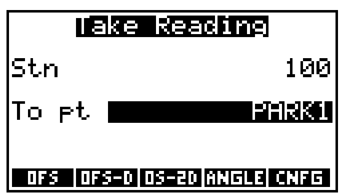
Recip Calc............ Choose whether to perform reciprocal calculation. The options are **Prompted**, **Always** or **Never**.

4. Press <**OK**> to accept options and continue.

✉ **Note**: If at any time you want to leave the set collection procedure completely, press **<Clear>**.

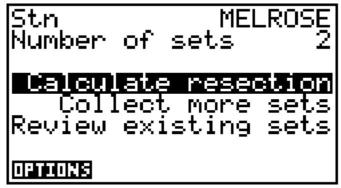
---

5. When the instrument is sighted correctly, press the **<Read>** key to initiate a reading. The standard observation screen will display.



6. Continue observing until you have collected the set of observations.

7. Once all the set criteria is complete, select from the three available options:



Calculate resection ....This option calculates the station by performing a least squares adjustment. For more information, see Section 9.1.2, *Calculate resection*, page 9-8.

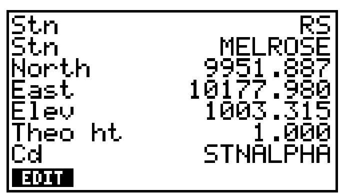
Collect more sets ....Select this option to collect more observation sets. For more information, see Section 9.1.3, *Collect more sets*, page 9-9.

Review existing sets .....Select this option to review the collected observation sets. For more information, see Section 9.1.4, *Review existing sets*, page 9-9.

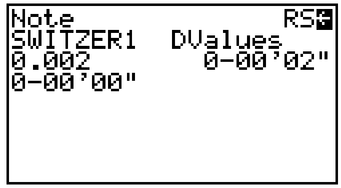
9.1.2 Calculate resection

The **Calculate resection** option calculates the coordinates of the station point. If redundant data exists, a least squares calculation is performed.

During calculation, the screen displays a **Processing data** message and indicates the current iteration. When calculations are complete, the SDR33 displays a station record containing the calculated coordinates.



Use the **<EDIT>** softkey to change the code. Otherwise, press **<Enter>** to store the record. If you press **<Enter>**, the SDR33 stores a series of notes that show the differences between the expected and actual observation values for each point. For example, if the SDR33 calculates station coordinates of 100, 300, the SDR33 calculates the inverse from the station to each observed point. The notes show the difference between the calculated inverse and the actual observations.



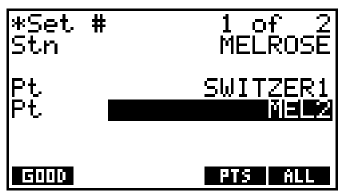
Press **<Clear>** to cancel this process, a confirmation prompt will display.

9.1.3 Collect more sets

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

9.1.4 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.



(For information on reviewing sets and marking a set as BAD, see Section 15.2.2.6, *GOOD and BAD sets*, page 15-18.)

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

9.1.5 Using an eccentric station setup

If a desired station location is inaccessible, you can perform an eccentric station setup using resection to calculate the coordinates. An eccentric station is essentially an offset with multiple observations. By setting up on an arbitrary point near a known and near the desired station location, the SDR can observe distance and angle measurements using several known points to compute the inaccessible station.

Steps for completing an eccentric station setup

1. Set up on any arbitrary point near the first known point.

2. Select **Resection** from the ***Survey*** menu.

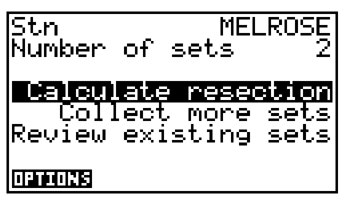
3. Use the <**OPTION**> softkey to access set collection parameters. For more information, see Section 9.1, *Using Resection*, page 9-2.

4. Take an offset distance reading to desired station location by pressing the <**OFS-D**> softkey. (You may wish to tape the distance.)

5. Take an angles only reading to the desired station location by pressing the <**ANGLE**> softkey.

6. Continue observing nearby points to complete the observation set.

7. Press <**OK**> to display the resection options.



8. Select **Calculate resection**, the Resection program calculates the new station position.

9. Press <**Enter**> to save the resection results as a series of notes in the SDR database.

9.2 Using Professional Positioning

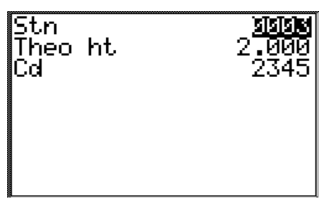
Professional Positioning (PROFPOS) determines the unknown position coordinates by way of two alternate adjustment procedures: Least Squares (LS) and Balanced Least Absolute Value Estimation (BLAVE). The LS procedure is used in typical resection calculations. The BLAVE procedure allows for the detection of outlying observation errors, or blunders, minimizing the leverage effect. The results of both adjustment procedures are available within PROFPOS.

The coordinates for the unknown station are found by observing a number of known positions from the unknown station. PROFPOS automatically calculates the approximate coordinates and executes the adjustment computations. Statistical methods within the BLAVE procedure minimize, and in most cases, eliminate the adverse affect of outlying observations on the calculated position. Once the results are given, the user is able to trace any errors, such as wrong target point, point displacement or incorrect measurement.

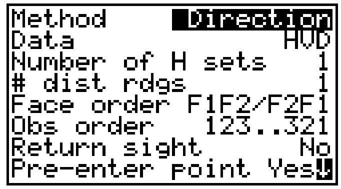
9.2.1 Using Professional Positioning to calculate a station

1. Choose **Positioning** from the ***Survey*** menu to start the Professional Positioning option.

2. The SDR33 displays the ***Confirm Stn*** screen. Accept or edit the station Pt ID and other fields.



3. Use the **<OPTION>** softkey to access set collection parameters.



Enter information in the following fields:

Method.................This field indicates the sets collection method:

Direction — observing several points using the same instrument orientation

Repetition — observing a single angle between two points several times using different instrument orientations.

Data.......................This field controls which observational measurements will be collected together. The options are as follows:

HVD — All measurements are collected in each set of observations.

H,VD — The horizontal angles are collected during one observation. The vertical angle and distance are collected on the next observation.

H,V,D — The horizontal angle, vertical angle, and slope distance are collected in separate observations.

Where: **H** = horizontal angle, **V =** vertical angle, and **D** = slope distance

Number H sets.....This field controls how many sets of horizontal angles are collected.

✉ **Note**: In the case where the data being collected is **HVD**, the **Number of H sets** is also the number of sets of vertical angles. 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, six physical rounds of observations are required (one for each face for each set).

Number of V sets This field appears only if the data being collected is **H**,**VD** or **H,V, D;** this field indicates how many sets of vertical angles are collected.

 # dist rdgs............. This field controls how many distance observations are made during each observational sighting. Enter a value between 0 and 9.

✉ **Note**: The SDR33 will initiate multiple distance reads only for Sokkia surveying instruments.

Face order............. This field controls the switching between F1 and F2 during the collection of single as well as multiple sets. Select from the following options:

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

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.)

Obs order .... This field specifies the order in which the SDR33 prompts you to observe points when collecting individual sets.

Unprompted - ...... The SDR33 will not prompt you at all and observations may be made in any order.

123...123 - .... The SDR33 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

123...321 - .... The SDR33 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

Return sight.......... This field specifies whether you wish to sight again on the first observed point in a set when the end of the set is reached. For example, if points 1, 2 and 3 are observed and a return sight is selected, then the physical observations made would be 1, 2, 3, 1. Any error found in the return sighting is distributed between the other observations.

This field displays only when the set collection method is **direction**.

Preenter points..... This field determines if you enter a list of points that you will observe, prior to observing any points in the set. The SDR33 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 **Yes**, the SDR33 allows you to enter a list of points that you will observe, prior to observing any points in the set.

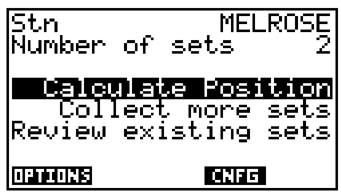
If this field is set to **No**, you will not be asked for the point names prior to observing the points. The SDR33 will, however, intelligently guess which point you are observing based on the observations taken, and assist you by supplying the point name, code and target height, if required. This feature is active only for sets collected by direction.

Recip Calc Choose whether to perform reciprocal calculation. The options are **Prompted**, **Always** or **Never**.

Note: A Note record is entered in the database when a reciprocal calculation is 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 #### & ####**.

---

4. Press <**OK**> to finish observing. The Professional Positioning options are displayed.



Select one of the available options:

Calculate position .... Select this option to calculate the unknown station. For more information, see Section 9.2.1.1, *Calculate position*, page 9-17.

Collect more sets .... Select this option to collect more observation sets. For more information, see Section 9.2.1.2, *Collect more sets*, page 9-22.

Review existing sets .... Select this option to review the collected observation sets. For more information, see Section 9.2.1.3, *Review existing sets*, page 9-22.

5. Press **<Enter>** to store the calculated position; press **<ESC>** to discard it.

6. (*optional*) The **<CNFG>** softkey allows you to change which adjustment procedure's calculated position is displayed on the initial results screen. The options are **BLAVE** and **Least Squares**.

BLAVE ....This option performs a BLAVE adjustment.

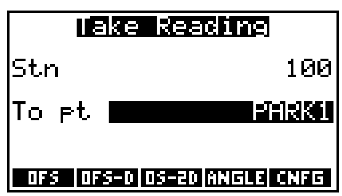
Least Squares ....This option calculates the unknown station using a least squares adjustment.

7. Press <**OK**> to accept options and continue.

✉ **Note**: If at any time you want to leave the set collection procedure completely, press **<Clear>**.

---

8. When the instrument is sighted correctly, press the **<Read>** key to initiate a reading. The standard observation screen will display.



9. Continue observing the observation set.

Face 1 and Face 2 observations and observation sets and averaged together. Observational errors can be minimized by distribution through the average. However, the BLAVE procedure statistically detects these errors, a more important property is real redundancy within a set of observations. By introducing more observations to unique points than necessary the unknown position is determined with more accuracy and better error detection. Redundant data generates better statistical results.

9.2.1.1 Calculate position

The **Calculate position** option calculates the coordinates of the station point. The screen will display a **Processing data** message. Calculations are performed for both adjustment procedures.

✉ **Note**: If the SDR33 detects any errors, a message will display. For more information, see Section 9.2.3, *Professional Positioning error/ warning messages*, page 9-24.

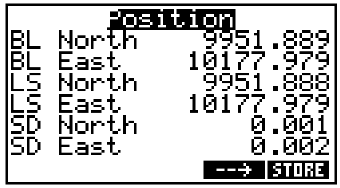
Once the calculations are complete, a station record containing the calculated coordinates of the configured adjustment procedure.

The **<RESULTS>** softkey gives position, correction and adjustment comparisons for both adjustment procedures. BLAVE is designed to detect errors as far as is statistically possible; least squares is designed to provide minimal standard errors for the computed position. When there are no errors in the observations, both procedures will yield virtually the same results within the standard error of the least squares position.

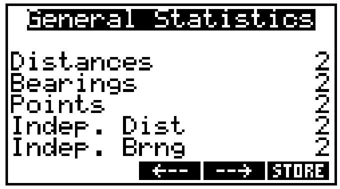
Use the **<STORE>** softkey at any point to store the displayed results within a note in the database. The <←> and <→> softkeys allow you to navigate through the screens. When applicable, the <PGDN> and <PGUP> softkeys allow the user to view more information on each observation point.

The following screens are available with the **<RESULTS>** softkey.

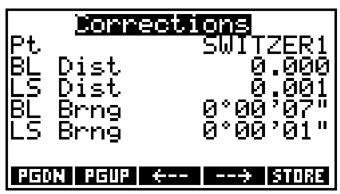
- ***Position*** screen — compares the coordinates calculated by both adjustment procedures.



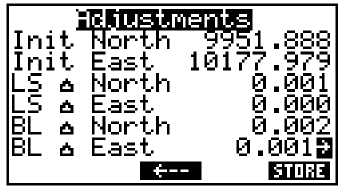
- ***General Statistics*** screen — provides general information about the points which were observed.



- ***Corrections*** screen — gives the bearing and distance corrections which were applied by each adjustment procedure. The BLAVE corrections will indicate certain observations with an asterisk next to the appropriate bearing or distance. The asterisk indicates that the corresponding correction exceeds the a priori standard error of the observation (observation tolerances as set in the ***Tolerance*** screen) multiplied by ten. This can be a useful tool in detecting blundered observations. Each observed point may be reviewed by using the **<PGDN>** and **<PGUP>** softkeys.



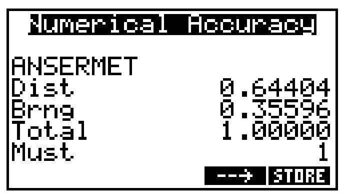
- ***Adjustments*** screen — shows the subsequent adjustments made to the coordinates of the initial position. Adjustments for both procedures are given as well as the initial coordinates.



The **<DETAILS>** softkey shows advanced least squares statistical data. You can use the <←>**,** <→>,**<PGDN>** and **<PGUP>** softkeys to navigate through the data. Three screens are displayed:

- ***Numerical Accuracy***
- ***Advanced LS Stats***
- ***Advanced LS Results***

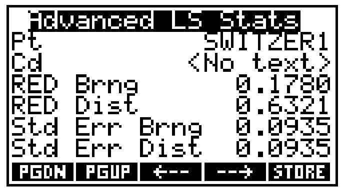
- The Ansermet data reveals information about the observations. An Ansermet of zero indicates there is no real redundancy in the adjustment. A separate warning screen is displayed prior to the display of the calculated position coordinates to warn the user of this situation. In the case of no redundancy (Ansermet = 0.0), error detection is not possible and all corrections become zero.



A typical Ansermet will be an integer value greater than zero. If an Ansermet is equal to 1, corrections are given but error detection is not theoretically possible. The same redundancy warning is displayed. If the Ansermet is not an integer value, it is an indication that computing problems were encountered in the adjustment.

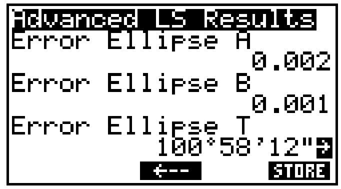
The next two screens, the ***Advanced LS Stats*** screen and the ***Advanced LS Results*** screen, are intended to give an understanding of the least squares results. Since the BLAVE procedure statistically detects errors and distributes the partial redundancies (see Section 9.2.4, *Understanding Professional Positioning results*, page 9-25), these screens are intended as additional tools to interpret results.

- The ***Advanced LS Stats*** screen gives the reduced bearing and distance as well as the standard error bearing and distance for the observed points. Each point can be shown by paging up and down.



The ***Advanced LS Stats*** screen gives the partial redundancies, ***RED Brng*** and ***RED Dist***, which range in value from 0.0 to 1.0. A large value (close to 1.0) has a minimal impact on the LS adjustment while a small value has a greater affect. Summing of these values leads to the degree of freedom. Equal numerical values for RED indicates equal distribution of the partial redundancies and therefore an ideal LS target point constellation. The ***Std Err Brng*** and ***Dist*** are a test for errors within a single point adjustment derived from LS statistics.

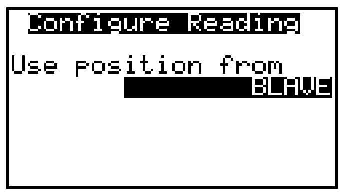
- An error ellipse, as shown in ***Advanced LS Results***, can be calculated to indicate the major and minor axis (A and B) of the ellipse related to the target point coordinate system. The azimuth T indicates the bearing of the major axis. The information is useful for location accuracy properties. Ideally, the error ellipse becomes a circle when the major and minor axis are equal (A = B).



While in ***RESULTS*** or ***DETAILS***, pressing the **<ESC>** or **<Enter>** will return you to the station record screen.

Press **<Enter>** to store the station record as well as a note stating which adjustment method was used to determine the coordinates. If you press **<ESC>**, a confirmation prompt verifies that the station record will be discarded.

The **<CNFG>** softkey allows you to change which adjustment method's results will be displayed in the station record screen.



To change the configured adjustment procedure, use the left and right arrow buttons to toggle between ***BLAVE*** and ***Least Squares***.

The coordinate qualifier of LS is used for least squares and BL for BLAVE. The least squares point standard deviation, multiplied by two, is compared to a user-supplied tolerance in the ***Functions*** menu under **Tolerances**. If it exceeds it, the Stn pos is determined as "Bad" to indicate further investigation of the results may be necessary.

The BLAVE results uses ***LS vs. BLAVE*** as seen on previous screens. That user-supplied tolerance as described above is applied to the horizontal distance between the determined station position of both adjustment procedures (multiplied by two). If it is exceeded, ***LS vs. BLAVE*** is marked “Bad.” It informs the user when the results of the two procedures deviate from each other.

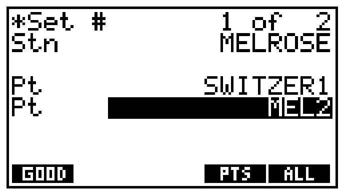
Use the **<EDIT>** softkey to change the station’s feature code.

9.2.1.2 Collect more sets

If you are not satisfied with the positioning coordinates produced, you can collect more sets with which to recalculate coordinates by selecting the **Collect more sets** option.

9.2.1.3 Review existing sets

You can use the **Review existing sets** option to view the data collected. (For information on reviewing sets, see Chapter 11, *Set collection*) If you find a set with errors, mark it “BAD” so it will not be used in calculations. An asterisk denotes a bad set.



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

9.2.2 Professional Positioning input

Two separate adjustment procedures are available within professional positioning: Least Squares (LS) and Balanced Least Absolute Value Estimation (BLAVE). The LS and BLAVE procedures differ in their initial estimation technique. The BLAVE estimation technique allows for detection of errors.

Determining an unknown position 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 SDR33 estimates an initial 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 is an iterative process that 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 five iterations because the reduction is not stable. An error message is displayed.

The LS procedure uses weighted averages of the observations to estimate an initial X-Y position. An observational error, or blunder, is thereby given unbounded influence to the estimation result.

The BLAVE technique, however, provides useful estimation data by balancing the observations, allowing detection of gross error by statistical means. Blunders then have minimal influence on the initial estimation. The estimation is then used in the iterative process.

The threshold of error detection for a BLAVE computation is dependent on the number of observations introduced. The equation is as follows:

> number of blundered observation components = (number of observation components - 3) / 2

where an observation component is a full bearing or a distance.

For example, three full readings (two components each) and a bearing (single component) allows for (7 - 3) / 2 = 2 blundered components. In determining your unknown station, introducing more observations than necessary will yield higher accuracy of the position, better checks on plausibility and improved error detection.

Although BLAVE is not as prone to geometric limitations as the least squares procedure, it is good practice to ensure that the geometry of the observations produces a stable result. For example, avoid your target points forming a straight line with the unknown station lying close to that line. Similarly, unreliable results will occur if the target points and the unknown station lie on a circle.

9.2.3 Professional Positioning error/warning messages

Error messages and warnings are given to the user if any situations arise for which a BLAVE and / or an LS adjustment procedure can not be computed. Additionally, warning messages are displayed if the computations could potentially suffer due to the data supplied. The following are the error and warning messages given by Professional Positioning with an explanation and possible solutions.

- **Computation of position not successful.** Add more target points. Too few target points were included from which to compute the unknown station position. Additional, non-identical target points should be added.

- **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.

- **Unable to determine a unique position.** Adjust target point constellation. A unique position is not possible due to lack of observation data to target points in existing constellation. Full observations should be taken if possible, or additional target points should be added.

- **Unable to determine approximate values.** Adjust target point constellation. The existing target point constellation possess unstable geometry or contains an incomplete combination of bearings and / or distances which may give erroneous results. The target point constellation should be supplemented with additional observations.

- **Results may suffer from rounding errors.** Adjust target point constellation. Rounding errors occurred within the Linear Programming algorithms. Numerical results may not be sufficient.

- **Maximum iterations reached.** The predefined maximum number of steps for the balancing computation has been reached. The resulting balancing factors were introduced to the BLAVE adjustment computation.

- **Observations not balanced.** The balancing procedure was not possible. A Least Absolute Value Estimation (LAVE) was executed instead of the BLAVE.

- **Ansermet < 2 No Redundancy caution.** The least squares ansermet is less than two. For more information, see 9.2.4, *Understanding Professional Positioning results*.

9.2.4 Understanding Professional Positioning results

Several qualifying indicators exist to guide the user toward understanding Professional Positioning results:

- **Least Squares statistical data -** can be used to determine, independently, the validity of the Least Squares result. This can be particularly helpful in the event that the LS and BLAVE results do not coincide. For discussion on the statistical data produced, please see Section 9.2, *Using Professional Positioning*, page 9-11.

- **Ansermet < 2 No Redundancy caution -** The determination for this warning message is the least squares ansermet. When the ansermet is equal to zero, there is no real redundancy in the adjustment. Error detection is not possible and all corrections become zero. If the ansermet is 1, error detection is not theoretically possible but some corrections are made. It can be an indication to the user that a particular situation could produce unreliable results. In the case of ansermet = 0 or the case of ansermet = 1 with a blunder detected, it should be verified that the geometry of the target point constellation is stable.

- **"Stn pos" -** A particular least squares statistic, the standard deviation, is used to determine a ***Stn pos*** as good or bad. The standard deviation, times two, is compared to a user-supplied tolerance in the **Func** menu under ***Tolerances***. If it exceeds it, the

Stn pos is determined as “bad”. This is meant to be an indicator to the user that the LS standard point deviation is large prompting further investigation of the results.

- **“LS vs. BLAVE” -** That same tolerance is applied to the horizontal distance between the determined unknown station position of both adjustment procedures (times two). It informs the user when the results of the two procedures deviate from each other. This would be expected in the presence of blunders which typically, and incorrectly, alter a Least Squares position.

- **Blunder detection -** Because blunders have an adverse affect on Least Squares adjustments and are helpful in explaining the status of other indicators, it is important for the user to be made aware of their presence. A target point observation, bearing or distance, is marked as a blunder if the corresponding correction exceeds the apriori standard error of the observation multiplied by ten. The apriori standard error of the observation are the observation tolerances set in the Tolerance screen in the ***Func*** menu.

3

Coordinate Systems

This section provides information on working with coordinate systems. The SDR supports local assumed, projected grid, and ellipsoidal coordinate systems. Also included in this section are procedures on uploading transformation files, performing calibrations, and working with functional exceptions.

Overview of Coordinate Systems

- *SDR Requirements*
- *Types of Coordinate Systems*
- *Understanding Transformations*

Using Coordinate Systems

- *Selecting Transformations*
- *Using Local Assumed Grid Coordinates*
- *Using Projected Grid Coordinates*
- *Using Ellipsoidal Coordinates*
- *Transferring (XFM) files*

Performing Calibrations

- *Calibrating Local Assumed Grid Coordinates*
- *Performing Calibrations with Projected Grid Coordinates*
- *Calibrating with the SDR33*

Chapter 10 Overview of Coordinate Systems

In this chapter

- SDR requirements
- Types of coordinate systems
- Reduction process
- Understanding transformations

A coordinate system is a reference frame used to designate a position. The SDR supports three types of coordinate systems - local assumed grid, projected grid, and ellipsoidal. The SDR33 enables you to select a reference frame and a coordinate system.

This chapter describes the various coordinate systems and the basics of the transformations required to move among the systems. For information on uploading transformation files to your SDR33, see Section 11.5, *Transferring (XFM) files*, page 11-6.

10.1 SDR Requirements

All points collected with the SDR33 during a survey must have an associated coordinate - a linear or angular value describing a point's position relative to a specific reference frame. The SDR33 enables you to define and use different coordinate systemsBecause the SDR33 can store ETS and RTK survey data in the same job, certain survey parameters must be set when you create a new job. Some of these parameters cannot be changed after selection. Therefore, it is important to evaluate your particular survey situation prior to job creation.

10.2 Types of Coordinate Systems

The SDR33 supports three types of coordinate systems:

- Local Assumed Grid Coordinates
- Projected Grid Coordinates, see Section 10.2.2, *Projected Grid Coordinates*, page 10-3.
- Ellipsoidal Coordinates, see Section 10.2.3, *Ellipsoidal Coordinates*, page 10-3.

10.2.1 Local Assumed Grid Coordinates

A large number of surveys require the use of a rectangular coordinate system. These systems, which are the traditional method of using coordinate systems with a SDR survey, consider the surface of the Earth as a plane. With regards to horizontal distances and directions — a level line is considered as mathematically straight, the plumb line is considered perpendicular to the level line and the same direction at all points with all angles being plane angles.

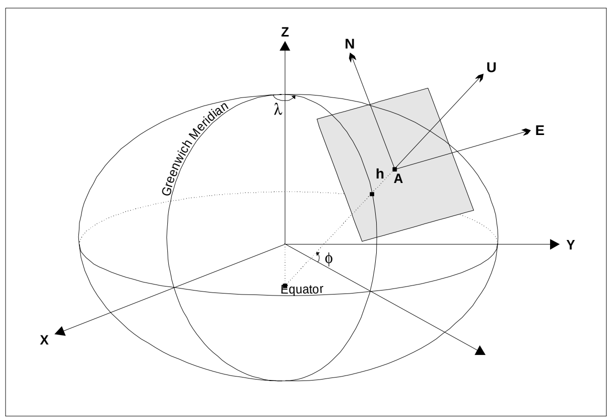


Figure 10-1: Relationship among Cartesian, geographic, and plane coordinates.

10.2.2 Projected Grid Coordinates

A projection is a specific type of coordinate transformation. In principle, a projection maps ellipsoidal coordinates to planar coordinates by projecting from the surface of the Earth to another 3D object that can be flattened, such as a cylinder or a cone (see Figure 10-2).

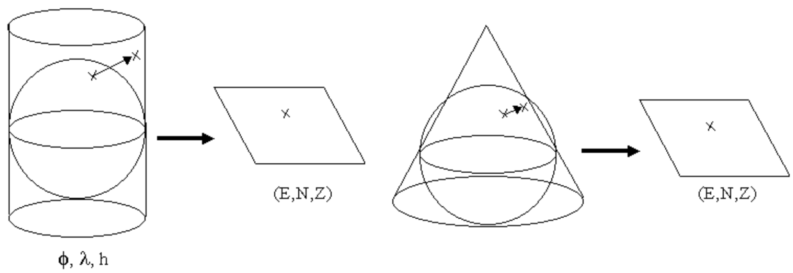


Figure 10-2: General Projection

A projection is a systematic representation of a curved surface on a plane. A curved surface cannot be mapped using plane coordinates without distorting angles, azimuths, distances, or area. However, projections can be defined to minimize certain types of distortion.

A projection should be selected based on the features you want to maintain. Several types of projections exist that emphasize different aspects of reduced distortion. A *conformal projection* minimizes the distortion of local angles; large areas may be distorted. An *equal-area* projection preserves areas but angles and distances will be distorted. An *azimuthal projection* maintains the correct direction, or azimuth from the center of the projection to every point on the map.

10.2.3 Ellipsoidal Coordinates

The Earth can best be approximated as an oblate spheroid of revolution. Mathematically, it is expressed as an ellipsoid with the axis at the equator greater than the axis through the poles. An ellipsoid is best described as an ellipse rotated about its minor axis.

An ellipsoid can be made to describe the Earth using two parameters:

- semi-major axis
- flattening

Historically, most mapping authorities adopted ellipsoids which best a particular region of use. Because of this, there are large differences among ellipsoids used throughout the world.

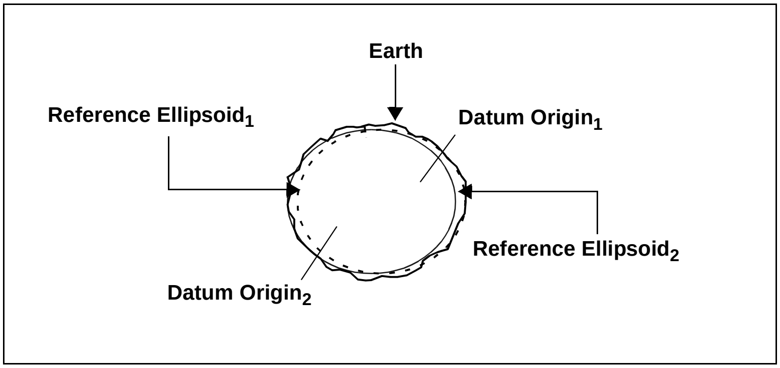


Figure 10-3: Reference ellipsoids

An ellipsoid defines the size and shape of a reference system (or datum). A datum is defined by an ellipsoid fixed in space (with origin) and a defined orientation. In the last few decades, mapping agencies have adopted geocentric datums. These datums, such as WGS84, are designed to “best fit” the earth’s mean sea level. Positions can also be described in terms of latitude, longitude and height. They are represented as follows:

ϕ .... latitude

λ .... longitude

h .... height

The latitude is defined as the angle between a normal to the ellipsoid at a point and the plane of the equator. Longitude is measured in the plane of the equator between the meridian through the point and the Greenwich meridian.

Latitude values start at zero at the equator and increase to 90° at the North Pole; decrease to -90° at the South Pole. Longitude values start at zero at the prime meridian at Greenwich and increase to the east, typically normalized between -180 (west) and +180 (east) degrees.

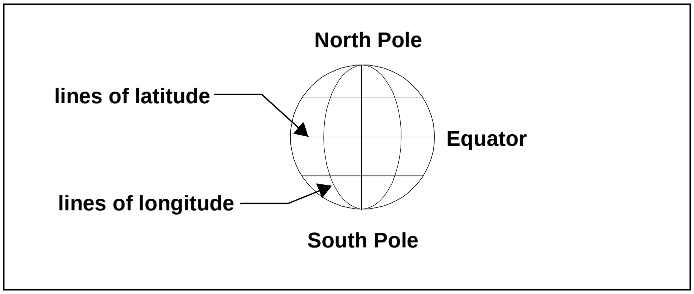


Figure 10-4: Latitude and longitude

The height is based on the surface of the ellipsoid. This is not to be confused with orthometric heights, which are based on a surface, called the geoid, which approximates mean sea level.

The geoid is a equal potential surface approximating mean sea level. In most cases, it is used as a height datum. Values referenced to the geoid indicate the direction water will flow.

The difference between the height of a point above the geoid and the height above the spheroid is called geoid undulation or geoid-spheroid separation. This geoid undulation will vary from point to point as the shape of the geoid is affected by gravity and mass distributions beneath the Earth’s surface. See Figure 10-5.

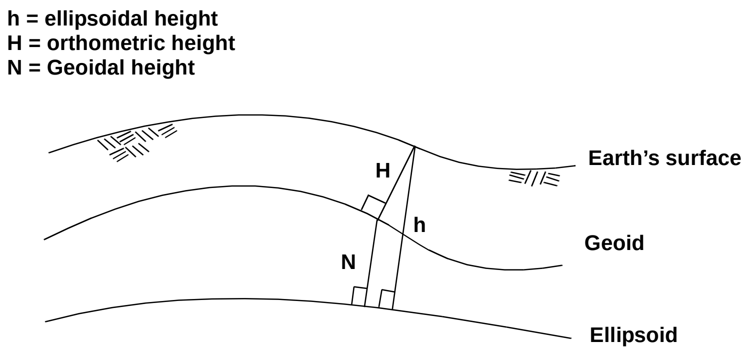


Figure 10-5: Geoidal undulation

10.2.4 Reduction view options

The SDR33 view options will vary depending on what instrumentation (GPS / RTK, Total Station, or both) you are using and whether or not you have selected a transformation. The following table details the various views available with each situation:

ETS - NO XFM	**RTK - NO XFM**	**ETS - XFM Selected**	**RTK - XFM Selected**
OBS	GOBS	OBS	GOBS
MC	GRED	WGS84	WGS84
RED	GPOS	DATUM	DATUM
POS	POS	GPOS	GPOS
		POS	POS

Figure 10-6: SDR33 View Options

10.3 Understanding Transformations

The use of any of the various coordinate systems requires a transformation of the data from one coordinate system to another. The transformation of one type of coordinate system to a coordinate system of the same type is defined as a *datum transformation* (ellipsoidal to ellipsoidal) or a *plane transformation* (rectangular to rectangular). A transformation between two different coordinate system types (ellipsoidal to rectangular) is defined as a coordinate transformation that usually contains some variation of a *map projection*.

The SDR33 provides two categories of mathematical processes to accomplish transformations:

datum transformation ...... ellipsoidal to ellipsoidal

projection.... .... ellipsoidal to rectangular

The entire transformation from one coordinate system to another may require a combination of the two processes described above.

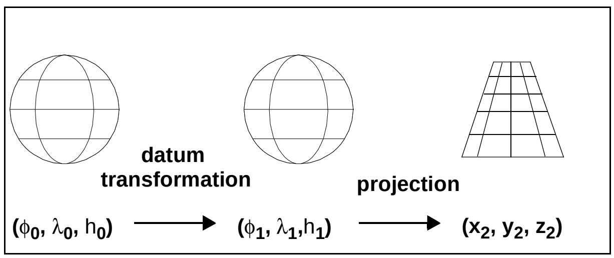


Figure 10-7: Typical transformation

A typical transformation, like that in Figure 10-7, will start with the WGS84 coordinate system. It may require a datum transformation to get to the destination ellipsoidal coordinate system. A coordinate transformation (projection) may then be required to project the ellipsoidal coordinates onto a planar surface.

10.3.1 Datum transformation

Datum transformations describe the specific datum transformation from one ellipsoidal coordinate system to another ellipsoidal coordinate system. The datum transformation is represented in Figure 10-8.

A datum transformation will convert one set of coordinates (ϕ_0,λ_0,h_0) into a different set of coordinates (ϕ_1,λ_1,h_1), or graphically:

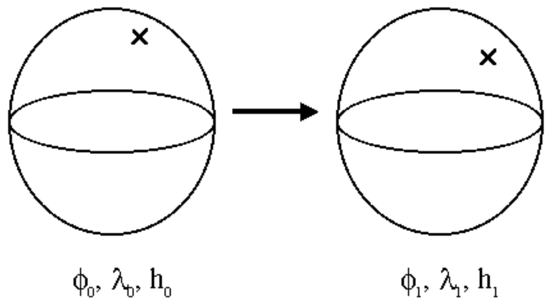


Figure 10-8: Datum Transformation

This process can be performed in several different ways. In actuality, a coordinate transformation and possibly a 3D transformation are performed. In this way an ellipsoidal coordinate can be converted to a Cartesian (rectangular) coordinate system where its datum origin point can be directly related to the new ellipsoid's datum origin point.

The transferred Cartesian coordinate can then be converted to an ellipsoidal coordinate using the new ellipsoid definition. The actual graphical representation is represented in Figure 10-9.

point. The translated Cartesian coordinate system can then be converted to an ellipsoid using the new ellipsoid definition. The actual graphical representation is as follows:

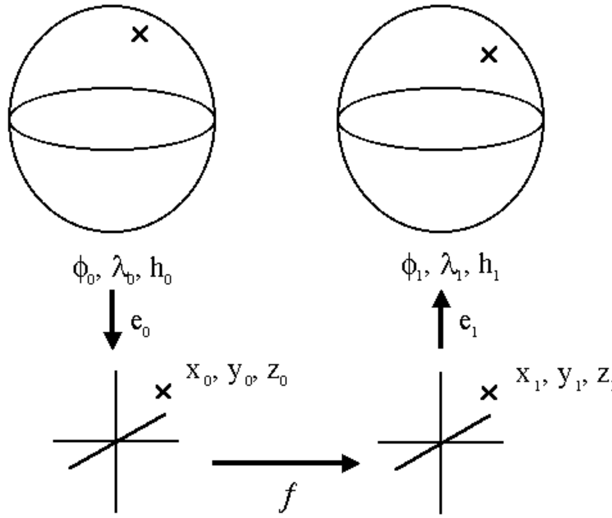


Figure 10-9: Datum Transformation with 3D transformation

The SDR33 performs the conversion by first converting (ϕ_0,λ_0,h_0) into a *Cartesian coordinate* (x_0,y_0,z_0). The ellipsoid definitions, represented by $\mathbf{e_0}$ and $\mathbf{e_1}$, consist of the semi-major axis and flattening on which (ϕ_0, λ_0, h_0) and (ϕ_1, λ_1, h_1) are based.

Once a Cartesian coordinate is derived, a 3D transformation can optionally be applied to convert from (x_0,y_0,z_0) to (x_1,y_1,z_1). This transformation is described by f, whose seven parameters are translations along three Cartesian axes, rotations about the three Cartesian axes, and a scale factor. With the new Cartesian coordinate (x_1,y_1,z_1), a conversion is made to the destination ellipsoid to arrive at (ϕ_1,λ_1,h_1), see Figure 10-9.

If the 3D transformation is omitted, the resulting conversion would resemble Figure 10-10. This simply changes the size and shape of the reference ellipsoid.

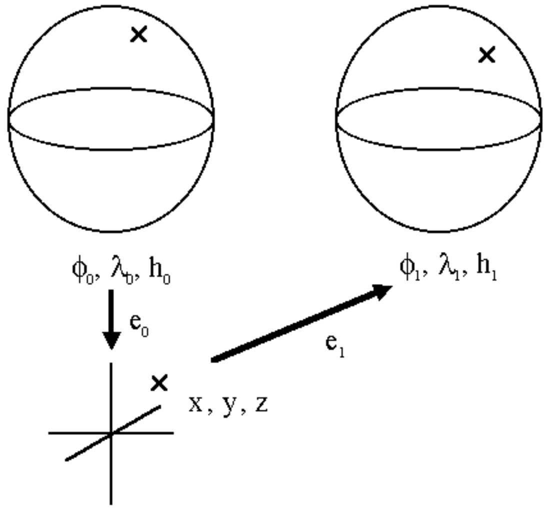


Figure 10-10: Datum Transformation without 3D transformation

Available datum transformations

The five types of datum transformations provided from least to most general, are:

Datum And Ellipsoid .. is the simplest type of datum transformation; it allows a conversion between ellipsoids (as shown in Figure 10-10).

Datum Shift .... allows conversion between ellipsoids that have different origins (in Figure 10-9, *f* applies a Δx, Δy, Δz to the Cartesian coordinate).

Datum Shift Rotate....... can convert further between ellipsoids whose Cartesian systems are rotated with respect to each other. That is, in Figure 10-9, f will apply a (Δx, Δy, Δz) as well as a rotation (rx,ry,rz).

Shift Rotate Scale.......... the most general type of datum transformation, is similar to DatumShiftRotate, but also provides a scale factor for converting between the Cartesian coordinate systems.

User Datum. .... is equivalent to the DatumShiftRotateScale, but the ellipsoid parameters are provided by the user.

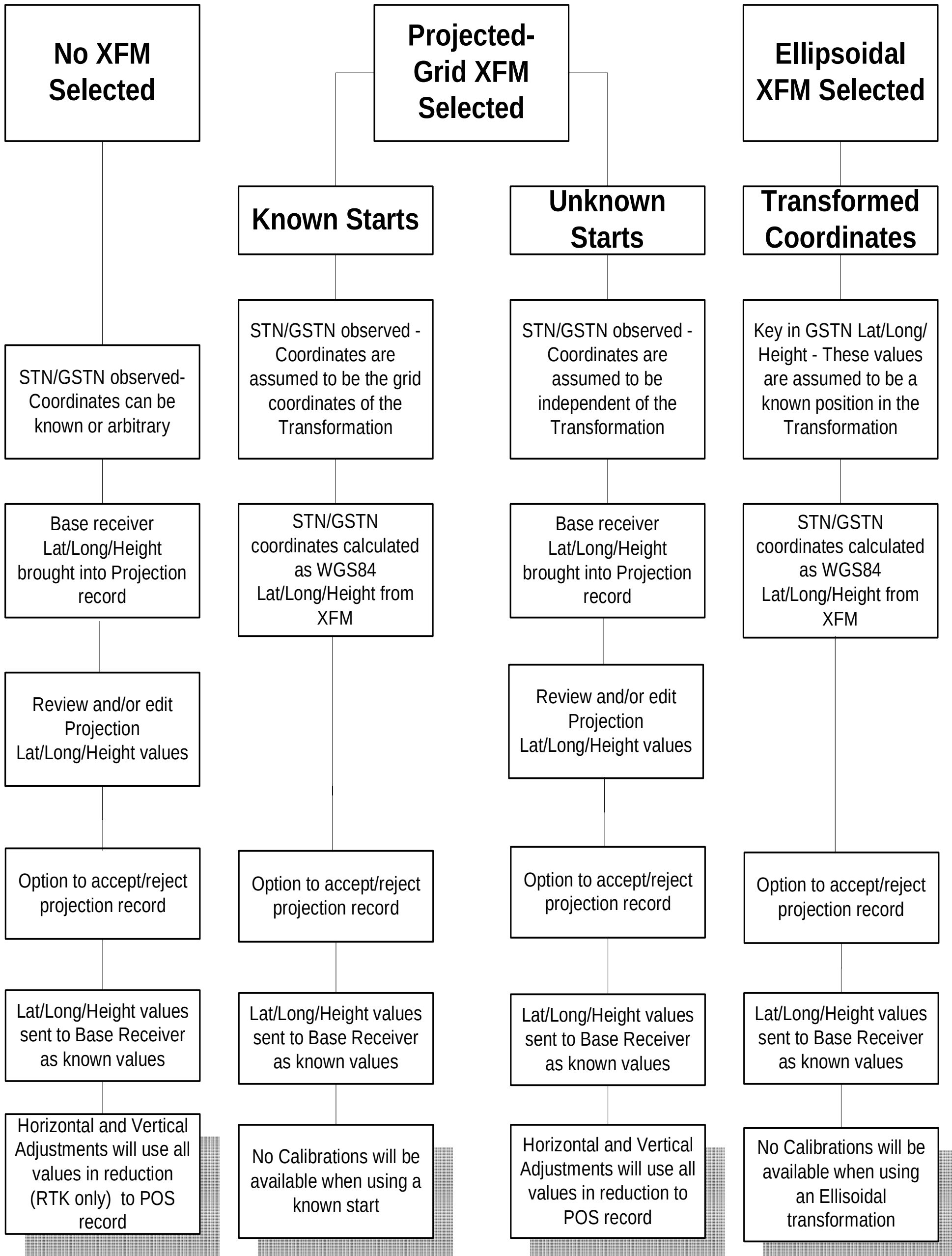
The most general datum transformation (DatumShift-RotateScale) could always be used, eliminating the need for the first three datum transformation types. To define a transformation that is equivalent, the scale is set to 1-0 and rotating and translation are set to 0-0. This causes no change to the original coordinates. The primary reason for the first three, more restrictive, types is to reduce the amount of information required to convert between ellipsoids.

10.3.2 Rules for STN and projection records

The SDR33 handles observation data differently depending on your selected coordinate systems and whether or not you are working with known or unknown starting positions.

The transformation process flow chart, see 10.3.2.1 *SDR33 transformation process*, details the SDR33 workflow for each of the three supported coordinate systems.

10.3.2.1 SDR33 transformation process



Chapter 11 Using Coordinate Systems

In this chapter

- Methods of using different coordinate systems
- Selecting transformations on the SDR33
- Using Local Assumed Coordinates
- Using Projected Grid Coordinates
- Using Ellipsoidal Coordinates
- Uploading transformation (XFM) files to the SDR33

A coordinate system is a reference frame used to designate a position. The type of coordinate system you use is determined when you create a new job. The SDR33 support local assumed grid coordinates, projected grid coordinates and ellipsoidal coordinates. See Section 10, *Overview of Coordinate Systems*, page 10-1.

11.1 Selecting Transformations

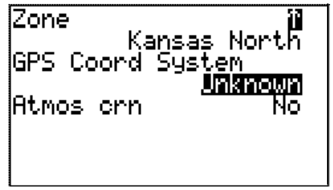
Coordinate systems are assigned to survey jobs. Each time you create a new job with the SDR33, you can select a transformation file for that job. Your selection determines what type of coordinate system will be used. For more information on creating new jobs, see Section 5.1, *Creating a New Job*, page 5-2.

Steps to select a transformation

1. Select **Job** from the ***Function*** menu and press **<OK>**.

2. When the ***Select Job*** screen displays, press the **<NEW>** softkey to open the ***Create Job*** screen.

3. Select **YES** in the **Select XFM** field by using the <←> and <→> keys.



✉ **Note:** When creating a new job, you must decide whether or not a local assumed grid or projected grid / ellipsoidal coordinate system will be used. Selecting **NO** in the ***Select XFM*** field will enable local assumed grid coordinates. Selecting **YES** enables either projected-gird or ellipsoidal coordinates. Once selected, this option cannot be changed for a particular job. For more information, see Section 10, *Overview of Coordinate Systems*, page 10-1. **If you select YES, you must know whether or not the coordinate system you choose in the *Zone* field in the *Create Job* screen is projected grid or ellipsoidal**.

The Select XFM field determines whether coordinate systems will be applied during the survey process. The following fields will display when this field is set to **YES**.

- **Transformation -** Select the type of transformation to be used on the job in this field.
- **Description -** (*display only*) This field displays a description of the transformation type selected in the Transformation field.
- **Zone -** Select the local zone to which the transformation will be applied.
- **GPS Coord System -** Selecting **Unknown** requires all Stns to have connectivity. This connectivity (or homogeneity) requires all points to be connected by observations. A selection of **Known** allows the use of disjointed Stns.

✉ **Note:** Careful planning is necessary when setting transformation parameters. The selection of **Known** or **Unknown** determines the Stn connectivity requirements for your job.

4. Once you have set these job parameters, press **<OK>** or <**Enter**>. The ***Note*** screen displays.

5. Enter your note records. The number of notes you can enter is limited only by available memory. Press **<Enter>** or **<OK>** to accept and store the note records.

11.2 Using Local Assumed Grid Coordinates

If you selected **No** in the ***Select XFM*** field when you set up your job, see Section 11.1, *Selecting Transformations*, page 11-1, you are using local assumed grid coordinates. This is the traditional SDR method of determining position. Both RTK and ETS data can be used with this coordinate system. If both devices are used, you should perform a calibration to minimize error. However, calibrations do not apply to ETS data. Any ETS data is assumed to be in the destination coordinate system. However, you can use a Helmert transformation after your survey if you have not set up ETS data in the destination system. For more information, see Section 32.1, *Using Helmert Transformation*, page 32-2.

11.2.1 Rules for working with Local Assumed Coordinates

When working with local assumed grid coordinates, observe the following rules when collecting data:

- Calibrations will not be applied to ETS data.

- All ETS station values must be in the destination coordinate system if you are using ETS before calibration. As an alternative, you can take readings with an ETS instrument after a calibration is performed.

11.3 Using Projected Grid Coordinates

A map projection is a specific type of coordinate transformation. For more information, see Section 10.2.2, *Projected Grid Coordinates*, page 10-3. If the option selected in the ***Zone*** field of the ***Create Job*** screen is a projected-grid coordinate system, follow the instructions and rules in this section.

When creating a job utilizing projected grid coordinate systems, plane curvature corrections, which account for the curvature of the Earth to provide accurate calculations of vertical height, are not applicable. Plane curvature corrections can only be used with local assumed grid coordinate systems, see Section 12.1, *Calibrating Local Assumed Grid Coordinates*, page 12-1.

11.3.1 Rules for working with Projected Grid Coordinates

When working with projected grid coordinates, observe the following rules and conditions when collecting data:

- Connectivity is required among all Stns if your selection is **Unknown** in the ***GPS Coord System*** field.
- Inverses will be calculated on the projected grid.
- Atmospheric corrections will be applied to ETS data only.
- Sea level, curvature and refraction corrections will not be applied.

Note: When using ETS with an unknown start at the initial Stn, latitude, longitude, and height values should be known to better than 32 meters.

11.4 Using Ellipsoidal Coordinates

Ellipsoidal coordinates (latitude, longitude, and height) can be used to describe the position of a point relative to the curved surface of an ellipsoid. See section Section 10.2.3, *Ellipsoidal Coordinates*, page 10-3, for more information.

If the option selected in the ***Zone*** field of the ***Create Job*** screen is a ellipsoidal coordinate system, follow the instructions and rules in this section.

11.4.1 Keying in values

To use ellipsoidal coordinate systems, all Latitude and Longitude values must be keyed in. **If you have selected Unknown in the *GPS Coord System* field, when you created your job,** see **11.1 *Selecting Transformations*, ellipsoidal coordinates cannot be used.**

✉ **Note:** All values keyed in, when using ellipsoidal coordinate systems, must be entered as degrees, minutes, and seconds.

Because ellipsoidal coordinates systems require known keyed in values, you must select **Known** during job creation. Calibrations are not applicable to ellipsoidal coordinate systems.

The option to choose a known or unknown start is enabled when you select **YES** in the ***Select XFM*** field when creating a job. For more information, see Section 5.1, *Creating a New Job*, page 5-2.

11.4.2 Rules for working with ellipsoidal coordinate systems

When working with ellipsoidal coordinates, observe the following rules and conditions when collecting data:

- Connectivity is not required between each Stn.
- Atmospheric corrections may be applied.
- Sea level or curvature and refraction corrections are not applied.

- Stake out operations cannot be performed when using ellipsoidal coordinate systems.
- Ellipsoidal coordinates are used for topography only.
- Coordinate geometry is not available.

11.5 Transferring (XFM) files

Transformation files are transferred to the SDR33 from a personal computer. Transformation files can be added to the SDR33 by using following two methods:

Permanent Installation will load transformation (XFM) files to the SDR33's non-volatile memory (NVM). These files will remain stored on the SDR33 regardless of any warm or cold boots.

Temporary Installation enables you to send an XFM file directly from Sokkia software packages to the SDR33. This process works similar to transferring a job. Transformation files installed using this method will be stored in memory and will be lost during a warm or cold boot.

For information and procedures on installing transformation files, see the ***SDR33 Installation Guide***.

Chapter 12 Performing Calibrations

In this chapter

- Calibrations with projected grid coordinates
- Populating the calibration list with points
- Reviewing the calibrated parameters

A calibration allows all records in the current coordinate system to be translated to a known coordinate system. Calibration is used to minimize error when using assumed coordinates. The calibration can be performed multiple times, at any time — before, during, or after a survey. For more information, see Section 32, *Transformations*, page 32-1.

Any calibration for total station data will be for translation (shift in north and east) only. **Scale and rotation do not apply to total station calibrations.**

✉ **Note:** In order to use calibrations, observed points must be saved as a GPOS record. The same point ID must also have a POS record loaded or created via keyboard input.

12.1 Calibrating Local Assumed Grid Coordinates

Three types of calibrations are available:

Hz/Vt calibration.. This option performs both a horizontal and a vertical calibration.

Horz calibration.... This option performs a horizontal calibration.

Vert calibration..... This option performs a vertical calibration.

The horizontal calibration calculation is based upon a two dimensional conformal transformation. If only one point is used, the scale and rotation parameters are ignored and the result is a translation in both the east and north directions.

The vertical calibration calculation is based upon a three parameter linear plane model which estimates the difference between the observed height datum and mean sea level based on the selected coordinate system. The three parameters are the slope of the plane in the east direction, the slope of the plane in the north direction and a constant translation applied to all points. If one point is used in the calibration process, the slope parameters are ignored and only a translation is used.

✉ **Note:** Calibration corrections cannot be applied to data collected via total station. To maintain a consistent coordinate system, any total station data collected should be set up in the destination coordinate system. All applicable settings must be established when creating a job. These settings include scale factor, curvature and refraction (if plane curvature correction is applied).

12.2 Performing Calibrations with Projected Grid Coordinates

When using projected grid coordinates, calibrations are limited to a single horizontal or vertical point. For more information on projected grid coordinate systems, see Section 10.2.2, *Projected Grid Coordinates*, page 10-3.

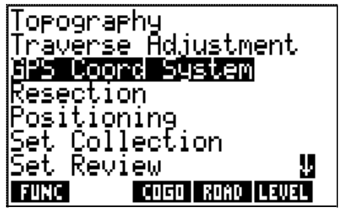
Unlike local assumed grid coordinate calibrations, which translate, rotate and scale all records in the current coordinate system to match a known coordinate system, projected grid calibrations solve to produce translation values of a single coordinate - the initial Stn.

12.3 Calibrating with the SDR33

Once you have decided on a coordinate system, local assumed grid or projected grid, you can use the SDR33's ***GPS Coord System*** option to carry out the calibration.

Steps to calibrate your coordinate system

1. From the ***Survey*** menu, select **GPS Coord System**.



✉ **Note:** The calibration being performed is associated with the current job. If a job is not currently selected, you will be prompted to select one before proceeding with the calibration. Projected Coordinate systems are enabled by selecting from the available transformations in the **Select XFM** field in the ***Create Job*** screen. **Once Local Coordinates are selected, you can not select another coordinate system for a particular job.** For more information, see Section 5.1, *Creating a New Job*, page 5-2.

2. Select the calibration method from the list and press **<OK>**.

Select one of the following options:

Hz/Vt Calibration..... This option calculates a horizontal and vertical calibration. You will need to select one point in the calibration point list for the calibration. If you select one point, it must have northing, easting and elevation values.

Horz Calibration....... With total station data, this option calculates a horizontal calibration. Points must have northing and easting values. However, it is common to have at least two points.

Vert Calibration .... This option calculates a vertical calibration. You will need to select one point with an elevation value or three or more points with northing, easting and elevation values.

Key in Parameters .... Select this option to manually enter horizontal or vertical parameters.

The SDR33 will search the database for GPS records and non-GPS POS records with the same point ID. These records represent the uncalibrated and destination coordinate systems respectively. Then, the SDR33 displays a generated list of all available points for calibration.

Note: If another job exists in the SDR and is marked as the control job, the SDR33 will search the control job for POS records if the points do not exist in the current job.

---

3. Review the point list. You can delete or add points to this list as needed. See 12.3.1 *Populating the Calibration List*. Only one point is required for calibration in total station data.

✉ **Note:** If you are using a projected grid coordinate system, you are limited to a single horizontal or vertical point for calibration. By default, the SDR33 will select the first point in the ***Horz*** or ***Vert Calibration*** list. You can also delete points from the list, see Section 12.3.2, *Deleting points from the calibration list*, page 12-8, until the desired point is selected.

The softkeys access the following options:

<INS> .... This softkey inserts one point at the highlighted location in the point list.

<DEL> .... This softkey removes the highlighted point.

<RANGE>... This softkey is used to specify a range of point to add to the point list.

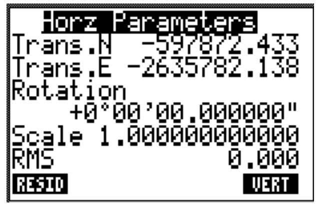
<ALL>.......... This softkey adds all available points to the point list.

✉ **Note:** For more information on the point list, see Section 12.3.1, *Populating the Calibration List*, page 12-7

✉ **Note:** The selected points also need to contain information for northing, easting and elevation values to be calculated (see Section 12.3.1, *Populating the Calibration List*, page 12-7).

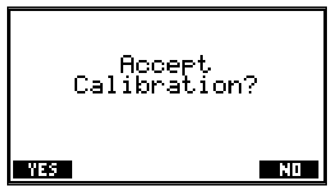
4. Press **<OK>** to initiate the calibration for the selected point. The SDR calculates the calibration. If performing a Hz / Vt calibration, the horizontal calibration is performed first.

5. Review the calculated parameters for the current calibration. For more information on reviewing the parameters, see Section 12.3.4, *Reviewing Calibration Results*, page 12-11.



6. If you accept the calibration, a record is added to the SDR database for your current job. This calibration is used to determine the display of the coordinates or GPS records through your current job, or until a new calibration is performed.

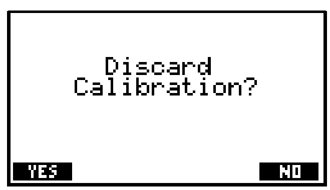
   To accept the calibration press **<OK>**. A message displays asking for confirmation.



<YES> .... The calibration is accepted and you are returned to the main menu.

<NO> .... The calibration is not accepted and you are returned to the Parameters screen for review.

To disregard the calibration, press **<Clear>**. A message displays asking for confirmation:



<YES> .... This softkey discards the calibration and moves to the main menu.

<NO> .... This softkey returns you to the ***Parameters*** screen for review.

12.3.1 Populating the Calibration List

After selecting the calibration type, the SDR33 generates a list of available points for the calibration. The points in this list are used to calculate the translation values for calibration. You can edit the calibration point list by adding or removing points. **When using a total station, the SDR33 can use only one point to calculate a calibration.**

A separate Calibration list is generated for horizontal and vertical calibrations. Depending on the selected calibration, the SDR33 requires a point with specific observations.

Hz/Vt........... One point is required for this calibration. Points must have Northing, Easting and Elevation coordinate values.

Horz .... One point is required for this calibration. The point must have at least Northing and Easting coordinate values.

Vertical......... One point is required. If a single point is used, it must have Elevation coordinate values.

You can add points to the Calibration list using two methods: adding a single point or adding a range of points. For more information, see Section 12.3.3, *Adding points to the calibration list*, page 12-8. You can remove points from the Calibration list at any time. You may want to add a range of points and then remove specific points. For more information, see Section 12.3.2, *Deleting points from the calibration list*, page 12-8.

12.3.2 Deleting points from the calibration list

To delete a point name from a calibration list, highlight the point ID and press the **<DEL>** softkey.

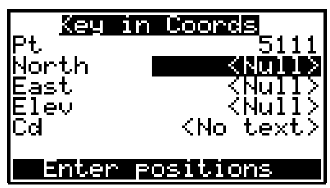
The point will be deleted from the list and from the subsequent calibration calculation

12.3.3 Adding points to the calibration list

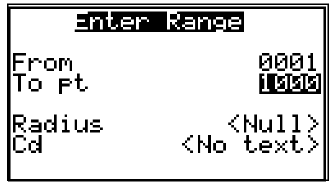
You can add new points to the list in several ways. Added points must meet the criteria described in Section 12.3.1, *Populating the Calibration List*, page 12-7.

- Enter point names in the blank entry at the bottom of the list. Press **<FUNC> +** <↓> to move to the bottom.

- Press the **<INS>** softkey, 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.



- Add a range of point names to the list by pressing the **<RANGE>** softkey. After you have specified the range, using any or all of the selection methods provided, the SDR adds all the points meeting the conditions to the list.



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 GStn will be included in the list.

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

Press **<Enter>**, the selected points will then be added to the current list of points to be calibrated. Combine these selection methods to select a very specific group of points or select this range option several times to add different point ranges 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 **<Func>** + <↑>.

Criteria for adding points

As points are added, the SDR initiates a search for GPS records and non-GPS POS records with the same point ID. The following messages display if the appropriate criteria are not met.

- If the point ID is a GPS record only, the following warning will display and the point will not be added to the list:

```
GPS point only found

...Press any key...
```

✉ **Note:** The known coordinate values can be added using the **Keyboard Input** option.

- If the point ID is a nonGPS record only, the following warning will display and the point will not be added to the list.

```
 No GPS point found

...Press any key...
```

- If the point ID does not exist in the database, the following warning will display.

```
   Invalid input

...Press any key...
```

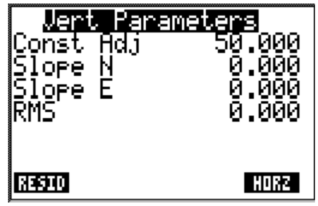
- A warning will display if an entered point does not possess adequate coordinate values.

```
N/E/or Elev is Null

...Press any key...
```

12.3.4 Reviewing Calibration Results

After the points are selected and the calibration is performed, the calculated values are displayed for review.

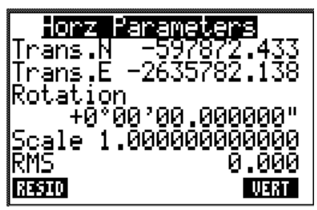


The last value displayed is the RMS (root mean square) of the adjustment residuals. If you performed a Horizontal / Vertical calibration, the parameters are shown separately. To toggle between the parameter displays, press the **<VERT>** or **<HORZ>** softkeys.

For information about specific parameters in each screen, see the following sections.

12.3.5 Horizontal calibration parameters

Horizontal calibrations fit local RTK plane coordinates to a locally known horizontal plane. Parameters for the Horizontal calibration are displayed in the following screen:



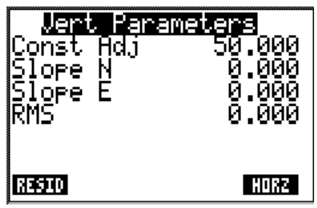
Trans.N............. The north shift parameter moves the GPS origin north to coincide with the locally-defined coordinate system.

Trans.E .... The east shift parameter moves the GPS origin east to coincide with the locally-defined coordinate system..

⌧ **Note:** Special attention should be given to pre-defined map projections. Because map projections are designed to show a large area on a flat surface, scale and orientation will fluctuate. Horizontal calibration processes use only a single scale and rotation angle. When using map projections, you should utilize a a projected grid coordinate system. For more information, see Section 11.3, *Using Projected Grid Coordinates,* page 11-4.

12.3.6 Vertical calibration parameters

Vertical calibrations account for undulating effects in the Earth's surface, variation in control values, and any error contained in collected observations. Parameters for the vertical calibration are displayed in the following screen:



Const Adj.... This field displays the constant height shift for all points based on the difference.

⌧ **Note:** When surveying in known areas of drastically changing geoidal undulations, special attention should be given to vertical calibration. The calibration process can only determine slope in two directions and will not compute anomaly deviations. By using a geoid model, determining the extent of the project area, and interpolating undulations, you can calculate the slope due to geoidal undulation and reduce possible errors. Examples of areas in which changing undulations can occur include mountain foothills or river and stream areas.

4

Topography

This section is a basic introduction to Topography and Remote Elevation. This section will explain the basics about topography and its relation to the SDR. The Remote Elevation chapter shows you how to take observations of points that you cannot access directly.

Collecting Topography Observations

Observing a Remote Elevation

Chapter 13 Collecting Topography Observations

In this chapter

- Overview of Topography operations

The SDR33's Topography program enables you to collect data on physical elements within an area. By using this program, you can collect site features, find relational information about points, locate points for contouring or other applications, and collect detailed information about the location and attributes of desired points.

The Topography program can be used for a variety of different surveys including boundary surveys, cadastral (plat) surveys, contour surveys, and two and three dimensional surveys.

Setting up the SDR33 to perform Topography is simple. All you need to do is create a job, see Section 5.1, *Creating a New Job*, page 5-2, and establish a station, see Section 7.1, *Establishing a New Station and Backsight*, page 7-2.

The SDR33 has a variety of options you can set to control and simplify data collection. You can use the options in Configure Reading to control number of readings, record view stored, auto point number and code fields. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6. Unit settings can be established for your job to ensure usable data (Section 6.4, *Defining Unit Formats*, page 6-16).You can also establish Tolerances to assure accurate data is collected. For more information, see Section 6.3, *Establishing Tolerances*, page 6-13.

While performing a survey, you can collect data by observing a direct location or observing distances or angles to an indirect location. To observe a direct location, you simply set up on the desired point and use the SDR to take a reading by pressing the <**Read**> key, see Chapter 8 *Taking a Reading*. If you need to observe a inaccessible or obscured point or an indirect location, you perform an offset. Offsets measure the distances and azimuths to the desired point and use geometric formulas to calculate the desired point.

The SDR33's Topography program allows you to perform four different types of offsets including:

- Azimuth
- Distance
- Delta North
- Delta East

For more information, see Section 8.2, *Observing Offsets*, page 8-3.

Data collected with the Topography program is stored in the SDR33 database. Each observation is stored as a specific record. For more information on types and specific records, see Chapter 33 *The SDR Database*.

Topography can be used to perform simple traverses and adjusted within traverse adjustment routine. Also, topography can be used in conjunction with Set Collection to combine precise traverse collection with Topography features. All the combined data can then be adjusted with the Traverse Adjustment program. For more information, see Chapter 16 *Traverse Adjustment*.

Traverse data can be collected in both the Set Collection and Topography routines, and adjustments can be performed with both types of data. When using the Topography routine, Face1 and Face2 observations can be collected but only one combination of these readings are used for producing an OBS MC record. OBS MC records are used to calculate the next station that will be occupied. Using the Set Collection routine many observations to the points can be collected and the resulting OBS MC records contain an average of all the observations.

When performing a set collection or observing a traverse route, you can return to a previous station location to collect more data. Make sure to include the next station and its backsight, in the traverse route so the SDR33 can perform a traverse adjustment on the collected data. For more information, see Chapter 15 *Traverse Collection Methods*.

Chapter 14 Observing a Remote Elevation

In this chapter

- Overview of Remote Elevation
- Taking a Remote Elevation reading

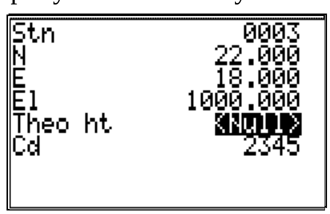
Using the remote elevation program, you can observe a point even if you cannot actually reach it. With this option, you use two observations - one for the base point and one for the vertical angle to calculate the point's elevation.

By placing the prism below or above the desired point, the SDR33 stores information about the base point. Then you can take a second reading, observing only the vertical angle to the target point. Using these two observations, the SDR33 calculates the intersection of the extended vertical angle with a vertical line from the base point to determine the elevation.

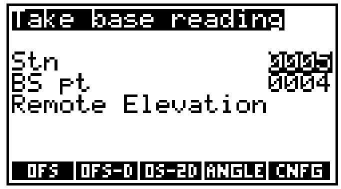
Steps to take a reading

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

2. The SDR33 prompts you to confirm your station and backsight.



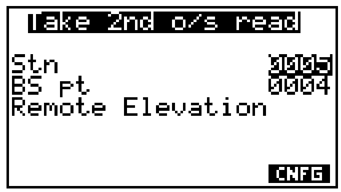
3. The SDR33 will prompt you to observe the base reading.



   Direct the rodman to place the prism rod directly under or over the desired point. Point the survey instrument to the prism and press **<Read>** to observe the base point. The SDR33 displays the observation. For more information, see Section 8.1, *Initiating the Observation*, page 8-1.

4. Press **<OK>** to accept the base point observation.

5. Sight your instrument on the desired point and press **<Read>** to observe the vertical elevation to the desired point.



✉ **Note**: The **Height** field indicates the difference in height from the base point of the prism point to the observed target point.

6. Press the **<STORE>** softkey to accept the result and store it as a **POS** (position) record. To observe the point again, press **<Read>.**

7. Press **<Clear>** to exit the ***Remote Elevation*** option.

5

Traverse

This section demonstrates how you can use the SDR to perform a traverse and then adjust the traverse. The SDR can perform a single collection traverse or use observation sets to increase a traverse's accuracy. Also explained in this section, several special cases you may experience when working with traverses.

Traverse Collection Methods

- *Traversing with Topography*
- *Traversing with Set Collection*

Traverse Adjustment

- *Calculating and Adjusting the Traverse*

Chapter 15 Traverse Collection Methods

In this chapter:

- Traverse collection methods
- Traversing with topography
- Traversing with Set collection
- Reviewing sets at the SETS, ALL, POINTS, SET-POINTS, and SET-POINTS FACES levels

A traverse is an operation in which you collect points to create a relationship between points in a survey. Collecting a traverse is an extension of taking a reading. First, you establish a station and take multiple readings to desired points. You can then form a traverse by selecting one of the observed points as your next station. The SDR33 then creates relationships between known stations and observed points.

✉ **Note**: You do not have to establish a station on a known location. The SDR33 can calculate an unknown station as long as there is at least one known location in your survey. For more information, see Chapter 9, *Calculating Unknown Stations*.

Most surveys performed with the SDR33 are a type of traverse, a collection of linked stations. You can “close” a traverse route by sighting your original station as the last observation in a survey. By closing the traverse route, you will improve the accuracy of the traverse.

Depending on the accuracy desired, the SDR33 can collect a traverse route two separate ways:

- Traversing with Topography
- Traversing with Set Collection

Using the Topography option, you can observe a point, move and set up on the observed point, observe another point, and continue until the entire traverse route has been observed. Traditionally, the starting point of a traverse route is a known location, although it is not necessary.

If your survey requires a greater accuracy that traditional topography, you can use the Set Collection option to collect multiple observations to a single point. These observations are then averaged and used to adjust the traverse. While Set Collection can take a longer time to observe a traverse route, the accuracy may be desirable. When observing sets, the SDR33 provides a structured method for observing the Face 1 and Face 2 observations. The resulting sets of observations can be used either for traverse calculations or resection calculations.

Detailed traverse data collected with Topography can be combined with Set Collection data for precise traverse collection. All the combined data can then be adjusted with the Traverse Adjustment program. For more information, see Chapter 16, *Traverse Adjustment*.

15.1 Traversing with Topography

Using the Topography option, you can collect individual traverse points along a traverse route. When collecting the traverse route, each station setup must be on a previously observed point. The SDR33 uses the previous OBS record to calculate the next STN record. This method creates a relationship between the points used to calculate and subsequently adjust the traverse route for greater accuracy. For more information on collecting single observations, see Chapter 8, *Taking a Reading*.

Face1 and Face2 observations can be collected but only one combination of these readings is used for producing an OBS MC record. OBS MC records are used to calculate the next station that will be occupied.

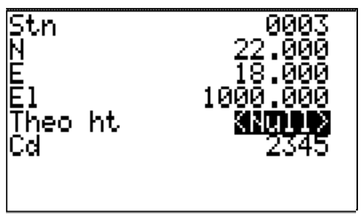
15.2 Traversing with Set Collection

You can collect multiple observations to individual traverse points using the **Set Collection** option. By collecting multiple observations to the points in your traverse route, the SDR33 can compute positions with greater accuracy. Each set of observations is computed and averaged to generate point coordinates, reducing the amount of inherent error in observations. Set collection may be entirely “free-form” or may be completely driven through a preentered set of parameters and points.

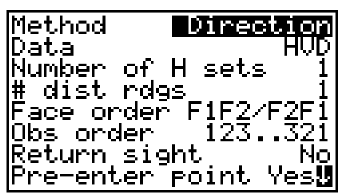
Steps to collect a set of observations

1. Select **Set Collection** from the ***Survey*** menu.

2. Confirm the station and backsight information by pressing <**OK**>. You can change the station or backsight by entering the new station point ID.



3. **Define the set collection method.** Select the **<OPTNS>** softkey in ***Set Collection*** to display the set collection options.



The nine field settings on these screens determine how the SDR33 does set collection. Enter information in the following fields:

Method .... This field indicates the sets collection method:

Direction — observing several points using the same instrument orientation

Repetition — observing a single angle between two points several times using different instrument orientations.

Data .... This field controls which observational measurements will be collected together. The options are as follows:

HVD — All measurements are collected in each set of observations.

H,VD — The horizontal angles are collected during one observation. The vertical angle and distance are collected on the next observation.

H,V,D — The horizontal angle, vertical angle, and slope distance are collected in separate observations.

Where: **H** = horizontal angle, **V =** vertical angle, and **D** = slope distance

H sets .... This field controls how many sets of horizontal angles are collected.

Note: In the case where the data being collected is **HVD**, the **Number of H sets** is also the number of sets of vertical angles. 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, six physical rounds of observations are required (one for each face for each set).

V sets........... This field appears only if the data being collected is **H**,**VD** or **H,V, D;** this field indicates how many sets of vertical angles are collected.

 # dist rdgs.... This field controls how many distance observations are made during each observational sighting. Enter a value between 0 and 9.

🖂 **Note**: The SDR33 will initiate multiple distance reads only for Sokkia surveying instruments.

Face order......... This field controls the switching between F1 and F2 during the collection of single as well as multiple sets. Select from the following options:

• F1 only	• F1F2 / F1F2	• F2F1 / F2F1
• F2 only	• F1F2 / 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.

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.)

Obs order......... This field specifies the order in which the SDR33 prompts you to observe points when collecting individual sets.

Unprompted .. The SDR33 will not prompt you at all and observations may be made in any order.

123...123 - .... The SDR33 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

123...321 - .... The SDR33 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

Return sight.......... This field specifies whether you wish to sight again on the first observed point in a set when the end of the set is reached. For example, if points 1, 2 and 3 are observed and a return sight is selected, then the physical observations made would be 1, 2, 3, 1. Any error found in the return sighting is distributed between the other observations.

This field displays only when the set collection method is **direction**.

Preenter points..... This field determines if you enter a list of points that you will observe, prior to observing any points in the set. The SDR33 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 **Yes**, the SDR33 allows you to enter a list of points that you will observe, prior to observing any points in the set.

If this field is set to **No**, you will not be asked for the point names prior to observing the points. The SDR33 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.

Recip Calc............ Choose whether to perform reciprocal calculation. The options are **Prompted**, **Always** or **Never**.

✉ **Note**: A Note record is entered in the database when a reciprocal calculation is 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 #### & ####**.

4. Press <**OK**> to accept options and continue.

5. (*optional*) If the ***Preenter points*** field was set to **Yes**, the SDR33 presents you with a screen for entering the names of the points that will be observed during each set. The first point displayed is the station's backsight.

   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 edit it in the usual manner.

   If you want to add an extra point name at a specific position in the list, move the highlight bar and press the **<INS>** softkey. A new point name field is inserted before the highlighted field.

   To remove an existing point name, move the highlight bar to it and press the **<DEL>** softkey. If you want to delete all point names, press the **<DEL ALL>** softkey.

6. Once the list is complete, press the **<OK>** key, the Take Reading screen displays.

The set number in the top right of the screen is the count of sets observed so far from the station you are set up on. If you have requested point prompting, the ***To pt*** field shows you the point name to observe.

✉ **Note**: If at any time you want to leave the set collection procedure completely, press **<Clear>**.

7. When the instrument is sighted correctly, press the **<Read>** key to initiate a reading. The standard observation screen will display.

   The SDR33 fills in the data fields (***H.obs, V.obs,*** and ***Dist***) when the values are available from the instrument.

   If the ***Obs order*** field is **Unprompted**, the code, point name and target height are filled automatically if you have observed this point before. The SDR33 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 SDR33 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.

8. (*optional*) To change the ***Pt, Code*** or ***Target ht*** fields, highlight the appropriate field and enter the new value.

9. (optional) If you set the ***Obs order*** field to **123...123** or **123...321**, the SDR33 will prompt you for the next appropriate point name. The code and target height will be filled in if this point has been observed previously.

10. Once all the set criteria is complete, select from the three available options:

    - Collect more sets (Continue taking more sets, start again at step 6.)
    - Change station (For more information, see Section 7.1, *Establishing a New Station and Backsight*, page 7-2.)
    - Review sets (For more information, see Section 15.2.1, *Viewing collected sets*, page 15-9.)

15.2.1 Viewing collected sets

You can review the collected sets while you are collecting the data or after you have finished set collection. The observations stored in the database during set collection can be reviewed two ways:

- using the standard data review method, **<VIEW>**, which displays each point in the order observed.

- using the specialized **Set review** option, which presents the points in the context of a collected set.

Both options display point information, however the Set review option displays the points within their corresponding set. The Set review option is a structured method to review sets in the same manner in which they were collected, allowing you to “traverse” the data. The **Set review** option also gives averages and deviations. The Set review option can give you a comprehensive view of your collected data.

The Set review option provides several ways of displaying data with softkeys. The initial Set review screen shows the first set associated with the selected station. You can navigate the Set review information using the available softkeys. Several different views of the collected data is available in Set review.

- The **<ALL>** softkey displays the number of collected sets and the associated points within the sets. For more information, see Section 15.2.1.2, *ALL level*, page 15-11.
- The **<PTS>** softkey displays individual point information. For more information, see Section 15.2.1.3, *POINTS level*, page 15-12.
- **<Enter>** displays all of the observations to a specific point occurring within the set. For more information, see Section 15.2.1.4, *SETS-POINTS*, page 15-13.
- Highlighting a specific observation and pressing <Enter> twice displays the point’s raw observation data in the SETS-POINTS-FACES screen. Several other data screens can be accessed via softkeys from within this view. For more information, see Section 15.2.1.5, *SETS-POINTS-FACES level*, page 15-14.

🖂 **Note**: Section 15.2.1.6, *Example of viewing collected sets*, page 15-15 provides an example set displayed with the Set review option.

You can access any of the Set review screens from any point within Set review. Figure 15-1 illustrates the abstract structure of the Set review option.

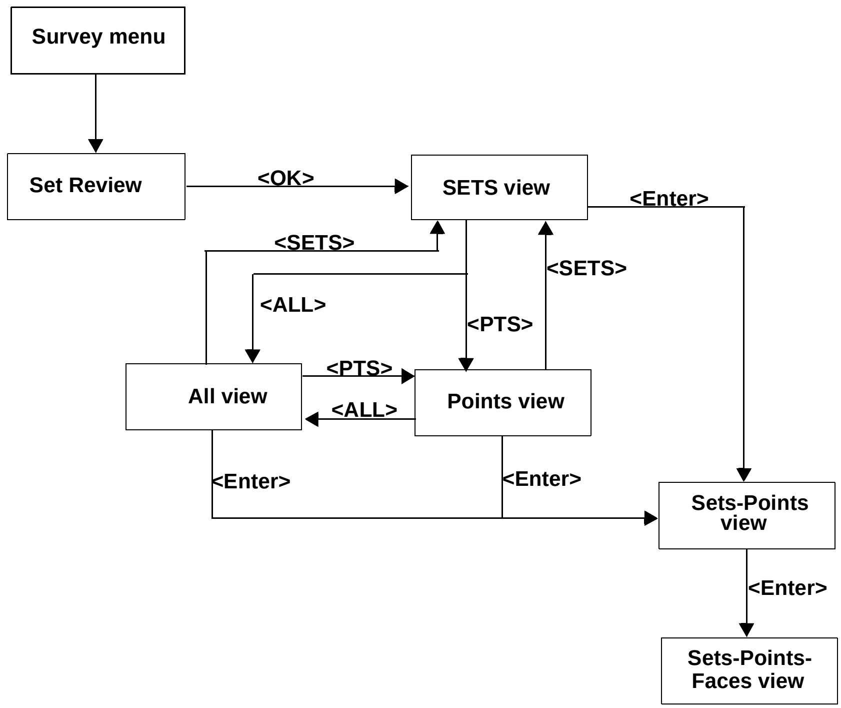
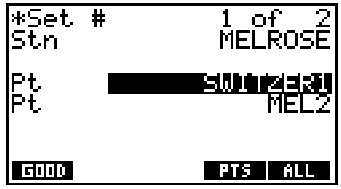


Figure 15-1: Set review

15.2.1.1 SETS level

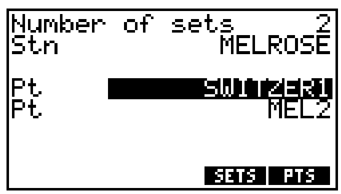
The initial Set review screen, the SETS level, indicates all of the points observed during the collection of set number 1 from the **MELROSE** station.



Note: Other sets collected using the **MELROSE** station can be displayed by pressing the <→> keys (see Figure 15-1). For example, pressing the <→> key shows the points observed in Set 2. You can navigate through all of the **MELROSE** station sets using the <→> and <←> arrow keys.

15.2.1.2 ALL level

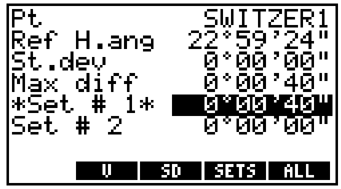
The ALL level displays general information about the collected sets, including the number of sets, the station point ID and the collected points. To access the ALL level, press the **<ALL>** softkey from the ***SETS*** or ***POINTS*** level.



Note: You can press <**Clear**> at any time during Set review to go back to the previous screen.

15.2.1.3 POINTS level

The **POINTS** level displays specific information about a point. Also, this level displays the average of all observations made to a point from each set in the station. You can access the **POINTS** level by pressing the <**PTS**> softkey in the **SETS** or **ALL** levels.



✉ **Note**: To view another point at the **POINTS** level, use the <→> and <←> arrow keys

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:

- The first set is treated as a reference set. For each subsequent set n, the first observation to a point *P* (with non-null horizontal angle) that also appears in the reference set is found.

- 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.

- The first non-null horizontal angle of the reference set is converted to an azimuth for display, and all other horizontal angles are reoriented accordingly.

An out-of-tolerance observation (with reference to the global **H. Obs, V. Obs**, and **EDM** tolerances) is displayed with an asterisk (*).

In the example sets, the first two horizontal angles to Point B in Sets 1 and 2 are 45°00'00" and 105°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°00'30". This results in (after the subsequent addition of 10 degrees, the azimuth to B from STN) azimuths of 55°00'00" and 54°59'50" for sets 1 and 2, the average being 54°59'55".

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

The **POINTS** level softkeys access information about other points associated with the selected set.

- To view the vertical angles observed for point B from **STN** in all sets, press the **<V>** softkey.
- View the distances observed for point B from **STN** in all sets by pressing the **<SD>** softkey.

15.2.1.4 SETS-POINTS

The ***SETS-POINTS*** level displays all the observations to a point in a specific set. You can access the **SETS-POINTS** level by pressing <**Enter**> from the **SETS**, **POINTS** or **ALL** levels.

The fields in this level display the following information:

The third and fourth lines list the horizontal angles of each observation made to 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).

Note: To view another point at the **SETS-POINTS** level, use the <→> and <←> arrow keys

It should be emphasized that return sights are displayed independently of initial sights to the reference point. The way in which return sights are isolated is described in Section 15.2.2, *Special cases*, page 15-16.

The **SETS-POINTS** level softkeys access information about other points associated with the selected set.

- To view the vertical angles observed for point B from **STN** in all sets, press the **<V>** softkey.
- View the distances observed for point B from **STN** in all sets by pressing the **<SD>** softkey.
- The **<← SET>** and **<SET→>** softkeys navigate between 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.

15.2.1.5 SETS-POINTS-FACES level

The SETS-POINTS-FACES level displays the raw observation data about a highlighted point. You can access this level by highlighting a observation in the SETS-POINTS level and pressing <Enter>.

> ✉ **Note**: To view another point at the **SETS-POINTS-FACES** level, use the <→> and <←> arrow keys

The **SETS-POINTS-FACES** level softkeys access information about other points associated with the selected set.

- The **<← PTS>** and **<PTS→>** softkey display raw observations of previous and subsequent points within the current set.
- The **<← SET>** and **<SET→>**softkey display raw observations of the current point (if possible, otherwise the first point) in previous and subsequent sets.

15.2.1.6 Example of viewing collected sets

As a means of explaining this abstract structure, the following two sets, collected using the SDR33, will be used. They represent the example survey illustrated in Figure 15-2.

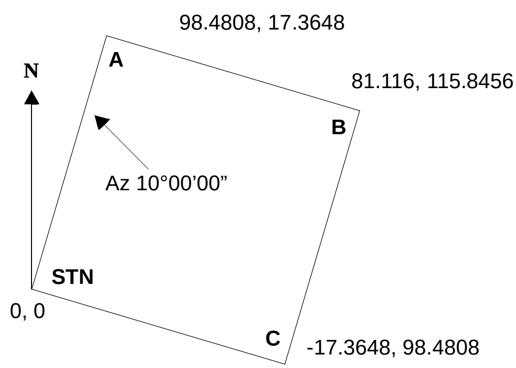


Figure 15-2: Example survey

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.

Set	Face	H.ang	V.ang	S.Dist
Set 1	Face 1			
STN	A	0°0'00”	90°00'00”	100.000
STN	B	45°00'00”	90°00'00”	141.420
STN	C	90°00'00”	90°00'00”	100.000

After you have collected face 1, the SDR33 displays this prompt:

Set	Face	H.ang	V.ang	S.Dist
Set 1,	Face 2			
STN	C	270°00'00”	270°00'00”	100.000
STN	B	225°00'00”	270°00'00”	141.420
STN	A	180°00'00”	270°00'00”	100.000

Upon completion of this set, select **Review sets** from the three available options:

Using **<OPTNS>**, change ***Face order*** to **F1** only.

Set	Face	H.ang	V.ang	S.Dist
Set 2, Face 1(Only)				
STN	A	60°00'30”	90°00'30”	100.020
STN	B	105°00'20”	90°00'20”	141.410

15.2.2 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.

15.2.2.1 Returning to collect more points

If you wish to return to a previous station to collect more points, the points collected during previous Sets need to be included in the additional Set(s). The traverse adjustment looks at the last station record for a point and considers it the most current information for the point. If the additional data does not include the back sight and next station in the traverse route, the route cannot be found. If the data is not included, a no existing fore sight (observation) message is displayed when the adjustment is attempted.

15.2.2.2 Collecting topography data with set collection

When collecting topography data with set collection data, the information contained in the sets must be included in the topography station record for the traverse route to be valid.

If the traverse is adjusted before the topography shots are collected the POS AJ records produced will be used when these stations are occupied in the Topography routine.

If the topography is to be collected at the same set up as the traverse then collect the traverse data in the Set Collection routine first.

When the data for the traverse is complete within the Set Collection routine the SDR33 will prompt to collect more sets, review sets or change stations. Press the ESC key to return to the SURV menu and select Topography. Accept the station and back sight displayed to collect topography data.

15.2.2.3 Tolerances exceeded

Tolerances are only checked between the Face1 and Face2 readings within the Set and tolerances are not checked on the back sight.

Within Topography if data is collected concerning a point that already exists a message is displayed, delta values are displayed and options for overwriting, renaming, check are available. If the Face1 and Face2 option is used and the tolerances are exceeded between the two readings the user is notified of the error and prompted to continue or not. When taking a back sight within Topography the tolerances are checked and messages displayed if exceeded.

15.2.2.4 Duplicate points

When collecting sets, the SDR33 does not provide a duplicate point message. You can use the database view option to check if a point exists.

15.2.2.5 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.

15.2.2.6 GOOD and BAD sets

The SDR33 permits you to mark a set as BAD if it contains inaccurate data or incorrect point identifier(s). Whenever an averaged set (of 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 marked 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. Use the **<BAD>** softkey to mark a set BAD (or the <GOOD> softkey, if it is already marked 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, change it back to 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.

15.2.2.7 Collimation correction

Collimation correction is applied to every level above the lowest (“raw observation”) level in the ***Set review*** hierarchy. All angles have collimation correction applied except in the ***SETS-POINTS-FACES*** level. For more information, see Chapter 38, *Measurement of Collimation Error*.

Chapter 16 Traverse Adjustment

In this chapter

- The traverse adjustment routine
- Procedures for selecting adjustment options
- Methods of traverse adjustment

The traverse adjustment option calculates error in an observed traverse route and enables you to adjust the traverse route to accommodate error. The SDR33 assists you in adjusting the traverse in the field, where you can immediately note and correct errors instead of waiting to adjust the traverse in the office.

The SDR33 has three separate methods of adjusting a traverse that you select from the ***Adjustment options*** screen:

- coordinate adjustment
- angular adjustment
- elevation adjustment

✉ **Note:** It may be beneficial to calculate the adjustment using all three methods and then use the results that best fit your survey.

When you adjust the traverse and store results, all observations using the selected stations will also be adjusted. You do not have to have observations in the same order as they were observed. At least one station must be a known location to perform a traverse adjustment.

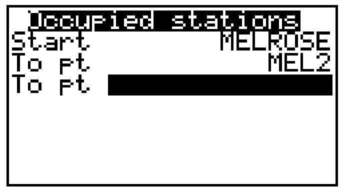
16.1 Calculating and Adjusting the Traverse

Using the ***Traverse Adjustment*** option, you can calculate and adjust a traverse. Access the adjustment options by using the <**OPTNS**> softkey. You may want to calculate the adjustment using different methods and then use the results that best fit your survey.

Steps to calculate and adjust a traverse

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

2. Enter the starting point IDs of your traverse in the ***Occupied Station's*** screen.



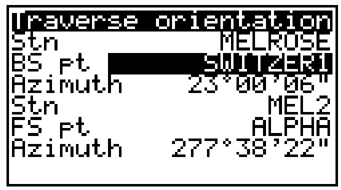
3. The SDR33 determines the traverse route and displays a complete list of stations. A warning message will display if one of the following conditions is present:

- 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 SDR33 can handle (200) has been exceeded

4. Review the traverse route. To modify the route, enter the next station's point name in the traverse route. The SDR33 will find more stations to add to the route.

   Use the <↑> and <↓> keys to move around the list. If a point ID is edited, the SDR33 discards the route and searches for a new traverse route starting from the newly entered point ID.

5. Press **<OK>** to accept the traverse route. The SDR33 will prompt you for details about the backsight and foresight azimuths to give angular control in the traverse calculation.



Enter information in the following fields:

Stn .... (*information only*) This field displays the starting traverse point ID.

BS pt............. Enter the backsight point ID.

Azimuth ...... Enter the backsight azimuth.

Stn .... Enter the ending traverse point ID.

FS pt............. Enter the closing foresight point ID.

Azimuth ...... Enter the closing foresight point ID.

6. The SDR33 displays defaults for **BS** (backsight) and **FS** (foresight) points and azimuths. Press **<OK>** to accept these default values or enter new values.

   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 Δang result field will be null). It will not be possible to carry out an angular adjustment.

- Enter the azimuths directly or enter point names (see Section 35.2, *Entering Known Azimuths*, page -2). The SDR33 calculates azimuths for you.

- A **FS** azimuth may not be specified unless there is a BS azimuth.

7. Press <**OK**> to accept the angular control.

8. The SDR33 will calculate the precision of the traverse and display the results. Review the calculated values.

D.ang............ This field shows the angular closure error.

D.Dist .... This field shows the horizontal closure distance.

Precision...... This field shows the precision of the traverse as a ratio of the total horizontal distance traversed to the closure distance.

D.North .... This field shows the closure distances for the north coordinates.

D.East........... This field shows the closure distances for the north coordinates.

D.Elev .... This field shows the closure distances for the north coordinates.

Note: If insufficient data existed to calculate the distance closure (for example, any leg of the traverse without distance information), the SDR33 reports only an angular closure.

9. (*optional*) You can press **<View>** to review records in the traverse. Press **<Clear>** to return to the ***Traverse precision*** screen.

10. Press **<STORE>** to save the precision results, closure notes, traverse route and **BS** and **FS** details as note records. To continue working and adjust the traverse, skip to step 12.

11. Press <**Clear**> to exit.

✉ **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 the 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.

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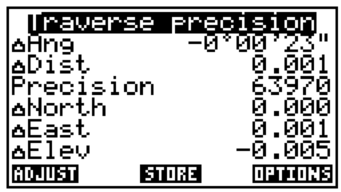
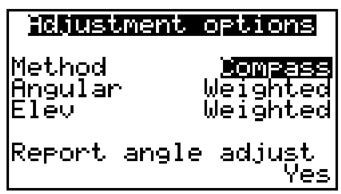
12. To carry out a traverse adjustment, see , *Steps to calculate and adjust a traverse* on page page 16-2, select the **<ADJUST>** softkey in the ***Traverse Precision*** screen.



13. Select the **<OPTNS>** softkey to specify the methods of coordinate, angular and elevation adjustment.



Enter information in the following fields. Use the left or right arrow keys to select the option you want.

Method .... Select the **Compass** or **Transit** coordinate adjustment method (Section 16.1.1, *Coordinate adjustment*).

Angular .... Select **Weighted**, **Linear**, or **None** (Section 16.1.2, *Angular adjustment*).

Elev.............................. Select **Weighted**, **Linear**, or **None** (Section 16.1.3, *Elevation adjustment*)

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.

14. Press the **<OK>** key to accept the adjustment options.

15. Press <**OK**> to start the traverse adjustment. Angular adjustments are carried out first. If the ***Report angle adjust*** field was set to **Yes**, (**<OPTIONS>** screen) a report of the updated closure and traverse precision details displays.

16. To continue with the coordinate adjustment (and elevation adjustment if selected), select the **<ADJUST>** softkey again or press **<OK>**. 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 SDR33 returns to the ***Survey*** menu.

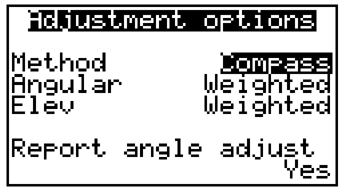
    As the SDR33 uses the latest point coordinates in its calculations, the adjusted traverse points will be used for calculations.

    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.

16.1.1 Coordinate adjustment

You can select the adjustment methods in the ***Adjustment Options*** screen, accessed by pressing the **<OPTIONS>** softkey. The coordinate adjustment method is specified in the ***Method*** field.



Two coordinate adjustment methods are available: **Compass** (or Bowditch) rule and **Transit** rule. Both of these methods distribute the latitude and longitude, or northing and easting, coordinate error throughout the traverse lines.

16.1.2 Angular adjustment

The ***Adjustment Options*** screen enables you to select the angular adjustment via the ***Angular*** field. 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.

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

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

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

16.1.3 Elevation adjustment

If you wish to adjust the elevation values, select an option in the ***Elev*** field of the ***Adjustment Options*** screen. 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.

6

Construction Stake Out

This section provides step-by-step instructions for setting out coordinates, lines and arcs.

Setting Out with the SDR

Setting Out Design Coordinates

- *Working with the Set Out List*
- *Staking Out a Point*

Setting Out a Line

- *Staking Out a Line*
- *Staking Out Relative to a Line*

Setting Out an Arc

- *Staking Out an Arc*

Chapter 17 Setting Out with the SDR

In this chapter

- Overview of setting out operations

After you have observed a number of points, you may want to stake out the observed points for construction or other purposes. Setting out points is the reverse of observing points. Instead of gathering data regarding desired points in the field, setting out locates the point for construction or development applications. Once a point has been located, the point is marked with a stake or other indicator.

Setting out can be used for a variety of applications. The SDR33 can be used before construction to initially set out a design or you can double check locations against a design during and after construction. Also, the Set Out options can be used to locate items underground from a design such as water or sewage pipes, electrical wiring, or storage tanks.

The SDR33 has three separate techniques for setting out points:

- Setting out design coordinates, see Chapter 15, *Setting Out Design Coordinates*, page 15-1.
- Setting out a line, see Chapter 16, *Set Out Line*, page 16-1.
- Setting out an arc, see Chapter 17, *Set Out Arc*, page 17-1.

The Set Out Coords option uses the Set Out List to designate desired set out points. The Set Out List can consist of observed points or manually entered points. The SDR33 directs you to the first point of the Set Out List and each subsequent point. You can use several methods to organize the Set Out List, including adding single points, adding a range of points, removing points and sorting points by azimuth.

Using the Set Out Line option, you can stake out points along a line, or relative to a line. You may have a design that identifies a baseline with the desired points specified as distances and offsets from the baseline. You can use the SDR33 and the Set out Line option to locate these points.

The Set Out Arc option enables you to stake out complex arcs for roading or construction purposes.

When using the Set Out Line or Set Out Arc options, the elevations are interpolated along the line. The SDR33 computes the elevation grade between points as a slope distance.

Chapter 18 Setting Out Design Coordinates

In this chapter

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

You can set out, or stake out, any observed point using one of three set out options. The Set Out Coords options allows you to stake out design coordinates in the field. Using this function, the SDR33 can stake out points relative to a coordinate without observing the desired point.

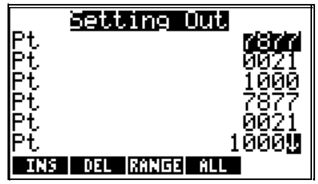
When setting out points, it is necessary to set up your instrument on a known location. The SDR33 will prompt you for a station and backsight setup before setting out. For more information, see Chapter 7, *Setting Up a Station and Backsight*.

Once a station and backsight are set up, the SDR33 checks for an existing list of set out points for the job. If a list is found, the SDR33 displays the available set out points. From this list you can enter, modify, insert or delete point names in the set out list. You can also add all known points, point range (for example, all points from 1000 to 1100), all points within a specified distance of the current station or all points with a certain feature code.

After completing the set out list, the SDR33 will assist you in navigating to the desired point using the rover receiver. The SDR will display your position relative to the desired set out point.

18.1 Working with the Set Out List

When setting out design coordinates, the SDR33 displays a list of available points after you enter a station and backsight.



Before setting out points, review the Set Out List for accuracy and efficiency. You may want to add, remove or sort points to eliminate multiple station setups.

You can modify this list by adding points, deleting points or by sorting the points by azimuth.

18.1.1 Adding Points to the set out list

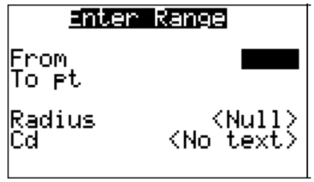
Before setting out a point, the SDR33 creates a list of the desired point to set out. The default Set Out List is blank, you can add points to the list using one or more of the following options. Select the option that best suits your desired workflow.

- Press the **<INS>** softkey to enter a point at a specific place in the list. The SDR33 will insert a blank field in which to enter the new point ID. If the point does not exist in the job, you will be prompted to key in its coordinates.

- Enter points to the end of the Set Out List be pressing **<Func> +** <↓> to move to the bottom and entering the point ID.

- Add all the points in the current job to the set out list by first pressing the **<ALL>** softkey. The SDR33 will display a list of three options. Select **Add all POSs to list**.

- Add a range of point names to the list by pressing the **<RANGE>** softkey.



After you have specified the range, using any or all of the range criteria, the SDR33 adds all the points meeting the conditions to the list.

Point ID ....The first range criteria consists of 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............If a distance value is entered into the ***Radius*** field, only points within that area (radius) from the current station will be included in the list.

Feature Code ...Specify a feature code in the ***Cd*** field; only points with a matching code will be included in the list.

Press the **<OK>** key to start 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 the range option several times to add different point ranges.

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 **<Func>** + <↑>. Once the set out list is complete, you can navigate to and set out your points. For more information, see Section 18.2, *Staking Out a Point*, page 18-5.

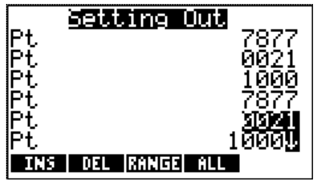
18.1.2 Deleting Points from the set out list

You can remove points from the Set Out List at any time.

Steps to remove points from the set out list

1. Select the **Set out coords** option from the ***COGO*** menu.

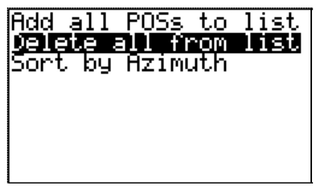
2. The set out point list will display. Highlight the point you wish to remove.



3. Press the <**DEL**> softkey.

—OR—

If you wish to remove all the point names from the list, press the **<ALL>** softkey to open the following option screen.



Select **Delete all from list** from the available list of options.

4. The SDR33 will then display the modified set out list.

18.1.3 Sorting the set out list by azimuth

The SDR33 can sort the Set Out List by azimuth as referenced from the current station to each point. Sorting a Set Out List by azimuth increases efficiency and can save time when setting out. Sorting a list by azimuth arranges points by proximity. By using this method, you can set out all the points in one area and direction before moving your station.

Steps to sort a set out list by azimuth

1. Select the **Set out coords** option from the ***COGO*** menu.

2. The set out point list will display. Press the **<ALL>** softkey to display the available options.

3. Select **Sort by Azimuth**. The SDR33 will display a **Working...** message that will move up and down the screen as the SDR33 sorts the list. A long list may take a few minutes to sort. When the sorting process 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.

18.2 Staking Out a Point

You can use the SDR33 to stake out a point for construction or other purposes. Before setting out, you will need to enter the desired set out points in the Set Out List. For more information, see Section 18.1, *Working with the Set Out List*, page 18-2.

Steps to set out a point

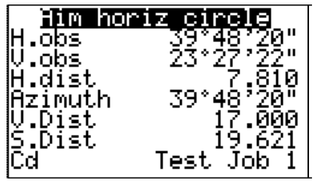
1. Select **Set Out Coords** from the ***COGO*** menu. The Set Out List will display.

✉ **Note**: If a current station for the setting out work, along with the backsight orientation for the station, has not been defined, the SDR33 will display the ***Confirm Stn*** screen.

2. Before setting out a point, review the set out list and make any necessary modifications. For more information, see Section 18.1, *Working with the Set Out List*, page 18-2.

3. Choose a particular point from the list of points on the screen to set out by highlighting it and pressing **<Enter>**.

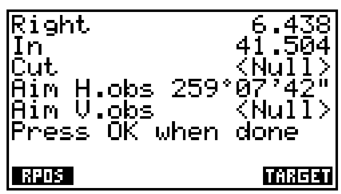
   The SDR33 displays the information required to set out the point: the necessary horizontal and vertical angles to observe, the desired slope distance to the point, the reduced horizontal and vertical distances and the azimuth.



4. Align your instrument to the horizontal angle shown. If you are using a two-way SET, the instrument is put into a countdown mode automatically to help you. Rotate the instrument until the countdown reaches zero, then direct the prism pole in line.

5. Sight on the prism and press the **<Read>** key.

   Information for setting out the plan position of the point displays in the Navigate screen.



The fields display the following information:

Right/Left.... This field shows you the distance to move either left or right to get on line. The direction is from the instrument operator's point of view.

In/Out .... This field shows you the 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 .... This field shows the cut / fill determined by the current point.

Aim H. obs.. This field shows the horizontal angles required to point to the target

Aim V. obs .. This field shows the vertical angles required to point to the target.

6. Press **<Read>** to take as many observations to the prism as you want. After each observation, the ***Left/Right***, ***In/Out*** and ***Cut/Fill*** fields are updated to reflect the latest position of the prism relative to the target point.

7. When you have navigated to the desired point, press **<OK>** to set out the height. Enter information in the following fields:

Fill .... This field shows you the amount of cut or fill the currently observed position represents relative to the design point. Remember the currently observed point is the physical point at the bottom of the prism pole.

Aim V.obs ... This field shows you the vertical angle that should be observed to obtain the design height plus the cut offset.

Cut o/s.......... This field 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.

If you are using a two-way SET, it is automatically put into a vertical countdown mode. When the countdown is zero, you will be sighting on the design elevation plus the value of the ***Cut offset***.

8. (*optional*) Use the **<STORE>** softkey as a shortcut to immediately store the results and return to the point selection screen.

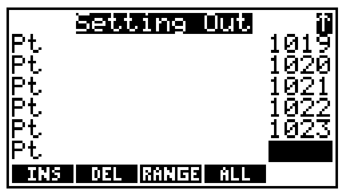
9. (*optional*) Use the **<TARGET>** softkey to initiate another reading and to enter a new target height.

10. (*optional*) Press **<Clear>** to return to setting out the plan position. This action might be necessary if the prism pole is inadvertently moved during the setting out of the elevation.

11. Press **<OK>** once a satisfactory elevation has been set out. The SDR33 then prepares to store the results. It will show you a default point name and code that it will use.

    You can modify the target height by pressing the **<TARGET>** softkey. Store the current setout position using the **<YES>** softkey on the ***Store Result*** screen.

12. Once the position record is generated, the SDR33 returns to the Set Out List. Another point can now be selected for set out. If the list is now empty, you may add more points to the list.



13. Press **<Clear>** to exit the **Set Out Coords** option.

Chapter 19 Setting Out a Line

In this chapter

- Setting out points along a line, in either the horizontal or vertical plane
- Staking out points relative to a line

The Set Out Line options can be used for setting out and checking alignment of curblines, construction boards and grades of pipes. Using the set out function, the SDR33 can stake out points relative to a line without observing the desired point.

You can set out lines horizontally or vertically. You can also set out the line itself (giving an off-line value), or specific points along the line. An offset left or right of the line can be set out. Elevations are interpolated where possible.

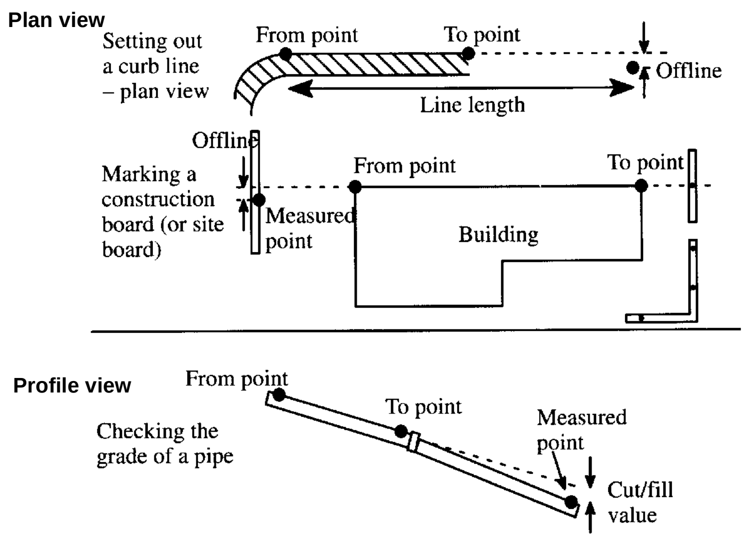


Figure 19-1: Setting out a line

You can use the **Set Out Line** option to set out a line or to set out relative to a line. Both procedures include these main steps:

- Defining the baseline
- Selecting set out points
- Setting out the points

19.1 Staking Out a Line

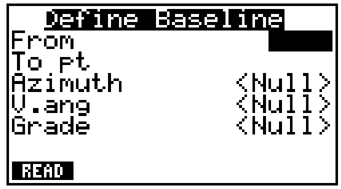
You can specify points along a line by a distance or a whole number of increments, including a horizontal offset to the point.

Steps to set out a line

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

🖂 **Note**: If a current station for the setting out work, along with the backsight orientation for the station, has not been defined, the SDR33 will display the ***Confirm Stn*** screen.

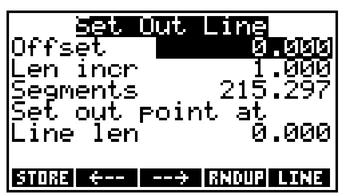
2. The ***Define baseline*** screen displays. Define your baseline by specifying two points. You also can specify one point plus an azimuth, a grade or a vertical angle, to allow the setting out of points along the defined line. If an unknown point name is entered, the ***Key in coords*** screen will display, allowing you to enter the appropriate coordinate values. The ***From*** field must be entered.



Press **<READ>** to observe the current location and establish it in the baseline.

When the ***Grade*** field is selected, **<HORIZ>**, **<1:>** and **<%>** softkeys are presented. The **<HORIZ>** softkey will set the Grade field to horizontal. The **<1:>** and **<%>** softkeys 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**).

3. After defining your baseline, press <**OK**>. The ***Set Out Line*** screen will display.



Enter information in the following fields:

Offset........... This fields is used for setting 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 pegs. A negative offset value indicates an offset to the left of the specified set out line.

Len incr........ This field 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.

The **< ¨ >** and **<Æ >** softkeys 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.

Segments..... This field displays only if both the ***From*** and ***To*** points were specified for the baseline. This field interacts with the ***Len incr*** field, because it displays the number of segments of the length specified in the ***Len incr*** field that fit in the defined baseline. Therefore, if you want to split the baseline into a specific number of evenly sized segments, enter the required number of segments into the ***Segments*** field. The ***Len incr*** field will then display the computed length of each segment. The **<RNDUP>** softkey, when selected, will round the value in the ***Segments*** field up to the next whole number. Again the **<RNDUP>** softkey is available only when both the ***From*** and ***To*** points are specified for the baseline.

Line len........ This field 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.

4. (*optional*) The **<DSGN>** softkey stores the coordinates of the point to 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.

5. Press **<OK>** to return to the ***Set out line*** screen to compute further points. You can elect to set out any specified position along the baseline by selecting the **<OK>** key. This will result in the point on the baseline being saved in the database followed by the presentation of the standard setting out screen.

   Once the point has been set out as required, press **<OK>** or **<STORE>** to save the coordinates of the set out point. A Note indicating how far off line the set out point was from the required line is stored. A negative off line value indicates that the measured point was to the left of the required line.

6. (*optional*) If there are no specific points to set out, for example, if you are checking a curb alignment or a new pipe grade, press the **<LINE>** softkey.

   Once you take a reading to a point you wish to check, the program will report how far off line the observed point was from the defined line. It will also report any cut or fill value from the measured point to the defined line.

7. (*optional*) The **<STORE>** softkey stores a POS record with the coordinates of the point measured followed by a Note containing the Off-line and Cut/Fill values as reported on the screen.

   Select the **<OK>** key to complete the operation. If you have not already saved the measured position using the **<STORE>** softkey, you will be given the opportunity to record the position and Off-line and Cut/Fill Note.

8. (*optional*) The **<POINTS>** softkey enables you to specify points for setting out along the baseline. Press <**Clear**> to exit.

19.2 Staking Out Relative to a Line

Setting out relative to the line allows the line to be located, then provides distance and offset values to the line. This option also allows you to specify a starting distance (stationing) for the line and a horizontal offset to the line.

Steps to set out relative to a line

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

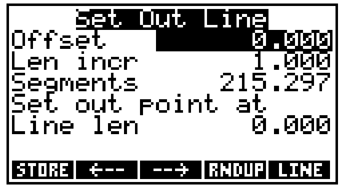
✉ **Note:** If a current station for the setting out work, along with the backsight orientation for the station, has not been defined, the SDR33 will display the ***Confirm Stn*** screen.

2. The ***Define baseline*** screen displays. Define your baseline by specifying two points. You also can specify one point plus an azimuth, a grade or a vertical angle, to allow the setting out of points along the defined line. If an unknown point name is entered, the ***Key in coords*** screen will appear, allowing you to enter the appropriate coordinate values. The ***From*** field must be entered.

   Press **<READ>** to observe the current location and establish it in the baseline.

   When the ***Grade*** field is selected, **<HORIZ>**, **<1:>** and **<%>** softkeys are presented. The **<HORIZ>** softkey will set the Grade field to horizontal. The **<1:>** and **<%>** softkeys 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**). See Section 19.1, *Staking Out a Line*, page 19-2 for more information.

3. After defining your baseline, press <**OK**>. The ***Set Out Line*** screen will display.



Enter information in the following fields:

Offset........... This fields is used for setting 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 pegs. A negative offset value indicates an offset to the left of the specified set out line.

Len incr........ This field 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.

The < ← > and <→ > softkeys 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.

Segments..... This field displays only if both the ***From*** and ***To*** points were specified for the baseline. This field interacts with the ***Len incr*** field, because it displays the number of segments of the length specified in the ***Len incr*** field that fit in the defined baseline. Therefore, if you want to split the baseline into a specific number of evenly sized segments, enter the required number of segments into the ***Segments*** field. The ***Len incr*** field will then display the computed length of each segment. The **<RNDUP>** softkey, when selected, will round the value in the ***Segments*** field up to the next whole number. Again the **<RNDUP>** softkey is available only when both the ***From*** and ***To*** points are specified for the baseline.

Line len..................This field 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.

4. Select the <**LINE**> softkey to set out a point relative to the line.

   Enter information into the available fields.

   Offset.....................This field is used for setting 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 pegs. A negative offset value indicates an offset to the left of the specified set out line.

   Start distance........Enter the distance from the starting point of the line to the initial point of the baseline in this field.

5. Press <**READ**> to take a reading and display the ***offline***, ***In/out*** and ***Cut/Fill*** values.

6. Press <**STORE**> to store the observation and a note record containing the cut or fill values, offline value and distance down the line, including the start distance.

Chapter 20 Setting Out an Arc

In this chapter

- Arc calculation using a variety of methods
- Coordination of points along arcs

The Set Out Arc option can be used to set out arcs or parts of arcs, including, intersection points and tangents. Using the set out function, the SDR33 can stake out points relative to an arc without observing the desired point.

The SDR33 provides a generalized arc calculator for defining 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.

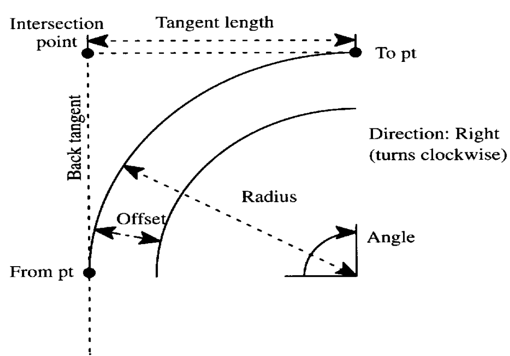


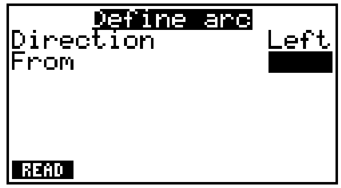
Figure 20-1: Arc details

20.1 Staking Out an Arc

Setting out an arc is similar to setting out coordinates or a line.

Steps to set out an arc

1. Select **Set out arc** from the ***Functions*** menu. The ***Define arc*** screen displays.



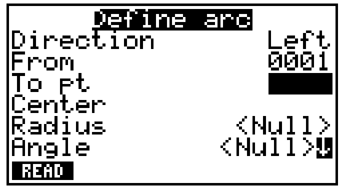
Note: If a current station for the setting out work, along with the backsight orientation for the station, has not been defined, the SDR33 will display the Confirm Stn screen.

2. Define your baseline by specifying two points. You also can specify one point plus an azimuth, a grade or a vertical angle, to allow the setting out of points along the defined line. If an unknown point name is entered, the ***Key in coords*** screen will appear, allowing you to enter the appropriate coordinate values. The ***From*** field must be entered.

   Press **<READ>** to observe the current location and establish it in the baseline.

   When the ***Grade*** field is selected, **<HORIZ>**, **<1:>** and **<%>** softkeys are presented. The **<HORIZ>** softkey will set the Grade field to horizontal. The **<1:>** and **<%>** softkeys 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**).

3. The ***Define Arc*** screen displays.



Enter the appropriate arc settings in the following fields:

Direction .... This field specifies whether the arc being defined turns toward the right (clockwise) or left (counterclockwise) when viewed from the From point. This field toggles between **Right** and **Left** when the ← or → keys are pressed.

From .... Use this field to enter a point; this field plus one of the other point fields (***To pt***, ***Center*** or ***Intersect pt***) **must be entered**.

To pt .... (*optional*) A point field used to define arc.

Center .... (*optional*) A point field used to define arc.

Radius.......... (*optional*) An arc field used to define arc.

Angle .... (*optional*) An arc field used to define arc.

Arc len .... (*optional*) An arc field used to define arc.

Chord ln ...... (*optional*) An arc field used to define arc.

Tan len .... (*optional*) An arc field used to define arc.

Back tan....... (*optional*) An arc field used to define arc.

Intersect pt .. (*optional*) A point field used to define arc.

✉ **Note**: 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 one of the arc definition fields (***Radius, Angle, Arc len, Chord ln, Tan len*** or ***Back tan***) can be entered to fully define the arc.

See Figure 20-1 for an illustration of the arc definition values that can be specified. The values for the rest of the fields are calculated and displayed (except for the point fields).

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. (*optional*) The **<READ>** softkey appears 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 ***Key in coords*** screen will appear, allowing you to enter the appropriate coordinate values.

   ✉ **Note**: The standard **<Read>** key on the keyboard can also be used. Pressing **<Read>** will take a reading directly without requiring confirmation of the station and backsight points.

5. Once the arc has been defined, the **<CREATE>** softkey will appear when the cursor is placed on the ***Intersect pt*** 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.

   ✉ **Note**: This option can be useful for calculating the IP or center point of an arc.

6. When **<OK>** is pressed, the ***Set out arc*** screen displays. Review the information in the following fields:

Offset.......... This field can be used to define a parallel offset from the originally defined curve. A negative value indicates an offset to the left illustrates an offset arc to the right.

Len incr........ (Length increment) This field allows 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.

The **<¨>** and **<Æ>** softkeys decrease and increase the current arc length (or chord length) to be set out by the value in the ***Len incr*** field.

∆Chordarc... This field 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.

Segments..... This field displays the number of segments the total arc length between the From and To points into which it will be split.

The ***Segments*** field displays the number of segments the total arc length between the ***From*** and ***To*** points is to be split into. 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 will be displayed.

The **<RNDUP>** softkey 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 ∆***Chordarc*** field and then select the **<RNDUP>** softkey.

Set out point at Arc len..... This field 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.

7. (*optional*) Press the **<CHORD>** softkey to set out points along the arc 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 the **<CHORD>** softkey and enter 50 into the ***Len incr*** field. Select the **<ARC>** softkey to return to defining the set out points in terms of arc lengths.

8. (*optional*) Press **<STORE>** 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.

9. Press **<OK>** when you are finished defining the arc to return to the Set out arc screen. You can elect to set out any specified position along the arc by selecting the **<OK>** key. This will result in the point on the arc being saved in the database followed by the presentation of the standard setting out screen.

10. Press <**Clear**> to exit the **Set out arc** option.

7

Roading

This section explains how to create a road, use a template, the differences between string and alignment roads and their corresponding elements. Setting out roads and road surfaces is detailed in separate chapters as well as road topography.

Working with Roads

- *Roading Basics*
- *Setting Up a Road Station*
- *Working with Templates*

Defining Roads

- *Using String Roads*
- *Using Alignment Roads*
- *Roading Example*

Setting Out Roads

- *Setting out Cross-Sections*
- *Setting out Sideslopes*
- *Staking Notes*

Set Out Road Surface

Road Topography

- *Using Road Topography*

Chapter 21 Working with Roads

In this chapter

- Road basics
- Setting up a road station
- Defining templates
- Template elements
- Removing templates

The SDR33 provides you with tools to design, manage, and set out roads. All options needed to survey, define, and set out a road are contained in the Roading menu. This feature is designed to make roading quick and efficient using standard SDR workflow. Roading procedures share similarities with other SDR options.

Before setting out a road or performing any road topography, you will need to create a road, define any necessary templates and set up a road station. If you plan to do any set out work, other than the centerline of the road, you will need to establish a roading template. This chapter explains the basic operations associated with roading options.

With the SDR33, you can create road templates using multiple template elements. You can create alignment roads and string roads using the SDR33. Depending on the road type, you can add multiple roading elements including superelevation and widening. You can also upload alignment files from external sources. For more information on road types and templates, see Chapter 22, *Defining Roads*.

After creating a road and defining the template, you can use additional SDR33 roading options to set out the road, set out road surface or perform road topography. For more information, see Chapter 23, *Setting Out Roads*, Chapter 24, *Set Out Road Surface* and Chapter 25, *Road Topography*.

21.1 Roading Basics

Roads are independent of jobs; however, they function in similar ways. The same management functions are available for roads as for jobs:

- Creating a road
- Selecting a road
- Reviewing road statistics
- Deleting roads

When you initially create a road, the SDR33 saves the road and any associated templates independently. You can import coordinates from the current job into the road file although only the coordinates will be saved (point numbers will not be saved).

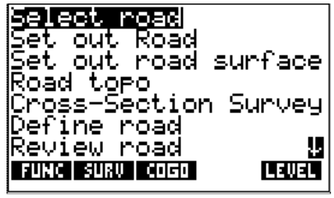
If you are going to perform any set out work, the SDR33 will import the road and template files into the current job. Whenever you access a roading set out option, the SDR33 will verify the current job contains the new roading file and templates.

21.1.1 Creating a road

To work with the roading features, you need to identify an existing road or create a new one. You can create multiple roads. however, the SDR33 will only work with one road at a time.

Creating a new road

1. Choose **Select road** from the ***Roading*** menu.



2. Access the ***Create Road*** screen by pressing the **<NEW>** softkey.

⌧ **Note**: If no roads have been created, the ***Create Road*** screen will display by default.

3. Enter a name, up to 16 characters.

⌧ **WARNING**: Roads are independent of survey jobs. They can have the same names as jobs, but this is not recommended.

4. Confirm a projection scale factor for the road. The scale factor is for internal SDR33 use, and *must be the same as any job scale factor* you use to set out the road or for road topo.

5. Press **<Enter>** to accept the road name and scale factor.

6. Enter any information in the ***Note*** screen, then press **<Enter>**.

7. You are now ready to continue your roading job.

Note: Once a road has been created, it is considered the "selected" road; you do not need to select it. All road programs will use it as the definition until a different road is selected.

21.1.2 Selecting a road

You can only work on one road at a time. If you just created a road, it is already selected as your current road. All roading options will use the selected road. You can switch between roads by selecting a new road in the ***Select road*** screen.

Selecting an existing road

1. Choose **Select road** from the ***Roading*** menu.

2. Use the <↑> and <↓> keys to highlight the desired road and press **<Enter>**.

   The **<PGUP>** and **<PGDN>** softkeys allow you to page through numerous roads. The **<STAT>** softkey is described in Section 5.3, *Reviewing Job Statistics and Renaming a Job,* page 5-6.

3. You can now add or modify templates, set out roads or perform road topography.

Note: Once a road has been selected, all road programs will use it as the definition until a different road is selected.

21.1.3 Accessing road statistics and renaming a road

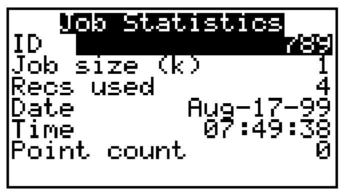
Using the ***Road Statistics*** screen, you can display the statistics for a road and rename the road. Roads operate similarly to jobs although they are saved separately. For more information, see Section 21.1, *Roading Basics*, page 21-2.

Steps to access road statistics

1. Choose **Select road** from the ***Road*** menu.

2. Highlight the road to be accessed.

3. Select the **<STAT>** softkey.



ID .... This field indicates the name of the current road. You can enter a new ID here if necessary.

Job size (k) .... (*information only*) This field displays the size of the road file, in kilobytes.

Recs used .... (*information only*) This field displays the approximate number of records (point positions, observations, notes, etc.) currently stored in the road.

Date and **Time**. (*information only*) These fields display the date and time the road was last accessed; therefore, the date and time displayed will not necessarily relate to the last time data was saved in the road. For example, the process of selecting a road as the current road will access the road files and therefore update the date and time.

Point count....... (*information only*) This field displays the number of points currently stored. A new road will have a point count of 0.

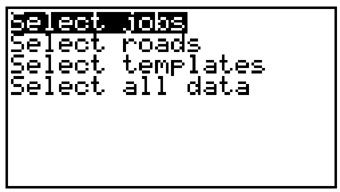
4. Press **<Enter>** to accept changes or **<ESC>** to return the ***Select road*** screen.

21.1.4 Deleting a road

Once you have transmitted a road to your office computer (or printed it out on a printer), you can remove it from memory. For more information on transferring roads, see Section 34.1.1, *Setting SDR communication parameters*, page 34-2.

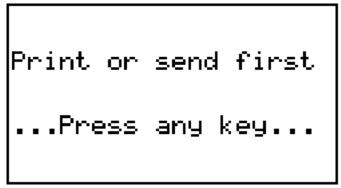
Steps to delete a road

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

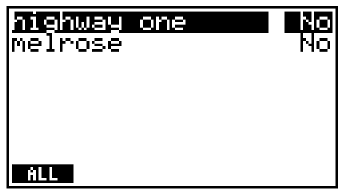


2. Highlight ***Select roads*** and press **<Enter>**.

The SDR33 checks to see if any roads have been transmitted and are available for deletion. If there are none, a message advises you to send or print the roads first.**You must either print or transfer a road or road template before it will become available for deletion**.



3. If any roads 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 you are deleting, then use the <←> or <→> keys to toggle settings from **No** to **Yes**.

5. Press **<Enter>** to delete the road.

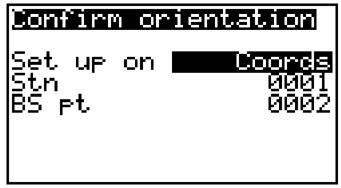
☒ **Note**: The **<ALL>** softkey allows all roads, which have been either printed or transferred, to be selected for deletion.

21.2 Setting Up a Road Station

Setting up a road station provides a known point for your road work. Whenever the **Road topo**, **Set out road** or **Set out road surface** options are selected, a road station must be set up.

Steps to set up a road station

1. Select **Set Out Road** from the ***Roading*** menu. The ***Confirm Orientation*** screen displays.



✉ **Note**: You can also access this screen by selecting **Road Topo** or **Set Out Road Surfac**e from the ***Roading*** menu.

Enter information in the following fields:

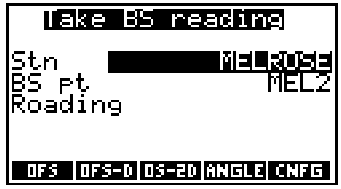
Set up on ..... This option is displayed when the road definition uses coordinates. Select from two options:

Coords - When setting up the road station, the SDR33 will prompt you for the coordinates of the total station.
Stn Offset - When setting up the road station, the SDR33 will prompt you for the station and offset of the total station in relation to the road definition.

✉ **Note:** For uncoordinated roads, the station position must be specified by station and offset. The backsight may not be specified by coordinates.

Stn .... Enter the point ID for your current Stn. If the point ID does not exist, the SDR33 will prompt you for the station information specified in the **Set up on** field.

BS pt............ Enter the BS pt. If the backsight point does not exist, the SDR will prompt you to manually enter the BS information.



The ***Key in azimuth*** and ***Key in coords*** options are the same as for normal station setup. For more information, see Chapter 35, *Operating with Keyboard Input*. The ***Key in Stn & Offset*** option allows you to specify a point relative to the road definition.

2. Press **<Enter>** to accept this screen; a road position record is stored with the backsight reading.

```
ROAD POS KI 8002      Sta.ing 32.000Offset 0.000
                      North 10354.985East 84333.033Elev 36.130
                      Cd CL
```

21.3 Working with Templates

Templates allow a predefined cross-section to be attached to the centerline definitions. A template can be used multiple times with different road definitions.

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 you are using a computer-based design, transmit the design file to the SDR33 using a communication program. For more information, see Chapter 34, *Communications*. If the design has been plotted on paper, enter the design elements in the SDR33 using the ***Define road*** option.

When defining templates that will be joined together, you may want to use the same number of elements. If there is a significant difference between two templates the SDR33 will interpolate the difference between the templates. Creating templates with the same types of elements can aid in the interpolation and reduce the amount of manual corrections needed. Once a template is defined, you can modify it by removing or adding additional template elements.

21.3.1 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 stored independently of both survey jobs and road definitions. Once you have defined your template, you can “attach” it to the road definition.

✉ **Note:** Road templates created with the SDR33 are single surface templates.

Templates must not fold on themselves so as to create an overhang although two consecutive points may be at the same offset (one vertically above the other).

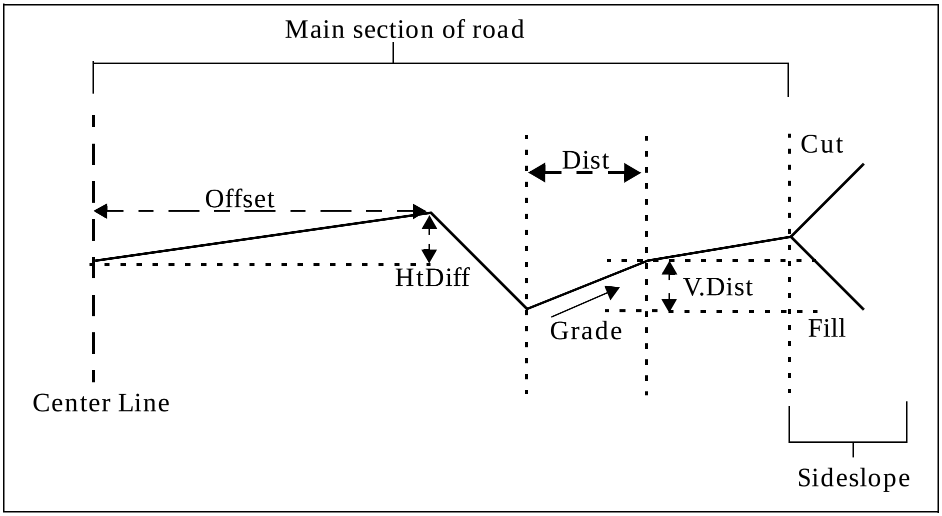


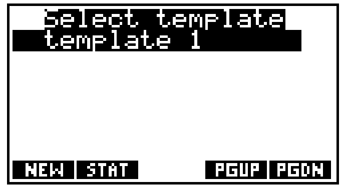
Figure 21-1: Example template

Steps to define a template

1. Choose **Define template** from the ***Roading*** menu.

✉ **Note**: If no templates exist, the ***Create template*** screen displays first.

2. The ***Select template*** displays. Access the ***Create template*** screen by pressing the **<NEW>** softkey.



3. Enter a template name and press **<Enter>**. The Note screen will display.

4. (*optional*) Enter as many descriptive notes as needed.

5. Press **<Enter>** when you are done. The ***Template Elements*** screen will display.

6. Define your template by adding template elements. Add as many elements as necessary to define your road template.

Templ-Offs/Htdiff... This element is used to create lines based off the center line of the road. Specify the offset distance and then the height difference from the desired station. For more information, see Section 21.3.1.1, *Template point by offset and height difference*, page 21-14.

Temp-Grade/Dist..... This element is used to create consecutive, incremental, joined cross-section lines. Specify the grade and distance incrementally from the previous station element. For more information, see Section 21.3.1.2, *Template point by grade and distance*, page 21-16.

Temp-Dist/VDist..... This element is used to create consecutive, incremental, joined cross-section lines specified by a distance and vertical distance. For more information, see Section 21.3.1.3, *Template point by distance and vertical distance*, page 21-18.

Templ-Sideslope...... This element is used for defining a sideslope and can be only the last component in a template. Specify the cut/fill ratio desired for the sideslope. For more information, see Section 21.3.1.4, *Template sideslope definition*, page 21-20.

The softkeys access the following options:

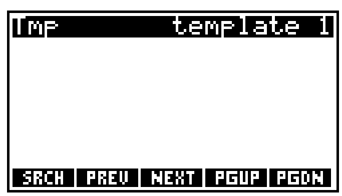
<REVIEW> . The <**REVIEW**> softkey allows you to view the current template definition. See step 8.

<UNDO>..... The <**UNDO**> softkey removes the last defined element from the template.

7. After an element is added, the template elements menu displays. Continue to add elements as required.

8. When you are finished defining the shape of the template, select the **Templ-Sideslopes** element to join the edge of the template and the existing terrain at a catch point.

9. (*optional*) You can review the template definition by pressing the **<REVIEW>** softkey. This step will show you the records that currently define the template.



Press <**Enter**> to view specific details about a highlighted element.

10. Press <**Clear**> to save and exit the template definition option.

21.3.1.1 Template point by offset and height difference

This element will normally start your roading template definition. Define a height difference and an offset to the highest section of the road from the centerline. The SDR33 will interpolate the slope for the template element. You can specify superelevation and widening in this screen or as a separate element in the template. For more information, see Section 22.2.4, *Applying superelevation and widening*, page 22-23.

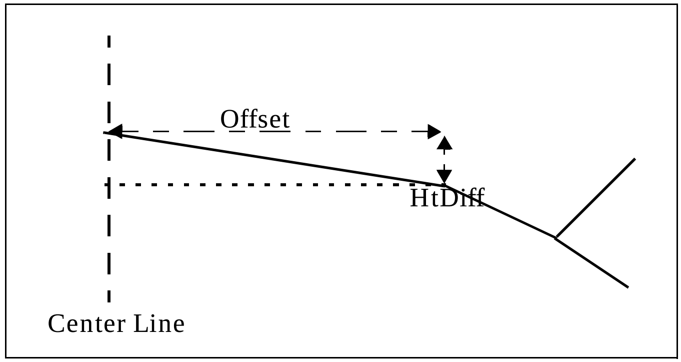
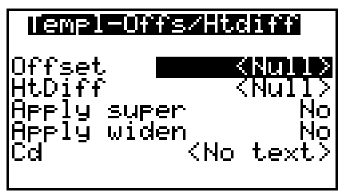


Figure 21-2: Template point with offset and height difference

When you select the Templ-Offs / Htdiff option, the following screen displays.



Enter appropriate values for the following fields:

Offset .... This field 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 .... This field specifies the vertical height difference of the point from the centerline. A positive height difference means the point is above the centerline.

Apply Super .... This field specifies whether or not the element will be affected by the application of superelevation. Select **Yes** or **No**.

Apply Widen .... This field specifies whether or not the element will be affected by the application of widening. Select **Yes** or **No**.

Cd .... This field allows a code to be attached to the point that this element defines.

Press **<Enter>** to accept the screen and return to the template menu. The defined point is joined to the previous template point to form the shape of the template. The element information is stored in the database in the following format.

```
TEMP ELEMENT    Grade%-3.000H.dist 25.000V.dist -0.750
                Offset 25.000HtDiff -0.750Apply super Yes
                Apply widen YesCd HIGHWAY
```

21.3.1.2 Template point by grade and distance

If you need to add another section onto your roading template defined by a grade and distance, use this option. Specify the grade and distance from the end point of your previous template element. You can specify superelevation and widening in this screen or as a separate element in the template. For more information, see Section 22.2.4, *Applying superelevation and widening*, page 22-23.

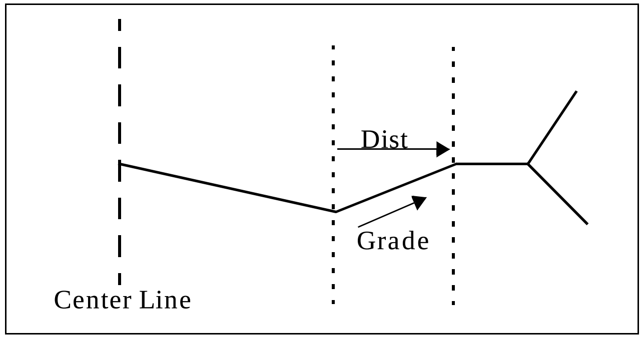
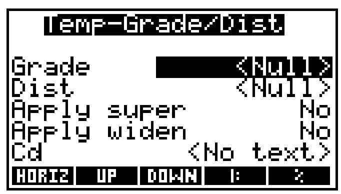


Figure 21-3: Template point with grade and distance

When you select the Temp-Grade / Dist option, the following screen displays.



Enter information in the following fields:

Grade .... This field specifies the grade of the element; it can be specified as **Horizontal** by pressing the **<HORIZ>** softkey, or to be a vertical up or down by pressing the **<UP>** or **<DWN>** softkey.

The **<%>** and **<1:>** softkeys 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.

Distance............ This field 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.... This field specifies whether or not the element will be affected by the application of superelevation. Select **Yes** or **No**.

Apply Widen... This field specifies whether or not the element will be affected by the application of widening. Select **Yes** or **No**.

Cd...................... This field allows a code to be attached to the point that this element defines.

Press **<Enter>** to accept the screen and return to the template menu. The defined point can be considered to be joined to the previous template point to form the shape of the template. The element information is stored in the database in the following format.

```
TEMP ELEMENT        Grade%-3.000H.dist 25.000V.dist -0.750
                    Offset 25.000HtDiff -0.750Apply super Yes
                    Apply widen YesCd HIGHWAY
```

21.3.1.3 Template point by distance and vertical distance

If you need to add another section onto your roading template defined by a vertical distance and distance (length), use this option. Specify the distance from the end point of your previous template element and the vertical distance between the two points. The SDR33 will interpolate the slope for you. You can specify superelevation and widening in this screen or as a separate element in the template. For more information, see Section 22.2.4, *Applying superelevation and widening*, page 22-23.

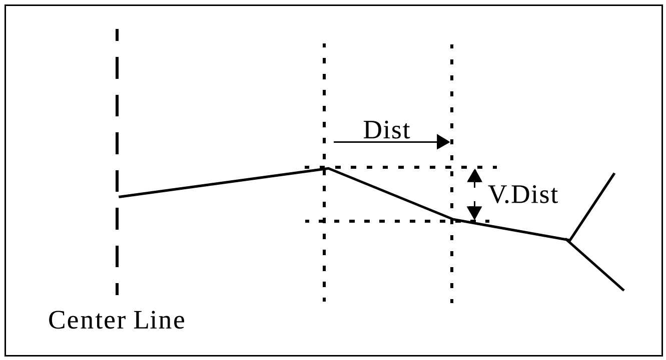
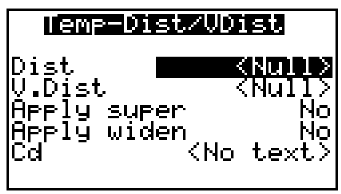


Figure 21-4: Template point with distance and vertical distance

When you select the Temp-Dist / VDist option, the following screen displays.



Enter appropriate values for the following fields:

Dist............... This field specifies the horizontal distance of the point from the previous template point. This distance must not be negative.

VDist.................This field 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....This field specifies whether or not the element will be affected by the application of superelevation. Select **Yes** or **No**.

Apply Widen...This field specifies whether or not the element will be affected by the application of widening. Select **Yes** or **No**.

Cd......................This field allows a code to be attached to the point that this element defines.

Press **<Enter>** to accept the screen and return to the template menu. The defined point can be considered to be joined to the previous template point in order to form the shape of the template. The element information is stored in the database in the following format.

TEMP ELEMENT	Grade%-3.000H.dist 25.000V.dist -0.750 Offset 25.000HtDiff -0.750Apply super Yes Apply widen YesCd HIGHWAY

21.3.1.4 Template sideslope definition

The sideslope element will normally end your template definition. Define a cut grade and a fill grade in this screen. When you are setting out the road, the SDR33 determines whether you are in cut or fill and uses the appropriate grade to set out the sideslope. See Section , *Steps to delete a template,* page 21-22.

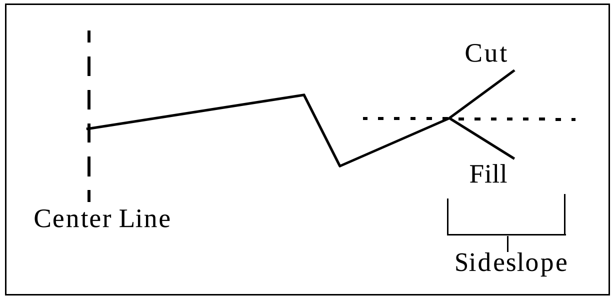
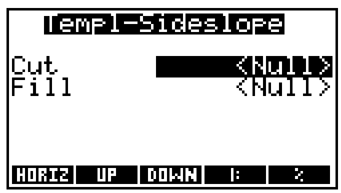


Figure 21-5: Template sideslope

When you select the Templ-Sideslope option, the following screen displays.



Define grades like you did in the **Temp-Grade/Dist** template point definition (Section 21.3.1.2, *Template point by grade and distance,* page 21-16). 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.

Enter information in the following fields:

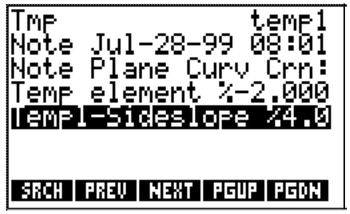
Cut................ This grade will be applied to meet existing terrain when the template is in a cut situation.

Fill .... This grade will be applied to meet existing terrain when the template is in a fill situation.

Press **<Enter>** to accept the screen.

21.3.2 Reviewing template definitions

The SDR33 provides an option to review a template definition similar to the method of reviewing database records. You can access the Template Review option by selecting **Review template** from the ***Roading*** menu. After selecting the template you wish to review and pressing **<OK>**, the following screen will display.



The softkeys access the following options:

<SRCH> ...... This option enables you to search for templates using template codes.

<PREV>....... Displays the previously accessed template.

<NEXT>....... Moves to the next template in the template list.

<PGUP> ...... Moves one screen up

<PGDN> ..... Moves one screen down.

✉ **Note**: You can only modify a template during the definition of a template, see Section 21.3, *Working with Templates*, page 21-9.

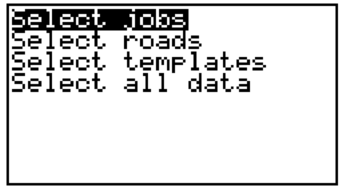
21.3.3 Deleting a template

The SDR33 provides a safeguard against deleting unarchived templates. Once a template is created, it must be transferred or printed before the template becomes available for deletion.

Once you have transferred a template to your office computer (or printed it out on a printer), you can remove it from memory. For more information on transferring files, see Section 34.3, *Transferring Data Files*, page 34-7.

Steps to delete a template

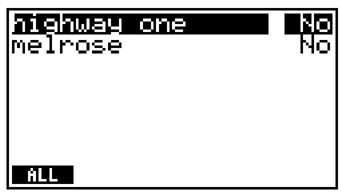
1. Select **Job deletion** from the ***Functions*** menu.



2. Highlight ***Select templates*** and press **<Enter>**.

   The SDR33 checks to see if any templates have been transferred and are available for deletion. If no templates have been transferred, a message advises you to send or print the templates first.

3. Available templates are marked **No**; unavailable ones are marked **N/A**.



4. Place the cursor on the template you are deleting, then use the <←> or <→> keys to toggle settings from **No** to **Yes**.

5. Press **<Enter>** to delete the template.

✉ **Note**: The **<ALL>** softkey allows all available templates to be selected for deletion.

Chapter 22 Defining Roads

In this chapter

- String road overview
- Defining string roads
- Alignment road overview
- Defining alignment roads
- Applying superelevation and widening
- Roading examples

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 program or a plotted design already on paper.

If you are using a computer-based design, send it to the SDR33 using a communication program. For more information, see Chapter 34, *Communications*. If you are using a paper-plotted design, you can manually enter elements like horizontal and vertical definitions, cross-sections, templates, super elevation and widening that define your road.

The SDR33 can handle two types of road definition. Each of these types of roads can be defined using specific elements. You can combine alignment roads with templates (see Chapter 21, *Working with Roads*).

- The string road type is intended to make it easy to use the output of many computerized road design programs. 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. For more information, see Section 22.1.1, *Defining a string road*, page 22-3.

- 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. For more information, see Section 22.2, *Using Alignment Roads,* page 22-4.

You may want to review the examples detailed at the end of this chapter for assistance and ideas on completing a roading job.

✉ **Note**: You can transfer road design to the SDR33 using the Communications option. For more information, see Chapter 34, *Communications.*

22.1 Using String Roads

The string road type is intended to make it easy to use the output of many computerized road design programs. 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 a string road is sent to the SDR33, you can set out the design in terms of stationing (chainage), offset and string name. This works similar to an alignment road. However, you can only set out those discrete points in the road definition. You cannot interpolate between them. You can also set out a horizontal offset to the centerline if desired.

A string road definition sent from a road design package will consist of a series of coordinates only. Azimuths, distances or point numbers will not be associated with the coordinates. You can add points to this definition or create your own definition by selecting points in the current job already surveyed with the SDR.

You may want to define a string road as a preliminary procedure when developing a road. String roads require less information and are easier to change than alignment roads. However, you cannot apply template elements, superelevation or widening to a string road. String road definitions are limited to defining the centerline only.

22.1.1 Defining a string road

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.

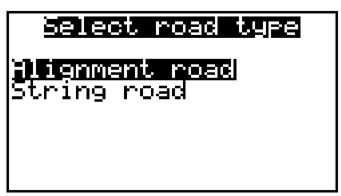
Note: Once the road type has been defined as string or alignment, it cannot be changed.

Steps to define a road

1. Select the road you want to define (See Section 21.1.2, *Selecting a road*, page 21-4).

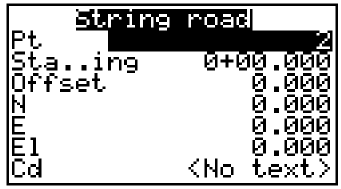
2. Choose **Define road** from the ***Roading*** menu.

3. From the ***Select Road Type*** screen, highlight **String road** and Press <**OK**>.



Note: If the type has already been defined, the associated definition screen will display.

4. The ***String road*** definition screen displays.



Enter information in the following fields:

Pt.................. This field indicates the current road station point ID.

Sta..ing......... This field indicates the current stationing value.

Offset........... This field indicates the offset value.

N .... Enter the north coordinate value.

E.................... Enter the east coordinate value.

El.................. Enter the elevation of the current point.

Code............ This field indicates a descriptive code.

5. Press **<Enter>** to store a road position record (**RPOS**) in the road definition and define the position of a point on the road at that station and offset.

6. Enter as many of these records as needed. Press **<ESC>** when finished.

22.2 Using Alignment Roads

By using Alignment Roads, you can create extremely specific road definitions. Alignment roads contain horizontal and vertical definitions and templates that use superelevation and widening values. While string roads will only allow the RPOS records used to define the road to be set out, alignment roads allow any part of the road to be set out whether it be a defined or a calculated position.

Note: Once the road type has been defined as string or alignment, it cannot be changed.

Steps for defining and setting out alignment roads

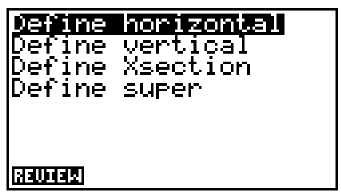
1. Highlight the **Select Road** option from the ***Roading*** menu and press **<OK>**.

2. Select the road you wish to define from the available list and press <**OK**>.

3. Choose **Define road** from the ***Roading*** menu.

4. From the Select Road Type screen, highlight **Alignment road** and press <**OK**>.

5. Select a roading element from the ***Alignment Road*** definition screen.



Start defining your road using one of the four available roading elements:

Define horizontal.....This option allows you to enter a variety of horizontal elements to your alignment road definition. For more information, see Section 22.2.1.1, *Adding horizontal elements*, page 22-11.

Define vertical .... This option allows you to enter a variety of vertical elements to your alignment road definition. For more information, see Section 22.2.2.1, *Defining a vertical alignment*, page 22-18.

Define Xsection .... This option allows you to attach a roading template to use instead of defining individual elements. For more information, see and Section 22.2.3, *Defining cross sections*, page 22-22.

Define super............. This option allows you to specify superelevation and widening to your road definition. For more information, see Section 22.2.4, *Applying superelevation and widening*, page 22-23.

Note: You can add roading elements in any order. However, once you start to add vertical or horizontal elements, you need to finish adding those components before switching to another option. For example, if you are defining the horizontal part of your road first, finish the horizontal definition before starting the vertical definition.

Note: If a point entered exists in the current job, the SDR33 will import the coordinates of the point into the road definition.

6. Continue to define the alignment road 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).

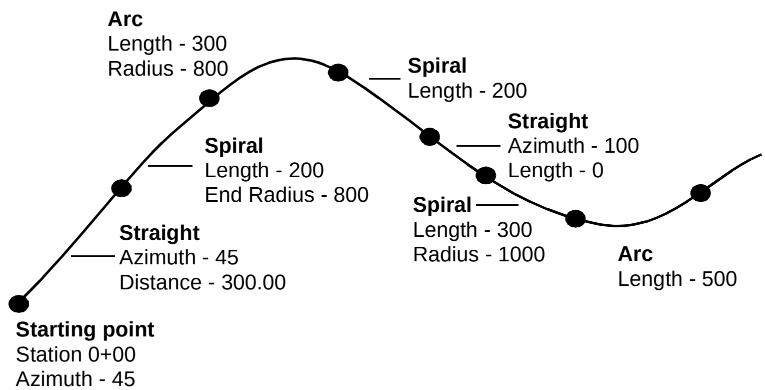
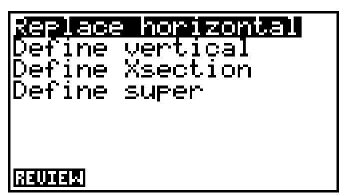


Figure 22-1: Road centerline design - horizontal elements

✉ **Note:** Compound Curves must be two simple curves separated by a zero-length straight.

✉ **Note**: 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.



7. Define the vertical design of the centerline as a series of elements that can be circular curve or vertical parabolas. Straight sections can be specified by defining a curve of zero length. Elements are

defined by the vertical intersection point (VIP) 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 VIP at a station of 90.

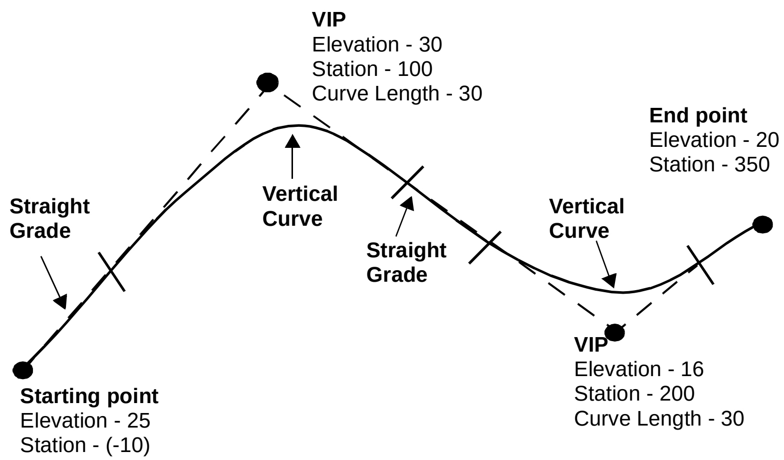


Figure 22-2: Road design - vertical elements

✉ **Note**: When defining your road, each point must be relative to either the last point in the definition or the centerline of the road. A point can be vertically above or below the previous point.

---

8. Define cross-sections by specifying which templates are attached to specified portions of the centerline. The SDR33 will interpolate between templates whenever possible.

9. The superelevation definition allows you to apply superelevation and widening to the road.

10. Once you have finished defining your road, you can either stop and proceed with other surveying functions or you can set out the road you just defined.

    To exit the alignment road definition option, press **<Clear>**.

    To set out the defined road, proceed to step 11.

11. Set up your instrument station. For more information, see Section 21.2, *Setting Up a Road Station*, page 21-7. You can establish your road station using one of two methods:

✉ **Note**: 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.)

✉ **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.

12. Set out your road using one of the roading set out options. When setting out, the SDR33 imports the road and associated template definitions into the current job. (If the road definition has already been copied into the job, the SDR33 verifies that it is the most recent version.)

Set out road....................For more information, see Section 23, *Setting Out Roads*, page 23-1.

Set out road surface ......For more information, see Section 24, *Set Out Road Surface*, page 24-1.

Set out sideslopes..........For more information, see Section 23.2, *Setting out Sideslopes*, page 23-10.

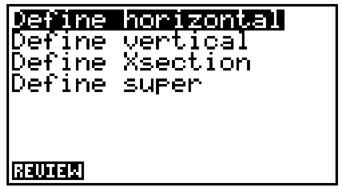
Set out cross-sections....For more information, see Section 23.1, *Setting out Cross-Sections*, page 23-2.

22.2.1 Defining a horizontal road alignment

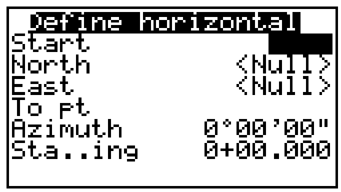
You can define the start of a horizontal alignment using methods such as existing point coordinates, or station and azimuth.

Steps for defining horizontal road alignment

1. Choose **Define horizontal** or **Replace horizontal**.



2. Enter the start point for the horizontal alignment:



3. Define the station at the start of the road in the ***Stationing*** field. The value may be negative.

4. Enter a value in the ***Azimuth*** field. Although the azimuth is not essential for all calculations, if a spiral or an arc is defined next, this azimuth is used.

   —OR—

   Enter a point name in the ***To pt*** field. The SDR33 calculates an azimuth from the start coordinates to the point.

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 ***North*** and ***East*** 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 ***North*** and ***East*** fields.

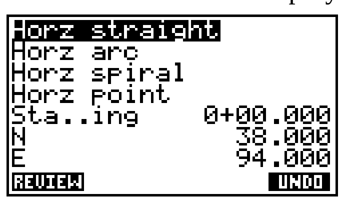
   - Key in coordinates to create a position (POS) record.

6. Press **<Enter>** to accept the screen.

If you enter a ***To pt***, the SDR33 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 22.2.1.5, *Horizontal point*, page 22-16). If you do not want to include the point as part of the alignment, press **<ESC>**, and the SDR33 displays the menu of horizontal elements (see Section 22.2.1.1, *Adding horizontal elements*, page 22-11).

22.2.1.1 Adding horizontal elements

Once the start point of the horizontal alignment has been defined, you will see a menu listing the four possible horizontal elements, 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.)



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 any order.

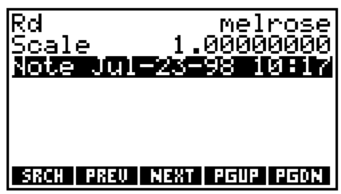
Steps for defining horizontal elements

1. After you have created your alignment road and the start point of the horizontal alignment, you can add horizontal elements.

2. Select **Define road** from the ***Roading*** menu. The ***Alignment Road Definition*** screen will display.

3. Define as many elements as you want by highlighting an element from the menu and pressing **<Enter>**. Each element is added to the end of the horizontal alignment.

4. Press the <**REVIEW**> softkey 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 the <**View**> key, (see Section 33.1, *Viewing the Database*, page 33-2). The only difference is that it shows the road definition rather than the job data.

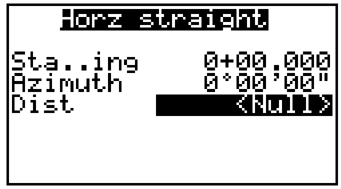


Note: Press **<UNDO>** to delete the last horizontal element defined.

5. When you have entered all the elements in your horizontal alignment, press **<ESC>** on the ***Elements*** menu. The SDR33 will prompt you to confirm alignment completion. Press **<Yes>** to confirm the alignment.

22.2.1.2 Horizontal straight

The ***Horz straight*** screen enables you to define a straight, horizontal section of your road. Specify the starting stationing for the element, the azimuth and the distance for the element. After defining the horizontal segment, press **<Enter>** to continue defining your road.



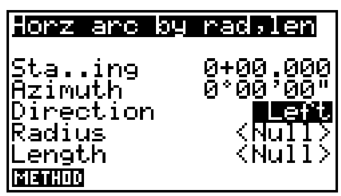
Sta..ing......... (*information only*) This field displays the station (chainage) at the start of the straight section.

Azimuth ...... This field 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....... This field specifies the length of the straight section.

22.2.1.3 Horizontal arc

The ***Horz arc by rad,len*** screen enables you to define an arc within your road definition. When you choose **Horz arc** from the ***Horizontal*** elements menu, the ***Horz arc by rad.len*** screen displays. Specify the starting stationing, the azimuth, direction and radius or length for the arc section. After defining the horizontal arc, press **<Enter>** to continue defining your road.



Stationing ... (*information only*) This field displays the station (chainage) at the start of the arc.

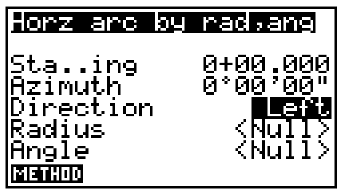
Azimuth ...... (*information only*) This field displays the azimuth at the end of the previous element, which is used as the azimuth for the start of the arc.

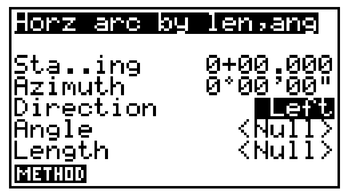
Direction ..... This field specifies whether the curve is a left or right hand curve.

Radius.......... This field specifies the radius of the arc.

Length.......... This field specifies the length of the arc.

Instead of specifying the arc by length and radius, you can press the **<METHOD>** softkey 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 SDR33 always stores arcs internally as radius and arc length. If you use an alternate definition method, the SDR33 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 SDR33 stores a definition showing radius and arc length with a note showing the subtended angle that you specified:

HORZ ARC	Sta.ing 82.000Dist 210.760Radius 300.000
NOTE RO	Angle 265'08"

22.2.1.4 Horizontal spiral

The ***Horz spiral*** screen enables you to define a spiral or spiral section within your road definition.When you choose **Horz spiral** from the ***Horizontal elements*** menu, the ***Horz spiral*** screen displays. Specify the starting stationing, the azimuth, direction, radius and length. After defining the horizontal spiral, press **<Enter>** to continue defining your road.

Sta..ing......... (*information only*) This field displays the station (chainage) at the start of the spiral.

Azimuth ...... (*information only*) This field displays the azimuth at the end of the previous element, which is used as the azimuth for the start of the spiral.

Direction ..... This field specifies whether the spiral is a left or right hand curve.

Radius.......... This field specifies the smallest radius of the spiral.

Length.......... This field specifies the length of the spiral.

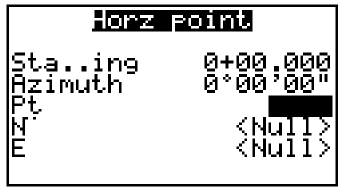
Press **<Enter>** to accept the screen.

✉ **Note:** 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 of the spiral it follows (a spiral following an entry spiral is an exit spiral, and vice versa).

22.2.1.5 Horizontal point

A horizontal point element is similar to a horizontal straight element, 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 ***Horz point*** screen displays.



Sta..ing......... (*information only*) This field displays the station (chainage) at the end of the previous element.

Azimuth ...... (*information only*) This field displays the azimuth at the end of the previous element.

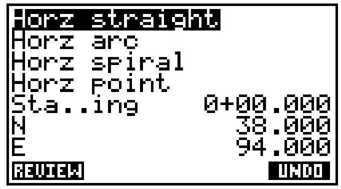
You can enter a point’s coordinates in one of three ways:

- Enter the point's coordinate values in the ***North*** and ***East*** 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 ***North*** and ***East*** fields.
- If you enter an unknown point, the SDR33 lets you create a new position record using the standard keyboard input method.
- If you enter a point that creates a line not tangential to the previous element in the alignment, the SDR33 displays a confirmation message.

When you finish entering the point’s coordinates, press **<Enter>** to accept the screen.

22.2.1.6 Deleting horizontal elements

You can remove the last horizontal element defined in a road using the **<UNDO>** softkey. To edit or replace an element from the middle of a road definition, you will need to delete all elements back to the element you are replacing. Road elements must start with the previous elements end stationing. (If the road is uncoordinated, the **Horz Point** option is not available, and the coordinates are not displayed.)



Steps for deleting horizontal elements

1. Select **Review road** from the ***Roading*** menu.

2. Review the horizontal elements defined. Press **<UNDO>** to delete the last horizontal element.

3. Press **<ESC>** on the ***Elements*** menu when the alignment is correct. The SDR33 asks you to confirm completing the alignment. Press **<Yes>** to confirm the alignment.

22.2.2 Defining a vertical alignment road

Define the vertical alignment in a similar manner to the horizontal alignment (see Section 22.2.1, *Defining a horizontal road alignment*, page 22-10). Vertical alignment roads differ from horizontal alignment roads in two ways:

- Only two element types exist for vertical alignment: parabolic curves and circular curves. These elements are joined by straight lines of constant grade.

- Vertical 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 vertical curves are linked by the straight tangent lines (see Figure 22-2). 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.

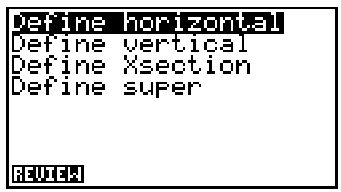
22.2.2.1 Defining a vertical alignment

To set out the vertical components of a road, you need to establish a vertical alignment.

Steps for defining a vertical alignment

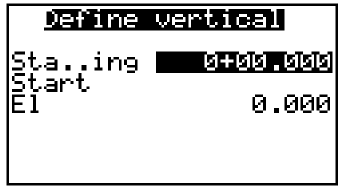
1. Once you have chosen **Define road** from the ***Roading*** menu, define the vertical alignment start point.

2. Choose the **Define vertical** option.



If an option displays as **Replace vertical**, it indicates a part of the definition exists. If you choose the **Replace** option, a confirmation prompt displays.

3. The ***Define Vertical*** screen displays.



Enter information in the following fields:

Sta..ing............. Define the point by specifying the station (chainage) to relate the vertical alignment to the horizontal alignment

Start.................. Enter a point name in the ***Start*** field; the point elevation value will display in the ***Elev*** field. (The point name itself is not actually stored in the vertical definition since the information and survey job are independent.)

El........................ Enter the point elevation in the ***Elev*** field.

✉ **Note**: The horizontal and vertical alignments do not have to start at the same station.

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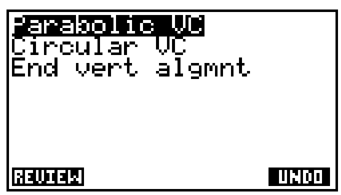
4. Press **<Enter>** to accept the screen. Select the desired element from the menu.



Parabolic VC ... Define the vertical intersection point **(VIP)** 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 **VIP**s.

Circular VC........... Define the vertical intersection point (V**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 **VIP**s.

End vert algmnt ... This option will end the vertical alignment definition. Skip to step 9.

The softkeys perform the following functions:

<REVIEW> . This softkey displays the element s in the vertical definition for review purposes.

<UNDO>..... This softkey deletes the last vertical element defined.

5. Press <**Enter**> to define the selected element.

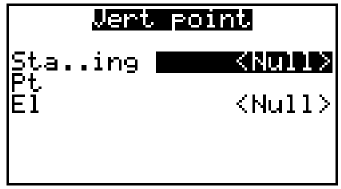
   You can define the intersection point in one of three ways:

   - Enter values in the ***Stationing*** and ***Elev*** fields.
   - Enter a point in the ***Pt*** field, and the elevation appears in the ***Elev*** field.

✉ **Note:** If you enter an unknown point name, create a position (POS) record using the standard keyboard input method.

6. Specify the distance covered by the curve in the ***Length*** field.
7. Press **<Enter>** to accept the screen. The SDR33 validates the compatibility of the intersection point for the previous curve. If not, the message **Curve overlap** appears.
8. If you wish to add another element, repeat steps 4 through 7.

9. When you have finished defining, select the **End Vert algnmt** option from the ***Vertical alignment*** menu to establish the end point.



10. Define the end point by specifying the station (chainage) in the ***Stationing*** field. Enter point elevation in the ***Elev*** field. You can also enter a point name in the ***Pt*** field, and the elevation appears in the ***Elev*** field.

11. Press **<Enter>** to accept the screen.

22.2.2.2 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.

22.2.3 Defining cross sections

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.

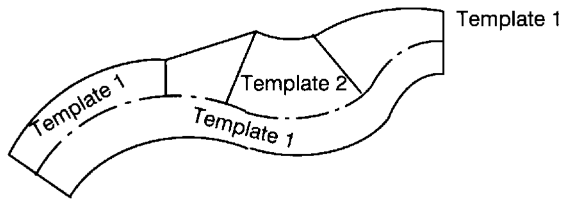
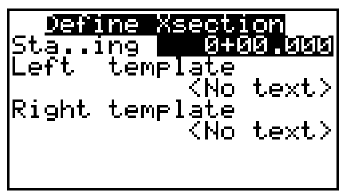


Figure 22-3: Horizontal overview

The ***Define Xsection*** screen enables you to define a template for the right or left side of the road (or both). Specify the starting stationing and the desired templates. Press **<Enter>** to accept the definition and continue defining your road.



Sta..ing.................. This field indicates the station (chainage) at the start of the cross section definition.

Left template .... This field indicates the name of the template to be inserted on the left side of the centerline.

Right template ..... This field indicates the name of the template to be inserted on the right side of the centerline.

22.2.4 Applying superelevation and widening

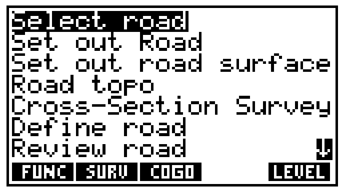
You can add superelevation or widening to your template. You may need to add superelevation and widening to account for curves or other special road features. Superelevation and widening are applicable only to alignment roads.

✉ **Note:** A road template must be set up to allow superelevation and widening before these options can be applied.

Steps to apply superelevation or widening

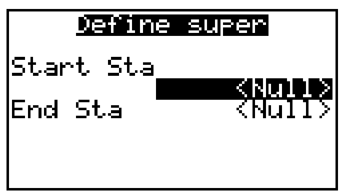
1. Select or define an alignment road (see Section 22.2, *Using Alignment Roads*, page 22-4).

2. Choose **Define road** from the ***Road*** menu.



3. The SDR33 will display the road definition menu. Select **Define super** from the menu and press **<OK>**.

4. The ***Define super*** screen will display.



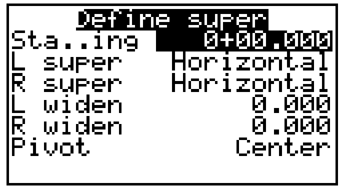
Enter values in the following fields:

Start stn .... This field specifies the starting station (chainage) of this application.

End stn......... This field specifies the end station for this application.

5. Press **<Enter>** to accept the screen.

6. You can now specify the actual values of superelevation and widening to be applied at as many stations within the application as needed in the ***Define super*** screen.



Sta..ing......... This field specifies the station to which these values are applied.

L super......... This field specifies the superelevation to apply to the template on the left side of the road. Highlighting the ***L super*** field will display three softkeys:

- **<HORIZ>** — applies horizontal superelevation to the left side of the road
- <**|:**> **—** converts a superelevation value to a ratio format (1:300)
- **<%>** — converts the superelevation value to a percentage

R super .... This field 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:

- **<HORIZ>** — applies horizontal superelevation to the right side of the road
- <**|:**> — converts a superelevation value to a ratio format (1:300)
- **<%>** — converts the superelevation value to a percentage

L widen........ This field specifies the amount of widening to add on to the elements of the template on the left hand side of the road.

R widen....... This field specifies the amount of widening to add on to the elements of the template on the right hand side of the road.

Pivot............ This field 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.

7. Press **<Enter>** to accept the screen. The SDR33 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 7.000L super%-3.000 R super%-3.000
                 L widen 0.000R widen 0.000 Pivot Center
APPLY SUPER      Sta.ing 32.000L super R super
                 L widen 0.000R widen 0.000 Pivot Center
APPLY SUPER      Sta.ing 57.000L super%-3.000 R super
                 L widen R widen Pivot Center
APPLY SUPER      Sta.ing 82.000L super%-6.000 R super%6.000
                 L widen 5.000R widen 10.000 Pivot Center
APPLY SUPER      Sta.ing 292.760    L super%-6.000 R super%6.000
                 L widen 5.000R 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 0.000R widen 0.000 Pivot Center
APPLY SUPER      Sta.ing 367.760    L super %-3.000 R super %-3.000
                 L widen 0.000R widen 0.000Pivot Center
```

✉ **Note**: When applying superelevation in which the values go from negative to positive or positive to negative, it is not assumed this point is exactly between maximum positive and negative values. A superelevation value of 0% needs to be entered where superelevation is 0% on the road definition.

22.2.4.1 Deleting superelevation and widening

If you make a mistake or want to delete superelevation, press the **<ESC>** key to return to the ***Road definition*** screen. A new option, **Delete super,** is available. Highlight this option and press **<Enter>** to erase the superelevation and widening. A new superelevation and widening or new limits of application can now be applied.

The SDR33 will prompt you to confirm deletion of the superelevation.

22.3 Roading Example

This section gives an example of SDR33 roading 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.

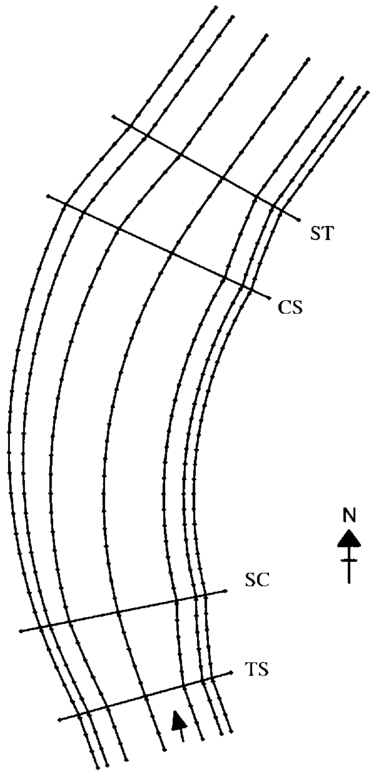
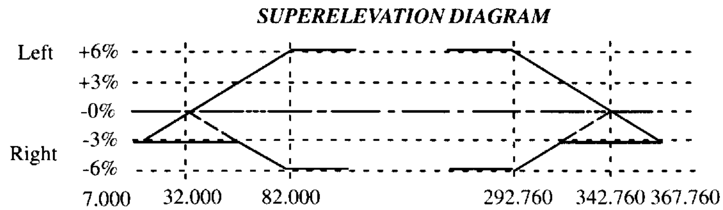
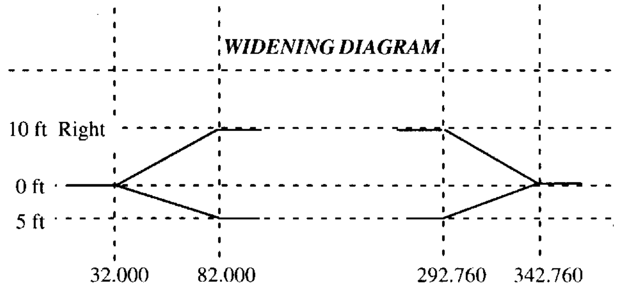
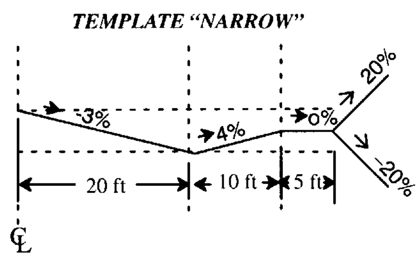
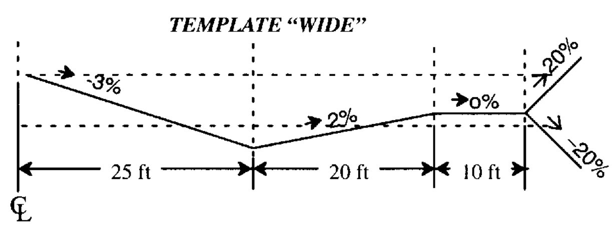


Figure 22-4: Example road horizontal alignment


SUPERELEVATION DIAGRAM
Left
+6%
+3%
-0%
-3%
Right
-6%
7.000
32.000
82.000
292.760
342.760
367.760


WIDENING DIAGRAM
10 ft Right
0 ft
5 ft
32.000
82.000
292.760
342.760


TEMPLATE "NARROW"
-3%
4%
0%
20%
-20%
20 ft
10 ft
5 ft
CL


TEMPLATE "WIDE"
-3%
2%
0%
20%
-20%
25 ft
20 ft
10 ft
CL

```
SDR33 V04-40        08-Oct-99 08:48
                    Angle DegreesDist FeetPress Inch Hg
                    Temp FarenhtCoord N-E-Elev

ROAD KI             ID MANUAL ROAD
SCALE               S.F. 1.00000000
NOTE TS             09-Apr-92 10:11
HORZ ALIGN          Start stn 0.000End stn 422.760Azimuth 342-43'00"
                    North 10324.430East 84342.540
HORZ STRAIGHT       Sta..ing 0.000Azimuth 342-43'00"Dist 32.000
HORZ SPIRAL         Sta..ing 32.000Dist 50.000Radius 300.000
HORZ ARC            Sta..ing 82.000Dist 210.760Radius 300.000
HORZ SPIRAL         Sta..ing 292.760Dist 50.000Radius 300.000
HORZ STRAIGHT       Sta..ing 342.760Azimuth 32-31'05"Dist 80.000
VERT ALIGN          Sta..ing 0.000Elev 33.000
VERT POINT          Sta..ing 500.000Elev 33.000
X SECTION           Sta..ing 0.000Left temp NARROWRight temp NARROW
X SECTION           Sta..ing 82.000Left temp NARROWRight temp NARROW
X SECTION           Sta..ing 292.760Left temp WIDERight temp NARROW
X SECTION           Sta..ing 500.000Left temp WIDERight temp NARROW
DEFINE SUPER        Start stn 7.000End stn 367.760
APPLY SUPER         Sta..ing 7.000L super %-3.000R super %-3.000
                    L widen 0.000R widen 0.000Pivot Center
APPLY SUPER         Sta..ing 32.000L super R super
                    L widen 0.000R widen 0.000Pivot Center
APPLY SUPER         Sta..ing 57.000L super R super %-3.000
                    L widen R widen Pivot Center
APPLY SUPER         Sta..ing 82.000L super %6.000R super %-6.000
                    L widen 5.000R widen 10.000Pivot Center
APPLY SUPER         Sta..ing 292.760L super %6.000R super %6.000
                    L widen 5.000R widen 10.000Pivot Center
APPLY SUPER         Sta..ing 317.760L super R super %-3.000
                    L widen R widen Pivot Center

APPLY SUPER         Sta..ing 342.760L super R super
                    L widen 0.000R widen 0.000Pivot Center
APPLY SUPER         Sta..ing 367.760L super %-3.000R super %-3.000
                    L widen 0.000R widen 0.000Pivot Center
TEMPLATE KI         ID NARROW
NOTE TS             09-Apr-92 10:15
TEMP ELEMENT        Grade %-3.000H.dist 20.000V.dist -0.600
                    Offset 20.000HtDiff -0.600Apply super Yes
                    Apply widen YesCd HIGHWAY
TEMP ELEMENT        Grade %4.000H.dist 10.000V.dist 0.400
                    Offset 30.000HtDiff -0.200Apply super Yes
                    Apply widen NoCd EDGE OF ROAD
```

```
TEMP ELEMENT      Grade HorizontalH.dist 5.000V.dist 0.000
                  Offset 35.000HtDiff -0.200Apply super No
                  Apply widen NoCd SIDEWALK
TEMP-SIDESLOPE    Cut %20.000      Fill %20.000
TEMPLATE KI       ID WIDE
NOTE TS           09-Apr-92 10:17
TEMP ELEMENT      Grade %-3.000H.dist 25.000V.dist -0.750
                  Offset 25.000HtDiff -0.750Apply super Yes
                  Apply widen YesCd HIGHWAY
TEMP ELEMENT      Grade %2.000H.dist 20.000V.dist 0.400
                  Offset 45.000HtDiff -0.350Apply super Yes
                  Apply widen NoCd EDGE OF ROAD
TEMP ELEMENT      Grade HorizontalH.dist 10.000V.dist 0.000
                  Offset 55.000HtDiff -0.350Apply super No
                  Apply widen NoCd SIDEWALK
TEMP-SIDESLOPE    Cut %20.000Fill %20.000
```

Chapter 23 Setting Out Roads

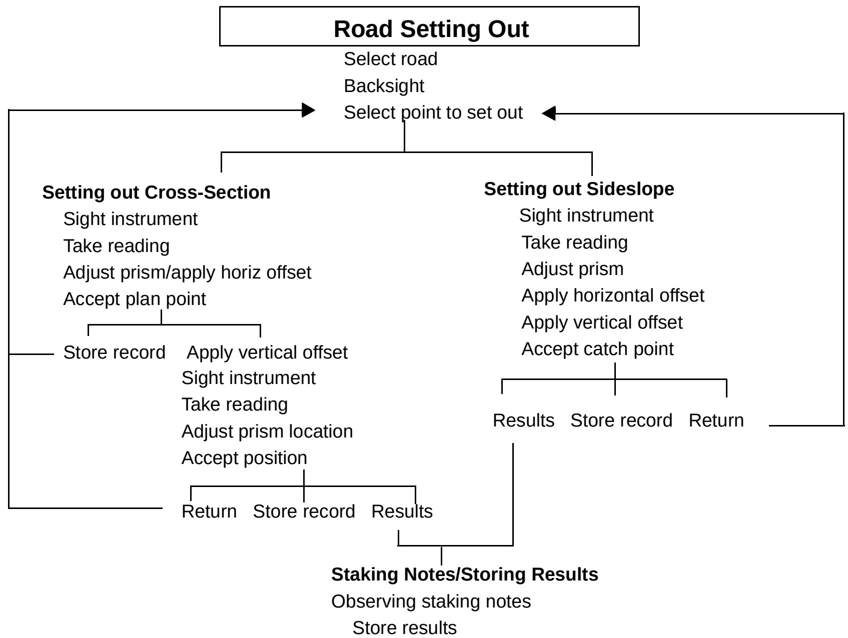
In this chapter

- Setting out cross sections
- Setting out sideslopes
- Staking notes

The SDR33 roading program is designed for setting out a road once it has been defined. For more information, see Chapter 22, *Defining Roads*. You can set out any point along the road by specifying its station and offset. The **Set Out Road** option is similar to other SDR33 set out options. The SDR33 allows you to set out the entire road or specific points. You can select from three different set out options, depending on the road sections with which you are working.

- Set out Road - This option enables you to set out cross sections of the road. For more information, see Section 23.1, *Setting out Cross-Sections*, page 23-2.
- Set out Sideslope - This option enables you to set out the sideslope of your road. For more information, see Section 23.2, *Setting out Sideslopes*, page 23-10.
- Set out road surface - This option enables you to set out the main surface area of your road. For more information, see Chapter 24, *Set Out Road Surface*.

You can access the first two set out options by selecting **Set Out Road** from the ***Roading*** menu. The following diagram shows the available options and the processes of setting out specific points:



23.1 Setting out Cross-Sections

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.

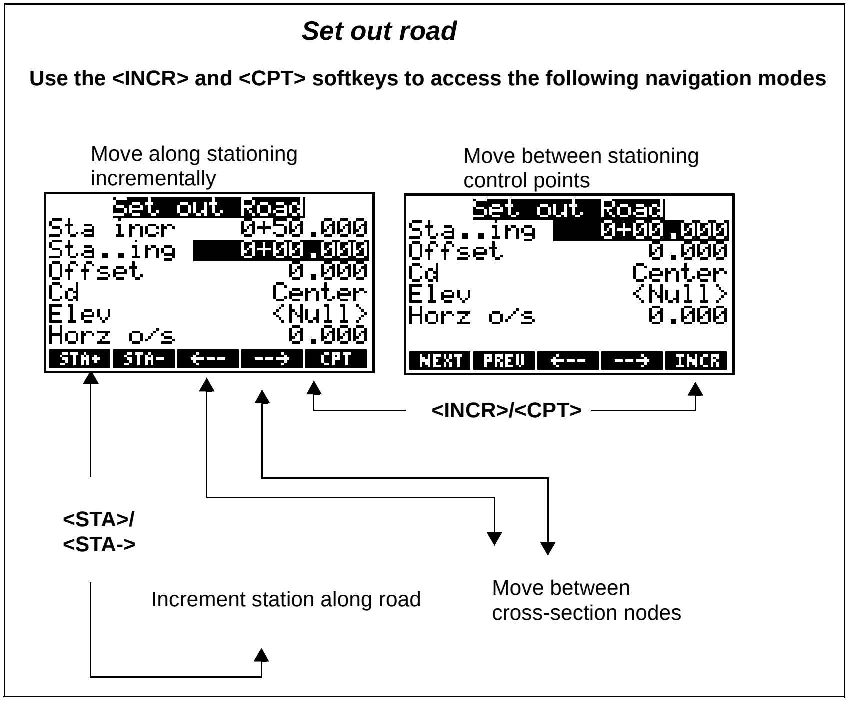
Steps for setting out cross-sections

1. Choose **Set Out Road** option from the ***Roading*** menu.

2. (*optional*) If you have not selected a current road, the ***Select road*** screen displays. Highlight the road you wish to set out and press <**OK**>.

3. Take a backsight reading or confirm the orientation.

4. The ***Set out Road*** screen is displayed.



Navigate to the desired point by using the available softkeys:

<INCR>/<CPT> ....This softkey 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*) This softkey increases or decreases the stationing by a set amount, determined by the *Sta incr* field.

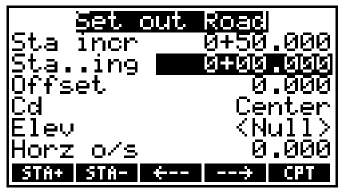
<NEXT> & **<PREV>**.(*in CPT mode*) This softkey increases or decreases the stationing between control points.

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.

<→> .... This softkey 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).

<←> .... This softkey decreases the offset to the previous point in the template.

5. Review the point information displays in the ***Set out Road*** screen.



Sta incr........ (*available only in INCR mode*) This field allows you to input the amount by which the stationing will increment or decrement using the <STA+> or <STA-> softkeys.

Sta.ing.......... This field displays the current stationing. This may not be less than the start station of the road or greater than the end station. You can enter a specific stationing value if desired.

Offset........... This field allows you to directly enter a fixed offset. Once you have entered a value into this field, the offset will not change until the <←> or the <→> softkey is pressed or a value is entered into the code field.

Cd .... This field displays the code as entered in the template definition if the point specified is the end point of that element.

- **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.

- **Center** specifies the centerline element.

Elevation ..... This field automatically calculates the elevation on the road at the specified station and offset. However, you can enter a different elevation.

Horz o/s ...... This field 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):

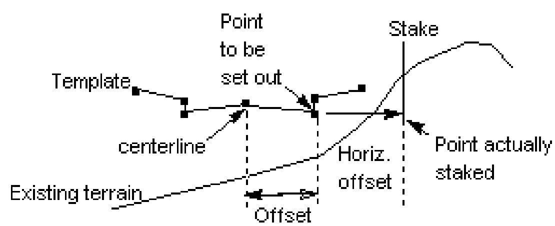
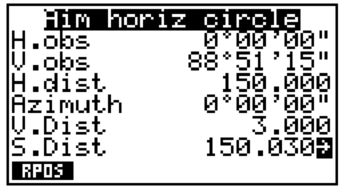


Figure 22-5: Staking out the template

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.

6. Press **<Enter>** to set out the current point.

7. The SDR33 displays the information required to set out the point.



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 SDR33 is put into countdown mode automatically to help you. Rotate the instrument until the countdown reaches zero, then direct the prism pole in line.

8. Press the **<READ>** softkey to initiate the first reading.

9. 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.

Left/Right.... (*information only*) This field displays the distance to move left or right to get on line (from the instrument operator's point of view).

In/Out.......... (*information only)* This field displays the distance to move in (toward the instrument) or out (away from the instrument) to get the prism on the target point.

Aim H.obs... (*information only)* This field displays the horizontal angle that you should be observing on your instrument. This field changes relative to the *Horz o/s* field.

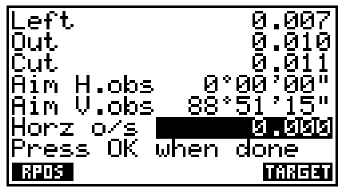
H.Obs........... (*information only*) This field indicates the horizontal observation angle.

V.obs .... (*information only*) This field indicates the vertical observation angle.

S.Dist .... (*information only*) This field indicates the slope distance.

Horz o/s .... This field shows the horizontal offset adjustment that you entered earlier. If modified, all other fields are adjusted accordingly.

10. Use the **<READ>** or the **<TARGET>** softkeys 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.



11. Once you have located the plan view position of the point, you can continue with one of the following steps:

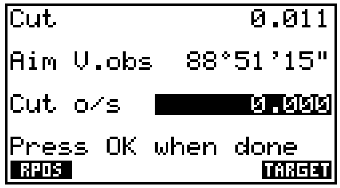
- Store a record and return to the ***Set out Road*** screen. Pressing **<STORE>** will store a RPOS record, containing the station and offset (and coordinates if known) on the final observed point. A NOTE record containing the cut/fill and differences in northing and easting from the design point also is stored. When completed, the SDR33 will return to the ***Set out Road*** screen.

✉ **Note:** If a horizontal offset was used, the offset point is taken as the design point.

- To apply a vertical offset, press **<OK>** and continue to step 11.

12. Enter a vertical offset in the ***Cut O/S*** field and press <**Enter**>.

13. A guidance screen displays to direct the prism to the target point.



Align your instrument to the horizontal angle shown. The SDR33 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*) This field 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 ... This field displays the vertical angle that should be observed.

Cut o/s.......... This field 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.

14. Press **<Read>** to initiate the first reading.

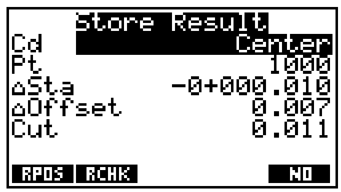
15. The guidance screen display information to help direct the prism to the target point. You can use the **<Read>** key or the **<TARGET>** softkeys to take as many observations to the prism as needed to locate the point.

16. 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 the **<STORE>** softkey 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, the SDR33 will return to the ***Set out Road*** screen.

- Store results. Pressing **<OK>** will take you to the ***Store Results*** screen, continue to step 17.

17. Review the information in the ***Store Results*** screen. You can change the point name and code if necessary.



18. Select the type of record you would like to store by selecting from the two available softkeys.

   - Press the **<RPOS>** softkey 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.

   - Press the **<RCHK>** softkey 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.

✉ **Note**: You can leave the ***Store Results*** screen without saving the observation. Press **<NO>** to return to the ***Set out Road*** screen without storing any results.

✉ **Note:** For either type of record, an additional note is stored, giving the cut/fill and the differences in northing and easting.

19. (*optional*) Press **<Clear>** to return to setting out. You can return to the ***Aim Horiz Circle*** screen. This might be necessary if the prism pole is inadvertently moved during the setting out of the elevation.

23.2 Setting out Sideslopes

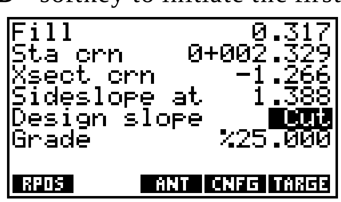
The procedure for setting out a left or right sideslope (the ***Cd*** field will indicate **L Sideslope** or **R Sideslope**) is different from setting out a point with a known, or fixed, offset from the center line. The SDR33 cannot determine the offset to the toe of the sideslope because it does not have a model of the underlying terrain. The SDR33, 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 catch point from the current point.

Steps for setting out a sideslope

1. Use the <→> and <←> keys to select the sideslope element of the template.

2. Select <**OK**>, the Take Reading screen will display.

3. Press the **<READ>** softkey to initiate the first reading.



Fill/Cut .... (*information only*) This field 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*) This field shows how to correct the current prism location to sight it on the sideslope line.

Xsect crn .... (*information only*) This field displays the necessary correction to the current prism location along the sideslope line to sight the toe of the slope.

Sideslope at ..... (*information only*) This field displays the horizontal distance from the beginning of the sideslope to the current prism location.

Design slope.... This field shows which design slope (cut or fill) is being used in the calculations; you may change it at any time.

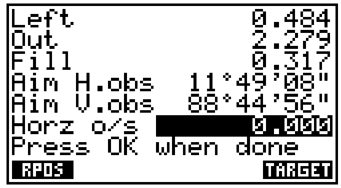
Grade .... (*information only*) This field indicates the grade that is being used in the calculations. This can be changed at any time.

✉ **Note:** Changes to the ***Design slope*** 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.

✉ **Note:** The toe of the sideslope is the point at which the ***Cut/Fill*** is zero and the ***Stn crn*** field is zero.

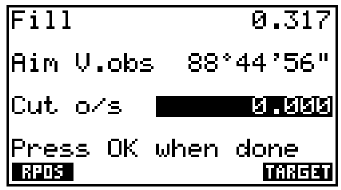
4. Adjust your prism location according to the corrections on the previous screen. As many readings as is necessary now may be taken by pressing the **<READ>** key or the **<TARGET>** softkey, using the values displayed to assist in determining where to move.

5. After the catch point is found, select <**OK**>. The ***Store Results*** screen will display.



6. (*optional*) Enter a horizontal offset in the ***Horz O/S*** field. The ***Aim H obs***. field will be updated.

7. Press <**OK**>, the Vertical set out screen will display.

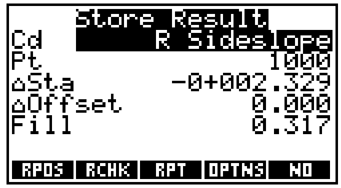


8. When you have either found the toe of the sideslope or have determined to set out some other point on the sideslope, you can proceed with one of the following options:

   - Store a record and return the ***Set out Road*** screen. Pressing the **<STORE>** softkey 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, the SDR33 will return to the ***Set out Road*** screen.

   - Store results. Pressing **<OK>** will take you to the ***Store Results*** screen.

9. Review the point information displayed in the ***Store Results*** screen. You can change either or both the point name and code if necessary.



10. Store the observation by selecting from the available softkeys.

   - Press the **<RPOS>** softkey 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.

   - Press the **<RCHK>** softkey 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.

Note: You can insert a staking note by using the <**RPT**> softkey. For more information, see .

Note: For either type of record, an additional note is stored, giving the cut/fill and the differences in northing and easting.

Note: You can leave the ***Store Results*** screen without saving the observation. Press **<NO>** to return to the ***Set out Road*** screen without storing any results.

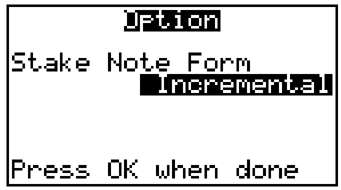
11. (*optional*) If you want to return to setting out, press **<Clear>**. You will be returned to the ***Take Reading*** screen. This might be necessary if the prism pole is inadvertently moved during the setting out of the point.

23.3 Staking Notes

After completing the set out steps for a sideslope, the ***Store results*** screen gives you the opportunity to access the staking notes report before returning to the ***Set out Road*** screen.

Press the **<RPT>** softkey to insert a slope staking report into the database.

The format of the staking notes can be changed with the **<OPTNS>** softkey. Select one of the two available options: **Incremental** or **Accumulative**.

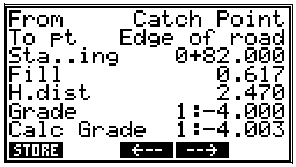


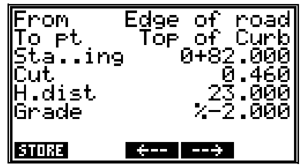
Incremental

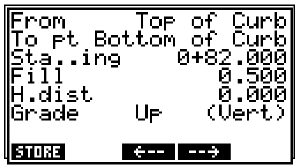
This option provides staking notes to each node on the cross-section in respect to its adjacent, outer node

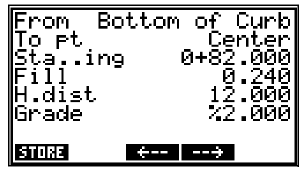
Once you press the **<RPT>** softkey, the staking notes are displayed according to the format defined via the **<OPTNS>** softkey.

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.



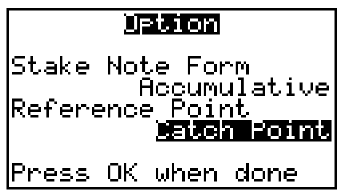




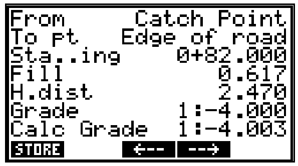


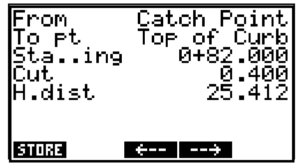
Accumulative

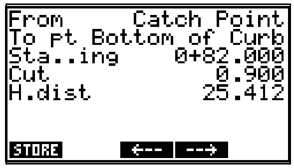
This option provides staking notes to each node on the cross-section in respect to a single reference point. The reference point can be the catch point or an offset of the catch point

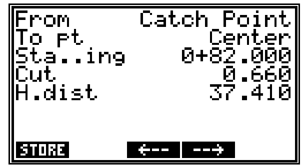


Additional options are available when the stake note form is **Accumulative** as shown below.









The ***Reference Point*** may be defined as one of the following:

- **Catch Point -** Each node will be defined with respect to the catch point 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.

  If the reference point was set to offset, each node would be defined with respect to the catch point offset (if supplied).

Storing Results

Staking notes for individual nodes can be stored to the database, as displayed on the staking notes report screens, by pressing the **<STORE>** softkey. You can access the various nodes by using the <←> and <→> softkeys. Pressing **<ESC>** will return you to the ***Store Results*** screen.

The ***Store Results*** 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. The options for leaving the ***Store Results*** 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 AUTO1001Sta.ing 81.983Offset -35.000
                    North 10395.564East 84285.594Elev 29.509
                    Cd EDGE OF ROAD

NOTE RO             Fill 2.091d.North -0.038d.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 AUTO1002Sta.ing 82.000d.Chn -0.017
                    Offset -35.000d.Offset 0.252Elev 29.509
                    d.Elev -2.091
                    Cd EDGE OF ROAD

NOTE RO             Fill 2.091d.North -0.038d.East -0.250
```

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 **<Clear>**. 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.

- Press the **<NO>** softkey 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.

Chapter 24 Set Out Road Surface

In this chapter

- Overview of setting out roads
- Steps to set out a road

The SDR33 roading program is designed for setting out a road once it has been defined. For more information, see Chapter 22, *Defining Roads*. You can set out any point along the road by specifying its station and offset. The **Set Out Road Surface** option is similar to other SDR33 set out options. The SDR33 allows you to set out the entire road or specific points. You can select from three different set out options, depending on the road sections you are working with.

- **Set out Cross-Section -** This option enables you to set out cross sections of the road. For more information, see Section 23.1, *Setting out Cross-Sections*, page 23-2.
- **Set out Sideslope -** This option enables you to set out the sideslope of your road. For more information, see Section 23.2, *Setting out Sideslopes*, page 23-10.
- **Set out Road Surface -** This option enables you to set out the main surface area of your road.

The Set Out Road Surface option is used to set out the vertical component of a road definition. This option 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.

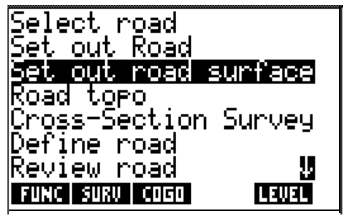
✉ **Note**: Horizontal setting out (station distance, offset, stationing) is not applicable here, because a surface rather than a point is being set out.

Steps to set out road surface

1. Choose **Select Road** from the ***Roading*** menu.

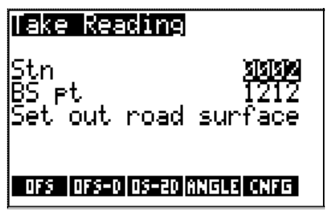
2. Highlight the road you wish to set out and press <**OK**>.

3. Select **Set out road surface** from the ***Roading*** menu.



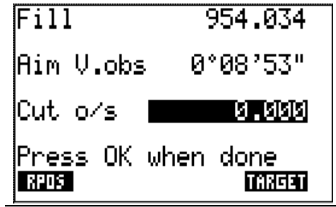
4. Confirm your station and backsight.

5. Press <**OK**>, the ***Take Reading*** screen will display.



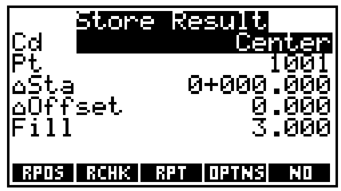
6. Press <**Read**> to take a reading to any point on the road surface.

7. The station and offset are calculated, and the road definition is used to calculate the design elevation. The vertical setting out screen is 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.

8. Press **<OK>** to display the ***Store Results*** screen.



9. Press **<OK>** to store an (**RPOS**) record, containing the station, offset, and coordinates of the point.

   The ***d.Sta*** and ***d.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.

   The station and offset are 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, a <Null> cut/fill value will be displayed.

Note: Press <**CNFG**> to access the ***Configure Reading*** screen and modify the Configure Reading parameters. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

10. (*optional*) You can take a reading with a new target height by pressing <**TARGET**>.

11. Press <**Clear**> to exit the ***Set Out Road Surface*** option.

Chapter 25 Road Topography

In this chapter

- Using road topography

Road Topography enables you to quickly take readings on specific or random points to verify their position as compared to the road definition. The procedure to collect road topography information is similar to collecting standard topography. With the road topography option, you can collect stationing (chainage) along the road as well as offsets.

25.1 Using Road Topography

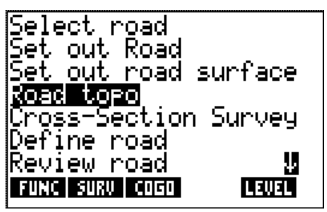
You can take multiple readings with the road topography option. Before observing points along a road, you will need to create a road.

Steps to use road topography

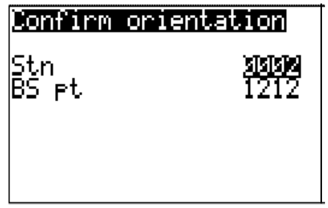
1. Choose **Select Road** from the ***Roading*** menu.

2. Highlight the road you wish to set out and press <**OK**>.

3. Select **Road topo** from the ***Roading*** menu.

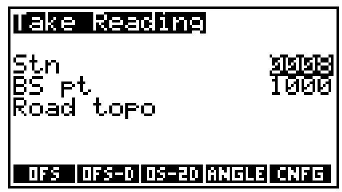


4. Confirm your station and backsight.



5. Take a backsight reading or confirm the orientation.

6. After you have sucessfully set up your station, the SDR33 displays the ***Take Reading*** screen.



The fields display the following information:

<Stn> .... This field displays the current station.

<BS pt>........ This field displays the current backsight point.

The softkeys access the following options:

<OFS>.......... This softkey enables an angle offset observation.

<OFS-D>..... This softkey enables a single distance offset observation.

<OS-2D> ..... This softkey enables a two-distance offset observation.

<ANGLE>... This softkey accesses the angles-only reading.

<CNFG>...... This softkey accesses the ***Configure Reading*** screen.

7. Press <**Read**> to initiate an observation.

8. Review the observation and press <**OK**> to accept it.

9. (*optional*) Press <**OK**> to save the raw observation and an RPOS record with Note record.

10. (*optional*) Press <**Read**> to accept the reading and take another reading.(*optional*) Select the <**TARGET**> softkey to take another reading. The previous reading will be discarded. Also, you can change the target height if necessary.

Note: If you do not wish to store this record, press **<Clear>**. You will be returned to the ***Take reading*** screen and can now take another reading.

11. A shortcut method is provided if you wish to take a number of readings and store the results for each one. Rather than pressing **<OK>** to store the road position record (**RPOS**), press the **<READ>** softkey; to store the record, initiate another reading, returning you to the ***Apply Stationing*** screen.

8

Additional Survey Methods

This section explores additional functionality including Cross-section Surveying, Taping from Baselines, Point Projections and Building Face Surveys. These predefined surveying techniques make surveying with the SDR33 flexible and easy, eliminating confusion and complexity when surveying different features. The SDR33 gives you the tools to survey according to the available data, projecting points from known locations or finding points relative to a baseline, instead of converting data in the office to a usable form.

Cross-Section Survey

- *Determining Survey Direction*
- *Performing a Cross-Section Survey*

Taping from Baseline

- *Setting Out Points From a Baseline*

Point Projections

- *Projecting Points*

Building Face Survey

- *Surveying Vertical Planes*
- *Surveying Nonvertical Planes*

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 Cross-Section Survey option enables you to survey cross-sections of roads or other linear features. This option works similar to topography. When surveying a cross-section, the SDR33 observes points along a series of stations. The procedural approach to cross-section surveying enables you to efficiently collect a larger number of points. Depending on the location and desired observations, you can conduct the survey using one of two methods:

- walking the minimum distances (see Figure 26-1)
- surveying from the centerline outward (see Figure 26-2)

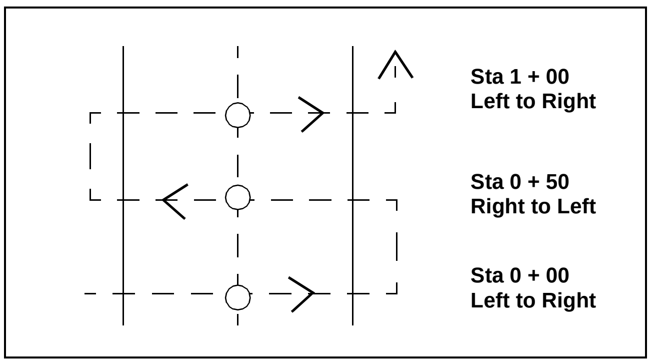


Figure 26-1: Survey cross-sections by walking the minimum distances

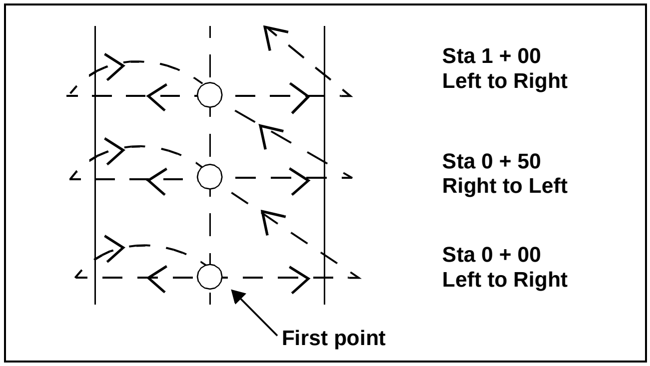


Figure 26-2: Survey cross-sections from the center line out

The SDR33 automatically calculates the offsets from an observation designated as the center line point.

26.1 Determining Survey Direction

You can perform cross section surveys in several different directions. You can specify the survey direction in the ***Direction*** field of the ***Cross-Section Survey*** screen. Select the method that best suits your survey and workflow.

- Surveying left to right
- Surveying right to left
- Surveying to the right
- Surveying to the left

26.1.1 Surveying left to right

The **Left>Right** option in the ***Direction*** field enables you to survey across a road starting at the left of the road. The first noncenterline point surveyed must be to the left of centerline. Depending on the number of prisms and preferred method, you can alternate readings from side to side or survey the left side of the road and then the right side.

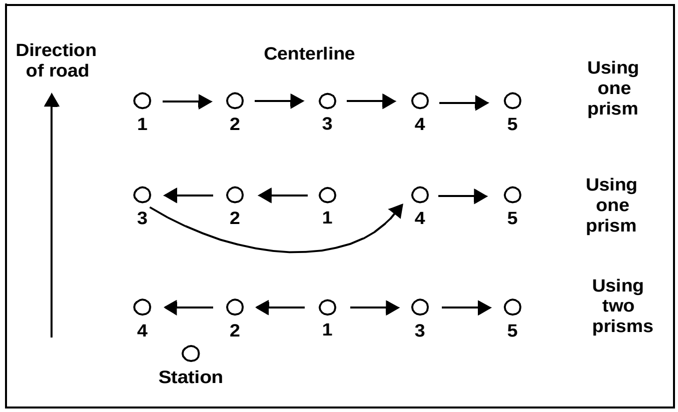


Figure 26-3: Direction specified left to right

26.1.2 Surveying right to left

When surveying **Right to left**, your first noncenterline observation must be to the right of the centerline. You can proceed across the road or survey the right side of the road and then the left.

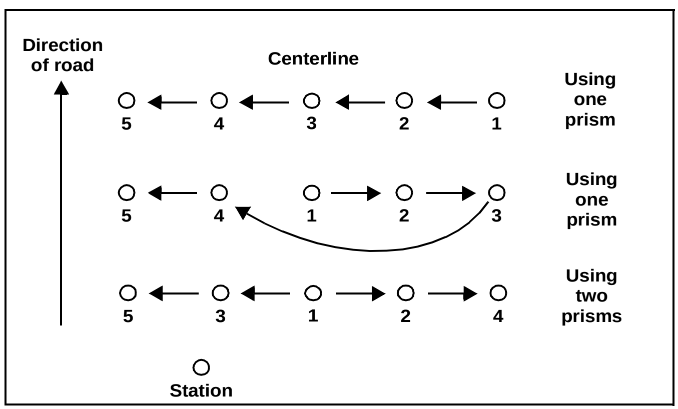


Figure 26-4: Direction specified right to left

26.1.3 Surveying to the right

You can begin on, or to the left of, centerline and proceed right when surveying to the **Right**. However, the rod man does not reverse direction after each cross section; all cross sections begin on or to the left of centerline and proceed right.

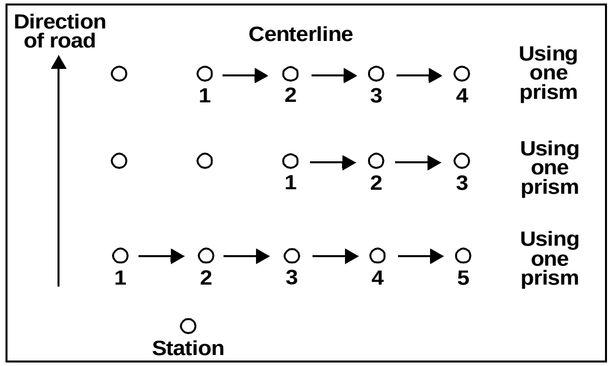


Figure 26-5: Direction specified right

26.1.4 Surveying to the left

When surveying to the **Left**, you can start on or to the right of the centerline and proceed left. However, the rod man does not reverse direction after each cross section; all cross sections begin on or to the left of centerline and proceed right.

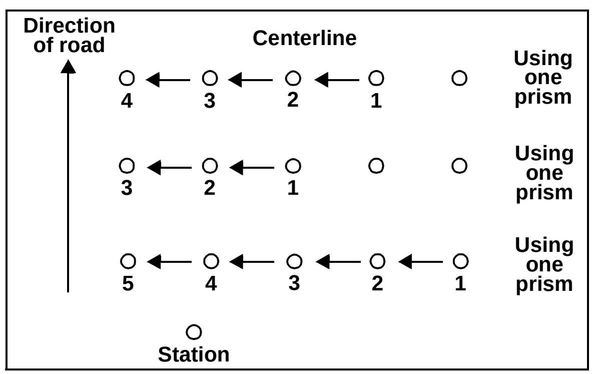


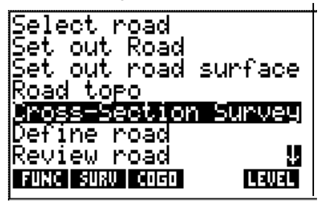
Figure 26-6: Direction specified left

26.2 Performing a Cross-Section Survey

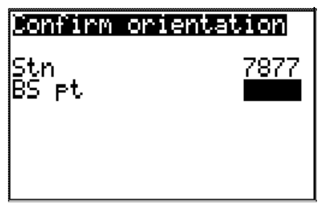
You can use cross-section survey to take multiple observations quickly. This surveying method can be used to collect information about ground details, sections of road or other topographical data.

Steps for using *Cross-section survey*

1. Select **Cross Section Survey** from the ***Roading*** menu.



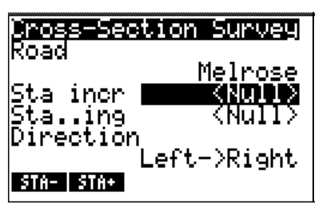
2. Review the information in the ***Confirm Orientation*** screen. If the ***Stn*** and ***Bs pt*** is correct, press <**OK**>.



To change the station and backsight setup, see Section 7, *Setting Up a Station and Backsight*, page 7-1.

3. Take a backsight reading or confirm the orientation.

4. The ***Cross Section Survey*** screen displays.



Enter information in the following fields:

Road .... This field indicates the name of the road where you are taking cross-sections in the field. Specifying a different road name in the ***Road*** field after observing some sections allows you to take cross-sections of subsequent roads.

> **Note**: You can enter any name into the ***Road*** field.

Sta incr......... The ***Sta incr*** field indicates the distance between each station.

Sta.ing.......... This field indicates the station (chainage) value for the first cross-section. Use the format XXXX.XXX. The number will be displayed in standard roading format XX+XX.XXX. For example, 1000.000 displays as 10+00.000. For more information, see Section 6.4, *Defining Unit Formats*, page 6-16.

Direction ..... This field specifies the survey direction of the cross-section. Choose from **Left->Right, Right->Left, Left**, or **Right** using the <←> and <→> arrow keys. For more information, see Section 26.1, *Determining Survey Direction*, page 26-2.

The softkeys access the following:

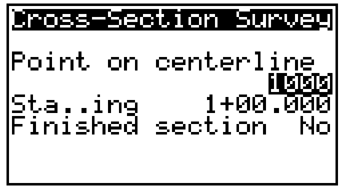
<STA-> .... This softkey incrementally decreases the station value. This is useful if you are surveying cross-sections at even intervals.

<STA+> .... This softkey incrementally increases the station value. This is useful if you are surveying cross-sections at even intervals. Pressing the **<STA+>** softkey adds the value in ***Sta incr*** to the station value to get a new station value.

5. Press **<Read>** to begin surveying the cross-section. After completing the observation, the SDR33 displays the ***Accept Reading*** screen.

✉ **Note**: Press **<Clear>** at any time to discard the current reading.

6. Press **<OK>** to store the record. The SDR33 will prompt you to identify the centerline point.



If the point is not the centerline, press **<Read>** to continue surveying the cross-section.

If the point you just observed is the centerline point, press **<OK>** to accept the ***Centerline point*** field. You can then toggle the ***Finished Section*** field to **Yes** or **No**.

✉ **Note**: You do not have to observe the centerline point. If you confirm you do not want to take the centerline reading, all the points on this section will have <Null> offsets.

If you select **Yes**, the SDR33 will display the ***Cross-Section Survey*** screen. Enter the new stationing value and survey the next cross-section.

If you are not finished with the cross-section, select **No**. Continue taking readings with the **<Read>** key until finished with the cross-section.

✉ **Note**: You can modify the values furnished by the SDR33 by manually editing the fields.

Once you have completed at least one cross-section, you may choose not to specify station value for subsequent cross-sections. If you do not specify station value, the SDR33 uses the horizontal distance between the new cross-section's centerline point and the last section as the station increment (This has the implicit assumption the centerline is a straight line between the two points).

When saving, observations initially have a <Null> offset. When you select **Yes** in the ***Finished Section*** field, the SDR33 calculates 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.

Chapter 27 Taping from Baseline

in this chapter

- Setting out by distance and offset
- Pickup of topographical detail by distance and offset

The Taping from Baseline option enables you to specify and stake out a distance and offset along a baseline. For some instances, a plan may show corners of a building, in terms of distance and offset, from a baseline. 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.

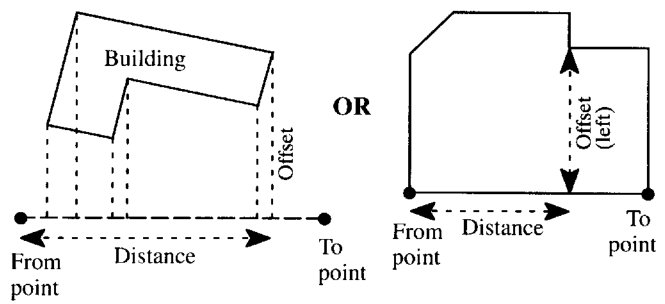


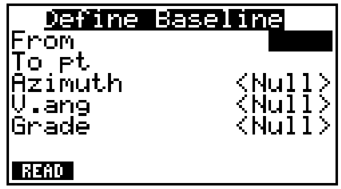
Figure 27-1: Measurements from a baseline

27.1 Setting Out Points From a Baseline

The SDR's **Taping from Baseline** option assists you in setting out points defined in relation to a line instead of coordinate values.

Steps to set out points from a baseline

1. Select **Taping from Baseline** from the ***COGO*** menu. The ***Define Baseline*** screen displays.



✉ **Note**: If a current station for the setting out work, along with the backsight orientation for the station, has not been defined, you will be prompted to enter for this information prior to the display of the ***Define Baseline*** screen.

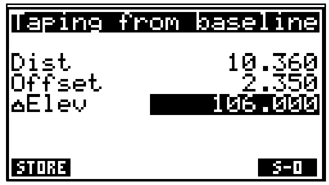
2. Take a backsight reading or confirm the orientation.

3. Define the baseline by entering either two points or one point plus an azimuth, a grade or vertical angle.

   The **<READ>** softkey is available when either the ***From*** or ***To pt*** fields are selected, enabling direct readings to establish these points if desired. If an unknown point name is entered, the ***Key in coords*** screen will appear, allowing you to enter the appropriate coordinate values. The ***From*** field must be entered.

   When the ***Grade*** field is selected, **<HORIZ>**, **<1:>** and **<%>** softkeys are presented. The **<HORIZ>** softkey will set the Grade field to horizontal. The **<1:>** and **<%>** softkeys 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**). See Section 19.1, *Staking Out a Line*, page 19-2 for more information.

4. Press **<OK>** after the baseline definition has been completed, the ***Taping from Baseline*** screen displays.



The fields display the following information:

Dist............... This field indicates the set out distance from the baseline to the point to be set out. 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).

Offset........... This field indicates the offset from the baseline. 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.

d. Elev.......... The ***d.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.

5. (*optional*) Press the **<STORE>** softkey to store a record of the calculated point. Enter a point ID, feature code and elevation if desired.

6. (*optional*) Press the **<S-O>** softkey to store and stake out the calculated point. The SDR33 will display the Store Reading screen where you can enter a point ID, feature code and elevation. Press **<OK>** to continue to the Set Out Coords screen.

7. Select <**Clear**> to exit the Taping from Baseline option.

Chapter 28 Point Projections

In this chapter

- Projecting points onto a line or arc
- Calculating offsets to a baseline

The Point Projection option projects a point onto a line or arc. It calculates distance and offset of a 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.

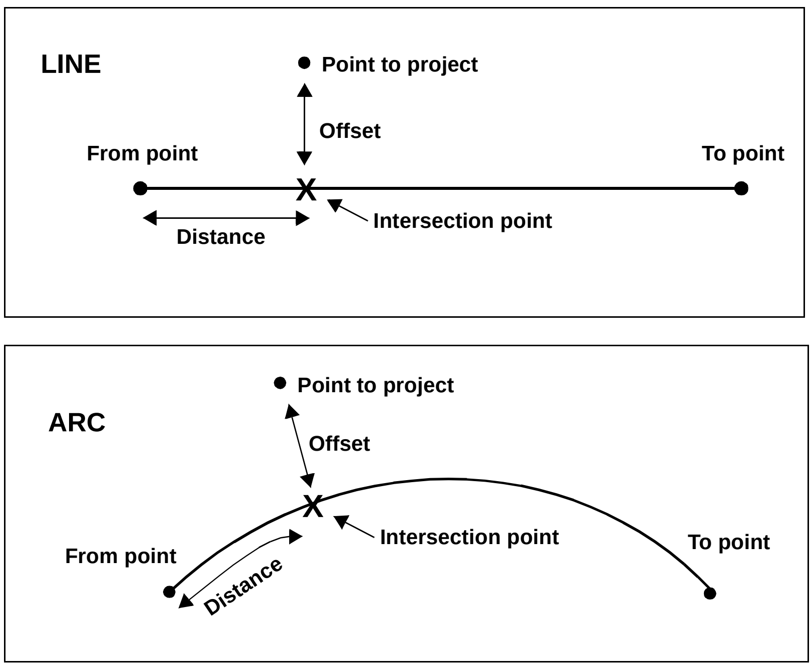


Figure 28-1: Point projections

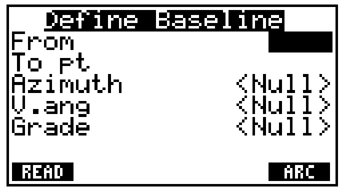
28.1 Projecting Points

You can project points onto a line or an arc with the SDR33.

Steps to project points

1. Select **Point Projection** from the ***COGO*** menu.

2. Confirm the orientation and press **<OK>**. The ***Define Baseline*** screen displays.



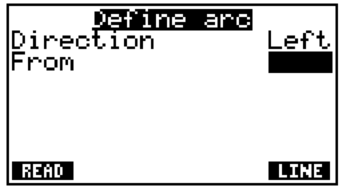
✉ **Note**: If a current station for the setting out work, along with the backsight orientation for the station, has not been defined, you will be prompted to enter this information prior to the display of the ***Define baseline*** screen. For more information, see Chapter 7, *Setting Up a Station and Backsight*.

3. Define the baseline or arc by toggling the **<ARC>** / **<LINE>** softkey.

The **<READ>** softkey 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 in coords*** screen will appear, allowing you to enter the appropriate coordinate values. The ***From*** field must be entered.

When the ***Grade*** field is selected, **<HORIZ>**, **<1:>**, and **<%>** softkeys are presented. The **<HORIZ>** softkey will set the Grade field to horizontal. The **<1:>** and **<%>** softkeys 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**). See Section 19.1, *Staking Out a Line*, page 19-2 for more information.

4. (*optional*) If you wish to project a point onto an arc, press the <ARC> softkey. The Define Arc screen displays.



Enter information in the following fields:

Direction ..... This field specifies whether the arc being defined turns toward the right (clockwise) or left (counterclockwise) when viewed from the ***From*** point. This field toggles between **Right** and **Left** when the <←> or <→> keys are pressed.

From............ *(required)* Enter a point from which the arc initiates in the direction defined.

✉ **Note:** The ***From*** field plus one of the other point fields (***To pt***, ***Center*** or ***Intersect pt***) **MUST BE ENTERED**. 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 one of the arc definition fields (***Radius, Angle, Arc len, Chord ln, Tan len*** or ***Back tan***) can be entered to fully define the arc. See Figure 28-1 for an illustration of the arc definition values that can be specified. The values for the rest of the fields are calculated and displayed (except for the point fields).

To pt............ *(optional)* The point field describes the point upon which the arc terminates.

Center.......... *(optional)* This field is used to define the center of the arc.

Radius.......... *(optional)* This field specifies the value used to define the radius of the arc.

Angle .... *(optional*) This field specifies the value used to define the subtended angle of the arc.

Arc len .... *(optional)* This field specifies the value used to define the distance along the arc.

Chord ln ...... *(optional)* This field specifies the value used to define the straight line distance between the ***From*** and ***To*** points.

Tan len .... *(optional)* This field specifies the value used to define the tangent length.

Back tan....... *(optional)* This field specifies the value used to define the back tangent length.

Intersect pt.. *(optional)* The point field is used to define the intersection of the tangents.

5. Press **<OK>** after the baseline or arc definition has been completed, the ***Point Projection*** screen displays.

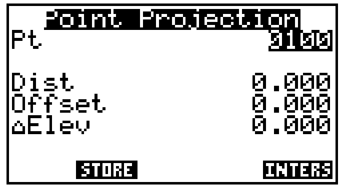
Enter the point ID you wish to project.

Note: The **<READ>** softkey is displayed when the ***Pt*** field is selected, allowing an instrument reading to a new point to be taken directly. If this **<READ>** key is selected, the result of the previous calculation will be saved, if applicable.

Note: Press **<Clear>** at any time to discard the current reading and return to the Point Projection Point List screen.

---

6. Press **<OK>,** the ***Point projection*** screen displays the information necessary to locate the point.



Review information in the following fields:

Dist.............. This field displays the calculated distance.

Offset........... This field displays the calculated offset.

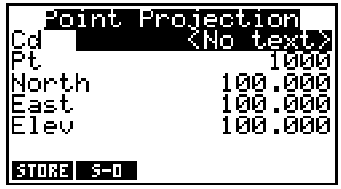
d.Elev........... This field is calculated using the elevation interpolated along the baseline or arc compared with the elevation of the specified point. You can enter an appropriate value if the field is <Null>.

7. If you enter a different point number into the ***Pt*** field, a message displays, asking if you wish to discard the data.

8. If you are projecting onto an arc, the **<NEXT>** softkey will appear on the ***Point projection*** screen. If this **<NEXT>** key 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.

9. The **<INTERSEC>** softkey allows you to compute and save the perpendicular intersection point on the baseline or arc. If you press the **<INTERSEC>** softkey, a screen similar to that shown below 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 an appropriate value if known.



10. Choose from the following softkeys and options:

- Press **<OK>** or the **<STORE>** softkey, 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 record. The ***d.Elev*** value is recorded in a second Note if the value was not <Null>.

- The **<S-O>** softkey allows you to directly set out the computed intersection point. You are presented with the standard setting out options once the **<S-O>** softkey has been pressed. Refer to Section 18.2, *Staking Out a Point*, page 18-5, for details relating to the setting out operation.

Chapter 29 Building Face Survey

In this chapter

- Surveying vertical planes
- Surveying nonvertical planes

The Building Face Survey option enables points on both vertical and nonvertical planes to be coordinated by angle-only observations. This feature is most often used 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 made, and the SDR33 calculates and stores coordinates of the angle intersection observation with the plane.

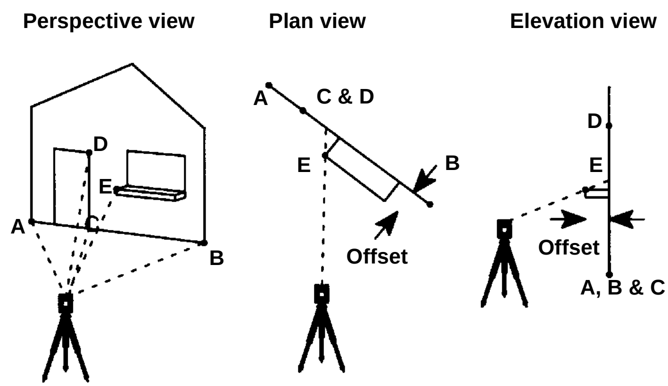


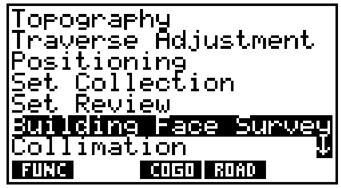
Figure 29-1: Building face survey

29.1 Surveying Vertical Planes

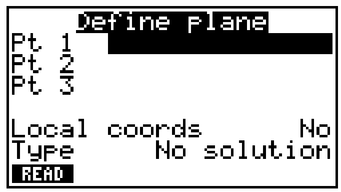
You can use the SDR33 to survey the vertical face of a building or other vertical planes.

Steps to survey a vertical plane

1. Select the **Building Face Survey** option from the ***Survey*** menu.



2. The SDR33 will display the ***Define Plane*** screen.



Enter the point information in the ***Define Plane*** fields.

Pt 1................ This field indicates the first point name to define the building face plane. Both ***Pt 1*** and ***Pt 2*** must have horizontal coordinates to properly define the building face.

Pt 2 .... This field indicates the second point name to define the building face plane. Both Pt 1 and Pt 2 must have horizontal coordinates to properly define the building face.

Pt 3................ This field indicates the third point name to define the plane. If you are surveying a vertical plane, or building face, the Pt 3 field should be left blank. For more information, see Section 29.2, *Surveying Nonvertical Planes,* page 29-5.

Local coords This field 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 calculated coordinates referenced to Point A as the origin of the local coordinate system. See Figure 29-1 for more information.

Calculated points are recorded with three coordinates; Horizontal distance from Point A, Elevation, and 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.

<READ>...... This softkey initiates a reading to fix the observed point.

🖂 **Note**: If a point is entered that has a null northing or easting, a **Null position** message will be displayed.

🖂 **Note**: If you want to define a local coordinate system, the horizontal coordinates cannot have any <Null> coordinates. If you want local coordinates, an elevation value must be entered also; the SDR33 cannot determine local coordinates without an elevation for point A.

---

3. Once you have specified the two defining points for the building face plane, press **<OK>**. The SDR33 will determine the available solution. One of the following messages will display:

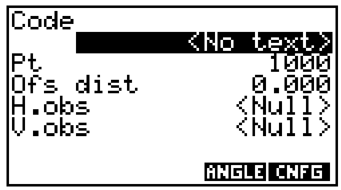
    - **No solution -** the SDR33 does not have enough information to fix the plane

    - **Vertical -** the SDR33 has enough data to fix a vertical plane

- **3D -** the SDR33 has enough information to fix an arbitrary plane

A note is saved in the SDR33 database recording the point numbers of the two points defining the building face plane, and whether local coordinates are in effect. See Section 33, *The SDR Database*, page 33-1

4. You can either press **<READ>** or the **<ANGLE>** softkey to take readings to points on the building face. The SDR33 will store the observed points on the building face using angle-only observations.



You can enter an offset value in the ***Ofs dist*** field to record a known offset distance from the building face plane.

Note: A positive offset distance indicates the observed point is "in front" of the plane, as observed from the occupied station. A negative offset distance indicates the observed point is "behind" the building face plane.

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 autopoint numbers.

Note: You can access the ***Configure Reading*** screen by pressing **<CNFG>**. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

5. Press **<Clear>** to exit the Building Face Survey option.

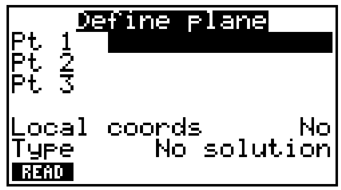
29.2 Surveying Nonvertical Planes

Surveying a nonvertical plane is similar to surveying a vertical plane. Once the plane has been defined, and you understand how the local coordinate system works for nonvertical planes, picking up detailed observations follows the same general process.

Steps to survey a nonvertical plane

1. Select the **Building Face Survey** option from the ***Survey*** menu.

2. The SDR33 will display the ***Define Plane*** screen.



Enter the point information in the ***Define Plane*** fields.

Pt 1................ Enter the first point name to define the building face plane. Both ***Pt 1*** and ***Pt 2*** must have horizontal coordinates to properly define the building face.

Pt 2 .... Enter the second point name to define the building face plane. Both Pt 1 and Pt 2 must have horizontal coordinates to properly define the building face.

Pt 3................ Enter the third point name to define a nonvertical plane.

✉ **Note**: When defining a nonvertical plane, the three points cannot be in a line. If the points are linear, you will get the warning message **Linear** and the ***Type*** field will display **No solution**.

Local coords The ***Local coords*** field controls the coordinate system to which the computed coordinates are referenced.

No computes the coordinates in ordinary North, East, and Elevation coordinates.

Yes calculates 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 and 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.

You can also use the **<READ>** softkey provided to fix the points by observation, if desired.

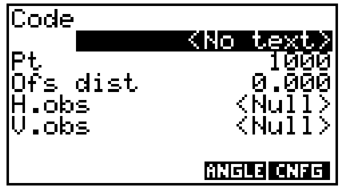
3. Once you have specified the three points that define the nonvertical plane, press **<OK>**. The SDR33 will determine the available solution. One of the following messages will display:

   - **No solution -** the SDR33 does not have enough information to fix the plane
   - **Vertical -** the SDR33 has enough data to fix a vertical plane
   - **3D -** the SDR33 has enough information to fix an arbitrary plane

   A note is saved in the SDR33 database recording the point numbers of the two points defining the building face plane, and whether local coordinates are in effect. See Section 33, *The SDR Database*, page 33-1.

   If you are defining a local coordinate system when surveying a nonvertical plane, no coordinate values may be <**Null**>. Also, the second point defines due east, not positive east, as with a vertical plane. However, the instrument station is still assumed to have a positive elevation in the local coordinate system, as it does with vertical planes.

4. You can either press **<READ>** or the **<ANGLE>** softkey to take readings to points on the building face. The SDR33 will store the observed points on the building face using angle-only observations.



You can enter an offset value in the ***Ofs dist*** field to record a known offset distance from the building face plane.

Note: 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.

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 autopoint numbers.

Note: You can access the ***Configure Reading*** screen by pressing **<CNFG>**. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

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.

5. Press <**Clear**> to exit the Building Face Survey option.

9

Leveling

This section is a basic introduction to the SDR33 Leveling program. You can use a digital level instrument to take elevation readings with your SDR33.

Leveling

- *Using the Leveling Program*
- *Making Reports/Adjustments*

Chapter 30 Leveling

In this chapter:

- Using the SDR's leveling program
- Moving the leveling instrument
- Leveling reports and adjustments

You can use a digital or manual level with the SDR33 to perform differential leveling. By using the leveling option to collect accurate elevations, you can improve the accuracy of your survey job. The elevations recorded from the Leveling option can be used to correct existing data in the SDR database. The SDR33 has two ***Leveling*** options:

Leveling................. This option takes level readings and adds them to the data base.

Report/Adjust...... This option uses level readings for adjustments and reports.

You can also key in leveling values using the **Keyboard Input** option in the ***Leveling*** screen.

When collecting points with the Leveling program, the SDR33 groups points into level loops. A level loop is a group of elevation readings starting and ending from a known elevation.

Level loops are similar to traverse routes in that the level instrument is moved to observe points to be included in the level loop. Each point is linked together, forming an observation “route.” You can close the level loop by reobserving the initial point from the last instrument occupation or to a known elevation.

You can take observations to multiple points to which you may not plan on moving your instrument. Any observed point not used as an instrument setup in the level loop is called a sideshot.

30.1 Using the Leveling Program

A level loop consists of several observations, or setups. The process begins by backsighting a known elevation and ends by reading a known elevation, which can be the starting point or another known point. A level loop allows you to collect and average multiple elevation observations to produce an accurate elevation value. Leveling loops can be used to adjust elevation readings in the same way Traverse Adjustment options are used to average traverse readings.

Steps to use the leveling program

1. Select **Leveling** from the ***Level*** menu.

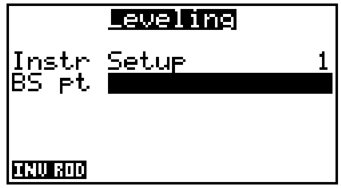
2. The SDR33 will display the ***Select Job*** screen. Select the job with which you wish to work and press the **<OK>** key.

Note: If you have not created a job, you will be prompted to create a new job.

3. The ***Instrument Setup*** screen displays. Review your current instrument settings and make any necessary changes. Be sure to select Level as your instrument.

4. When finished, press **<OK>**.

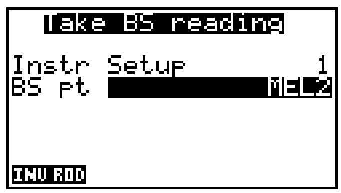
5. The SDR33 displays the ***Leveling*** screen. Enter the backsight point ID and press <**OK**>.



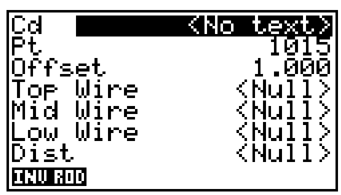
The ***Instr Setup*** field displays the number of existing leveling setups in the current job. The number will increment after each level loop observation.

Press the **<INV ROD>** softkey to take a reading with an inverted rod. Inverse readings are taken when the point of interest is too high to place the rod on top. In these cases, the rod is inverted and the bottom of the rod is elevated until it touches the point. An example is standing under a bridge and taking an elevation to the underside of the bridge.

6. The SDR33 will prompt you to observe the backsight. Press <**Read**> to initiate an observation of the backsight point.



7. Press **<OK>** to start observing elevations with the SDR33.



The Level Reading screen contains the following fields:

Cd .... This field can be used to enter a feature code for the point.

Pt.................. This field enables you to enter a point ID, except when taking a backsight. The ***Pt*** field cannot be changed for backsights.

Offset........... The value entered in the ***Offset*** field represents the target height. Once the ***Offset*** has been entered, it will be used for other readings until it is changed. The ***Offset*** value is added to the rod reading.

Top Wire...... This field displays the top wire reading.

Mid Wire..... This field displays the mid wire reading.

Low Wire..... This field displays the low wire reading.

Dist.............. This field displays the distance reading.

Note: If ***Manual*** was chosen as the instrument and ***3-wire reading***s was also selected, all three fields will be displayed. Manually enter the desired values with the keyboard. Three- and singlewire readings are chosen from the ***Configure Reading*** screen. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

Note: Once the SDR33 has two of the wire readings, it will calculate the distance. If you enter another distance, tolerances will be checked using the stadia constant. The wire readings will also be checked by comparing the (Top+Low) /2 compared with the Mid Wire.

8. You can now take sideshots by pressing <**Read**> or <**INV ROD**>.

9. Press **<OK>** when you want to move your leveling instrument. The SDR33 displays a confirmation message.

10. Press the **<YES>** softkey to continue. The SDR33 increases the instrument setup number by one (1) and displays the Level Reading screen.

11. The SDR33 will fill the ***BS pt*** field with the name of the last point you observed before moving the instrument. You may accept the point ID or enter a new one based on your survey needs. Four options are available for the ***BS pt*** field:

    - You can accept this point. If you do, you are continuing the level loop.

    - You can enter the name of a point already in your level loop. If you do, you will be branching the level loop.

    - You can enter the point name of another point in the SDR database. This has to be a point that was not added by the leveling instrument. As an example, an earlier topographic survey has added point 1234 to the database. If you backsight to this point, the level loop is broken; you have started a new loop.

    - You can enter a point name for a completely new point of unknown elevation. The SDR33 will search the database and prompt for an elevation if the point is not found. You may enter an elevation or leave it <Null>. In either case, the level loop is broken.

12. Continue your survey by taking sideshots. Use <**Read**> or <**INV ROD**> softkeys.

13. When you are finished observing the level loop, take a foresight reading to a known point or move your instrument and backsight a point of known elevation. The SDR33 will automatically close the loop.

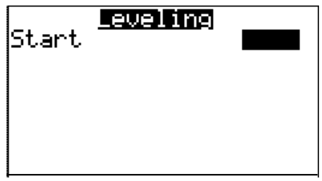
30.2 Making Reports/Adjustments

Once enough readings have been taken to define a Level Loop, you can adjust or print the level loop.

Steps to adjust and print a level loop

1. Select the **Report/Adjust** option from the Level menu.

2. The SDR33 will prompt you to enter the starting point ID of your level loop.



3. Enter the starting point and press the **<OK>** key. The SDR33 builds the route. The SDR33 will pause when a route branch is detected and you need to decide which path to take, or when a point that could be used as a close point has been found.

When the loop has been entered, press **<OK>** and the main ***Report/ Adjust*** screen will be displayed. This screen contains the following fields:

From .... This field indicates the starting point ID of the level loop.

To Pt .... This field indicates the ending point ID of the level loop.

D.Elev .... This field displays the change in elevation in the level loop.

Dist.............................. This field displays the loop distance.

Adj Selector .... This field toggles between **Yes** and **No**. If **Yes** is displayed, you may select the adjustment method.

Method Selector ....This field toggles between **Weighted** and **Linear**.

Weighted ....This field spreads the misclosure to each point depending on the length of the leg to that point.

Linear ....This field spreads the misclosure to each point evenly.

Two softkeys are available:

<REPORT> . This softkey is used to send a report to a printer or personal computer. This report contains a level book style display of the data obtained. It also contains an elevation summary (adjustment method is displayed) at the end of the report for all of the turning points. The parameters of the last communication session will be used. See *Chapter 34, Communications*.

<STORE>.... This softkey will store Notes, and depending on the value in the ***Adjust selector*** field can store adjusted Level Elev records. If the ***Adjust selector*** field is set to **Yes**, both Notes and adjusted records will be stored, otherwise only notes will be stored. Adjusted Level Elev records will have a derivation code of **AJ.** Once the **<STORE>** softkey has been pressed, it will disappear until the ***Method Selector*** field has changed.

🖂 **Note**: When the SDR33 adjusts the loop, ALL points in between the Start and End points are adjusted. Therefore, if you have known bench marks, use these as the Start and End points of the loop. This method gives you control over what points will be adjusted and what points will not.

10

Coordinate Geometry

Section 9 shows you how to solve difficult surveying problems by using COGO functions. The Transformation chapter explains how to use Helmert and linear transformations to correct survey data.

COGO Options

- *Calculating an Inverse*
- *Calculating and Subdividing Areas*
- *Intersections*

Transformations

- *Using Helmert Transformation*
- *Using Linear Transformation*

Chapter 31 COGO Options

In this chapter

- Calculating Inverses
- Calculating Area
- Calculating Areas using a parallel subdividing line
- Calculating Areas using a subdividing line intersecting corner points
- Computing intersection calculations: two azimuths, azimuth and distance, and two distances.

The COGO menu of the SDR33 provides several options to perform coordinate geometry calculations, including inverses, areas and intersections. You can use these tools to calculate distances, azimuths and coordinates separately from traditional SDR33 methods.

31.1 Calculating an Inverse

The SDR33 can calculate an inverse, the vertical distance, azimuth and horizontal distance between two points, using coordinate geometry. The inverse program calculates a reduced record from two known coordinates. The reduced record is then stored in the SDR database.

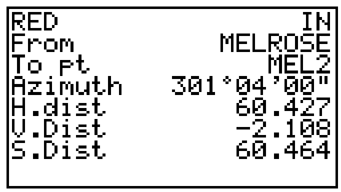
Steps to calculate an inverse

1. Select **Inverse** from the ***COGO*** menu.

2. Enter a ***From*** point and a ***To*** point in the ***Inverse*** screen.

3. Once you enter these points in the appropriate fields, press **<OK>**. If either of the points is not known, you have an opportunity to enter the coordinates.

4. Once the coordinates of both points are known, the vector between them is calculated and displayed.



5. If you press **<OK>**, the data is stored in the database as a reduced (**RED**) record. If you do not wish to save the result, press **<Clear>** to exit to the menu.

31.2 Calculating and Subdividing Areas

You can use the SDR33 to calculate area and subdivide the area. This option may be useful when determining lots, building sites or other purposes. When calculating the area, you will need to specify a set or corner points. To calculate an area, you need to specify at least three points. The SDR33 will check the integrity of the shape by verifying:

- the point exists
- both the northing and easting values are not null
- the point is not a duplicate entry
- the line created between the point and the previous point does not cross any of the existing edges (to avoid a figure 8)

The SDR33 uses the point order to determine the shape of the area. 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.

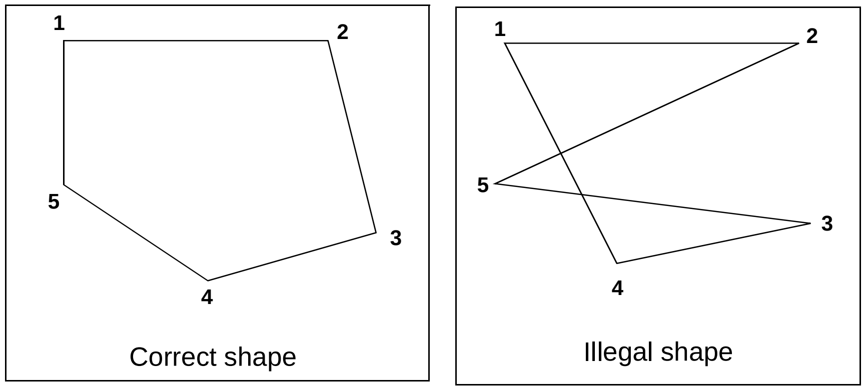


Figure 31-1: Calculating and subdividing areas

If the order of the points cause edges to overlap, as in the second example, the SDR33 will display an “Illegal shape” message. You can add or remove points in the ***Define Area*** screen to correct the error.

After calculating the area, you can subdivide the 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.

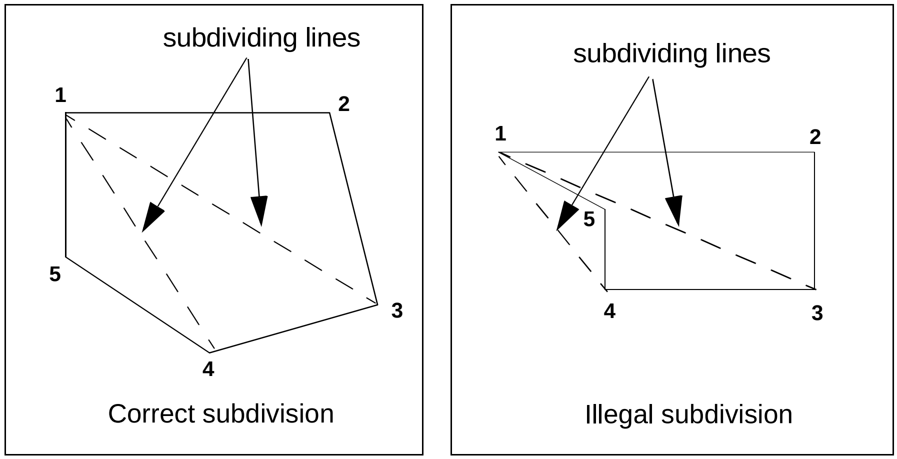


Figure 31-2: Subdivision rules

- Make the subdividing line parallel to a given line. The two points where the subdividing line intersects the perimeter of the area are calculated.

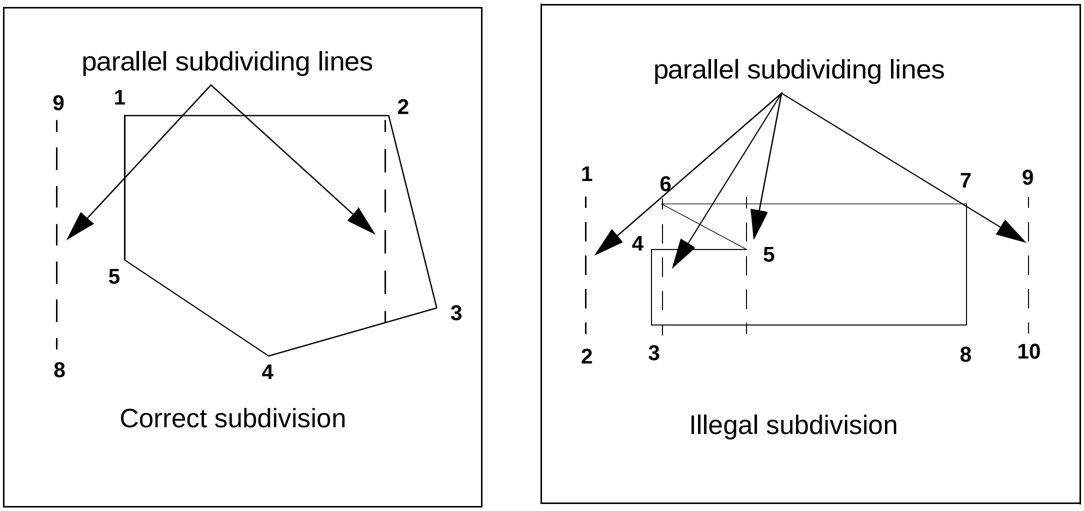


Figure 31-3: Parallel subdivision lines

✉ **Note**: All coordinates calculated by this program are stored as **POS** records with an **AR** derivation code.

Steps to calculate an area

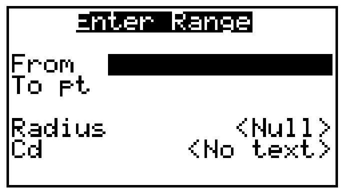
1. Select **Areas** from the ***COGO*** menu.

2. Enter the corner points in the ***Define Area*** screen. You can enter point IDs using the keyboard or by using the softkeys.

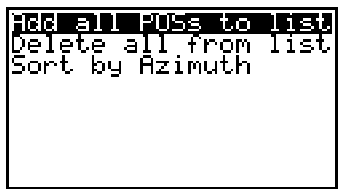
- Enter each point in a ***To pt*** field

✉ **Note**: If coordinates do not yet exist, entry of a starting point will first display the ***Key in Coords*** screen.

- Press the **<RANGE>** softkey to enter all points within a specific range.



- Press the **<ALL>** softkey and select **Add all POSs to list** to enter all POS points.



3. Review the points entered in the ***Define Area*** screen. The SDR33 will use the point order to define the area.

   You can delete points by highlighting the point and pressing the **<DEL>** softkey.

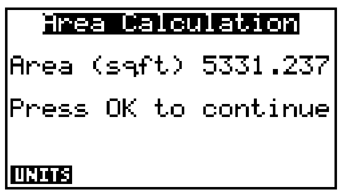
> **Note**: You can remove all points from the ***Define Area*** screen by pressing the **<DELALL>** softkey. A confirmation message will display.

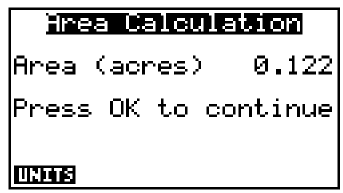
> **Note**: Do not enter the initial point number at the end of the list of point numbers or a duplicate point error occurs. The ***Areas*** program includes this edge implicitly.

4. Press **<Enter>** at the ***To point*** prompt to end point entry. Press **<OK>** to start area calculation.

> **Note**: If an error is detected, an error message displays and the SDR33 will display the ***Define Area*** screen. Review the specified points and remove or add points as necessary.

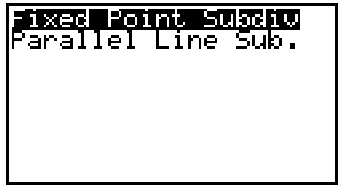
The SDR33 will display the results of the area calculation. To change the units of the area, press the **<UNITS>** softkey.





5. Press **<OK>** if you want to store the NOTE AR record and continue with the subdivision. Extra notes are stored with the point numbers that outline the area. Press **<Clear>** to discard the calculation.

6. If the area is stored, a menu with the two methods of subdividing displays (for more information, see the following sections).



7. Press **<Clear>** to exit the program without subdividing.

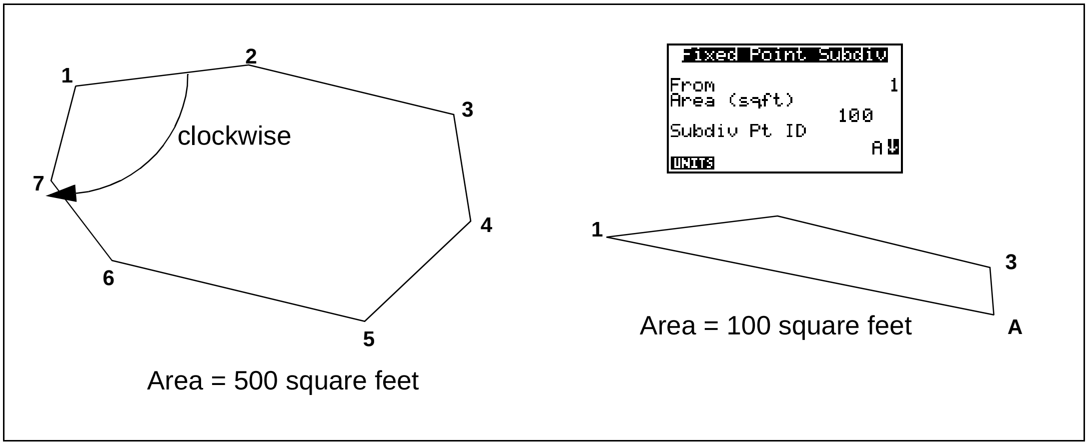
31.2.1 Subdividing by rotating from a fixed point

After calculating an area, you can subdivide the area for a variety of purposes. The SDR33 can subdivide an area using one of two methods:

- subdividing by rotating from a fixed point
- subdividing with a line parallel to an existing line (see Section 31.2.2, *Subdividing with a line parallel to an existing line*, page 31-12.)

Select the method that best suits the area and the desired results.

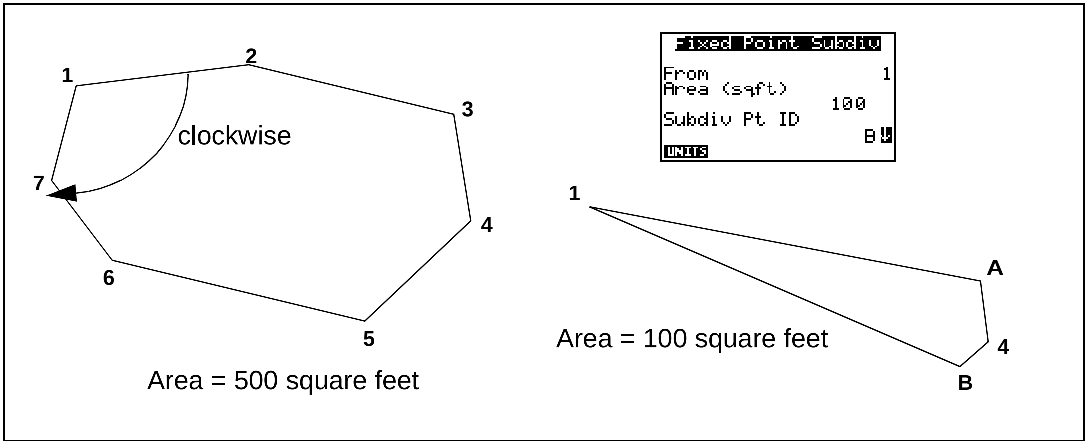
The area is subdivided by specifying a corner point, the desired area and the subdivision point ID. The SDR33 then rotates a line around the perimeter in a specified direction until the desired area is reached. A new point is created using the subdivision point ID. You can continue to subdivide the area as long as there is a legal shape. In the following example, point 1 is held fixed to create a new area of 100 square feet.



Subdividing an area by rotating a fixed point clockwise

Figure 31-4: Fixed point subdivision

After each subdivision, the SDR33 checks the remaining area to determine if another subdivision can be created. If a subdivision is available, the SDR33 will display the ***Fixed Point Subdiv*** screen.

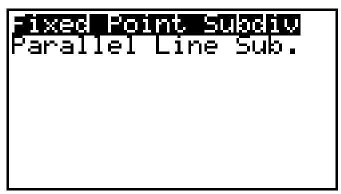


Subdividing an area by rotating a fixed point clockwise

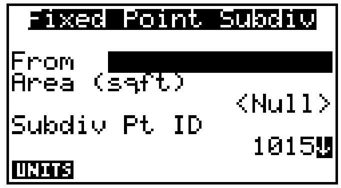
Figure 31-5: Complete subdivision

Steps for completing subdivision

1. After the area is calculated, select **Fixed Point Subdiv** and press **<Enter>**.



2. The Fixed Point Subdiv screen enables you to specify the subdivided area you wish to create.



Enter information in the following fields:

From .... This field indicates the point ID you wish to hold fixed.

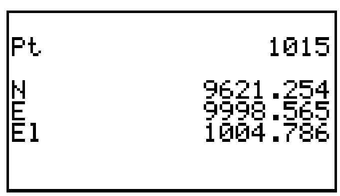
Area (sqft) .... This field indicates the area of the new subdivision. The SDR33 automatically enters the area previously calculated. You can enter a value between 0 and the calculated area.

Subdiv Pt ID.... This field indicates the point ID of the newly created end point.

Direction .... This field indicates the direction in which the SDR33 will rotate the fixed point: **Clockwise** and **Anticlock**.

✉ **Note**: To change the units, press the **<UNITS>** softkey.

3. Press **<OK>** to start the subdivision. The SDR33 will display the coordinates of the newly calculated end point.



Note: The SDR33 will display an “Illegal Shape” error if a problem exists in the defined subdivision. Review the fields in the ***Fixed Point Subdiv*** screen to correct the error. For more information on the causes of illegal shapes, see Section 31.2, *Calculating and Subdividing Areas*, page 31-2.

4. Press **<OK>** to store a **POS** record for the calculated position or **<Clear>** to discard it.

31.2.2 Subdividing with a line parallel to an existing line

After calculating an area, you can subdivide the area for a variety of purposes. The SDR33 can subdivide an area using one of two methods:

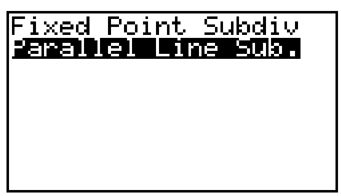
- subdividing by rotating from a fixed point (see Section 31.2.1, *Subdividing by rotating from a fixed point*, page 31-8)
- subdividing with a line parallel to an existing line

Select the method that best suits the area and the desired results.

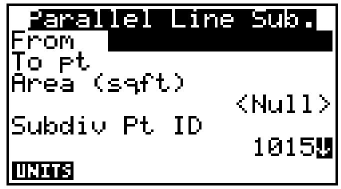
Subdividing an area using parallel lines can create uniform subdivisions. You may want to use this option when dividing an area into lots or other application. When creating the initial area, remember to avoid instances where the lines may intersect during the subdivision.

Steps for completing the subdivision

1. After the area is calculated, select **Parallel Line Sub** and press **<Enter>**.



2. Create the line you wish to use to subdivide the area by specifying the end points in the ***From*** and ***To pt*** fields of the ***Parallel Line Sub*** screen.



The SDR33 will use the defined line to generate parallel lines to subdivide the calculated area.

From .... The starting point for the line.

To pt .... The ending point for the line.

Note: If the points have not been observed, the SDR33 will display the ***Key in Coords*** screen.

Area (sqft) .... This field indicates the amount of area of the new subdivision. The SDR33 automatically enters the area previously calculated. You can enter a value between 0 and the calculated area.

Subdiv Pt ID.... This field indicates the point ID of the newly created end point.

Note: To change the units, press the **<UNITS>** softkey.

---

3. Press **<OK>** to start the subdivision. The SDR33 will create the first subdivision by creating a line parallel to the line defined in step 2, creating a subdivision with the specified area. The SDR33 will start the subdivision with the point within the area closest to the defined line.

The SDR33 will display the coordinates of the newly calculated end point.

```
Pt            1015

N         9621.254
E         9998.565
El        1004.786
```

Note: The SDR33 will display an "Illegal Shape" error if a problem exists in the defined subdivision. Review the fields in the ***Fixed Point Subdiv*** screen to correct the error. For more information on the causes of illegal shapes, see Section 31.2, *Calculating and Subdividing Areas*, page 31-2.

4. Press **<OK>** to store the subdivision **POS** records, or press **<Clear>** to discard them.

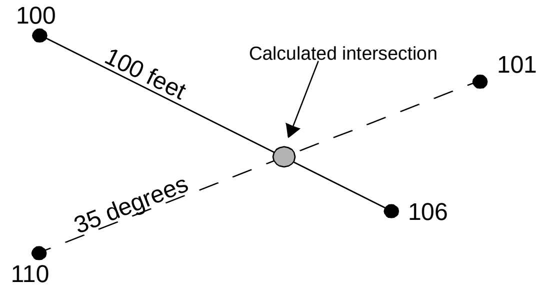
5. Continue to subdivide the area until complete.

6. Press **<Clear>** to exit the option.

31.3 Intersections

You can calculate a point intersection in the field using the SDR33's **Intersection** option. The SDR33 can calculate any point generated by the crossing of two vectors. To calculate an intersection, you will need one of the following combinations:

- Two azimuths
- Azimuth and distance
- Two distances

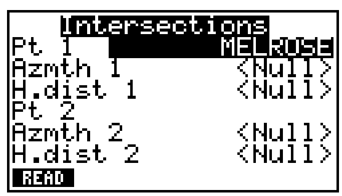


✉ **Note**: In the azimuth and distance method, you cannot use the same point for the starting point for both the azimuth and the entered distance. This specification is the same as entering an azimuth and distance from the selected point. If you want to use this method, use the ***Key in Azmth / Dist*** function from the ***Keyboard Input*** option.

When computing an intersection, there may be two possible solutions. The **<OTHER>** softkey enables you to view both solutions before deciding which record you wish to store.

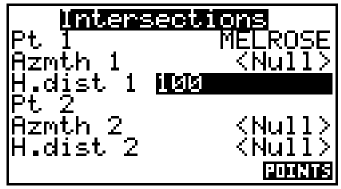
Steps to compute an intersection

1. Select the **Intersections** option from the ***COGO*** menu, and the Intersections screen is displayed.



2. Enter the first point in the ***Pt 1*** field.

3. Specify the azimuth or horizontal distance for ***Pt 1*** by highlighting one. You can specify either an azimuth or a horizontal distance, but not both.

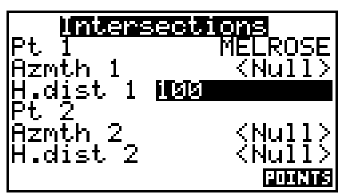


4. (*optional*) Press the **<POINTS>** softkey and one of two screens appears, either ***Azimuth from Points*** or ***Distance from Points***, depending on the currently selected field. Each of these screens has ***From*** and ***To pt*** fields.

Enter the points you wish to use to calculate the distance or azimuth. The SDR33 will compute the inverse between the two points to use for the intersection.

Press **<READ>** to initiate a point observation and enter it in the selected field.

5. Enter the second point for the intersection calculation in the ***Pt 2*** field. Follow Steps 2 through 4 above to enter the intersection azimuth or distance for ***Pt 2***.



6. Press **<OK>** to initiate the intersection computation. The computed intersection coordinates display.

7. (*optional*) If two possible intersection solutions exist (often the case with azimuth and distance and two distances), then the **<OTHER>** softkey appears. Select the **<OTHER>** softkey to navigate between the two solutions.

8. (*optional*) Review the information displayed in the ***Solution*** screen. Edit the point ID, feature code and elevation if desired.

9. (*optional*) Press **<S-O>** to set out the computed point.

10. Press the **<STORE>** softkey or **<OK>** to save the intersected point, or discard the result by pressing **<Clear>**. If you enter values in the ***Code***, ***Pt*** or ***Elev*** fields, then choose to discard the calculation result, a confirmation prompt will display.

11. You can continue to calculate intersections or press **<Clear>** to exit.

Chapter 32 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 SDR33 can compute a Helmert or linear transformation to transform a survey job from one coordinate system to another using coordinate geometry. The two transformations use different methods to recalculate the coordinates into the new coordinate system. You can select the transformation best suited to your survey needs.

The parameters for a 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 SDR33 uses a combination of translation, rotation and scaling to effect the linear transformation. When calculating a linear transformation, the SDR33 does not alter redundant data. You may want to use this transformation when you are slightly altering coordinate system and do not need to average elevation values.

When performing a transformation (Helmert or linear), the SDR33 uses two jobs: the original job and a second job to store the transformed points. Using two jobs allows you to perform multiple transformations without ever altering your original data.

32.1 Using Helmert Transformation

The Helmert transformation uses the least squares method to transform the coordinates. To carry out a Helmert transformation you must first create a new job containing the correct datum coordinates of the control points.

You may want to send an existing job file to the SDR33, or you can create a new job and key in the coordinate values from a plan. The SDR33 saves the input coordinates in the new (current) job. When inputting coordinates, remember to use the same naming conventions for easy transformation. The control point IDs in the job you wish to transform need to correspond to the correct datum coordinates you enter.

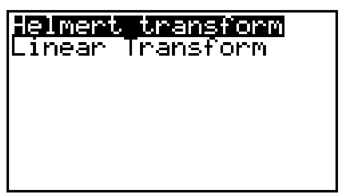
Steps to perform a Helmert transformation

1. Create a new job to hold the control points by selecting **Job** from the ***Functions*** menu. For more information, see Section 5.1, *Creating a New Job*, page 5-2.

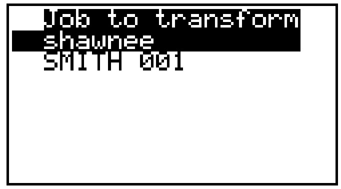
2. Using the **Keyboard Input** option, enter the correct datum coordinates of the control points. For more information, see Chapter 35, *Operating with Keyboard Input*.

3. Select **Transformation** from the ***COGO*** menu.

4. Select **Helmert transform** from the menu and press <**OK**>.



5. Select the job you want to transform and press <**OK**>. The SDR33 will use the job you created in step 1 to store the transformed coordinates.



   The SDR33 will search for any point names 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.

6. If an unacceptably large error is calculated, press **<Clear>** to escape.

   Each uncommon point in the selected coordinate system job (job selected in step 10) will be transformed and stored in the new job (job created in steps 2-6). 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.

32.2 Using Linear Transformation

The linear transformation is a “simple” transformation, avoiding the use of least squares. The linear transformation performs a translation, rotation or both to the coordinates in the selected job.

When performing a linear transformation, you will need to establish a new job containing at least one control point to hold the transformed coordinates.

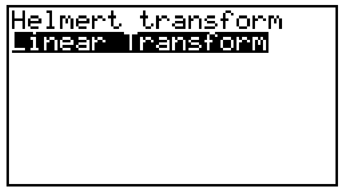
Steps to use a linear transformation

1. Create a new job to hold the control points by selecting **Job** from the ***Functions*** menu. For more information, see Section 5.1, *Creating a New Job*, page 5-2.

2. Using the **Keyboard Input** option, enter the correct datum coordinates of the control point. For more information, see Chapter 35, *Operating with Keyboard Input*.

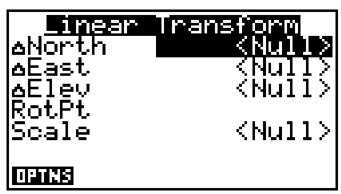
3. Select ***Transformation*** from the ***COGO*** menu.

4. Select **Linear transform** from the menu options and press <**OK**>.



5. Highlight the job you wish to transform and press **<OK>**.

6. The ***Linear Transformation*** screen will display.



Enter information in the following fields:

ΔNorth .... This field shifts the north coordinates.

ΔEast............ This field shifts the east coordinates.

ΔElev .... This field shifts the elevation coordinates.

Rot Pt .... Enter a point ID to use as the rotation point. All coordinates will be rotated around this point.

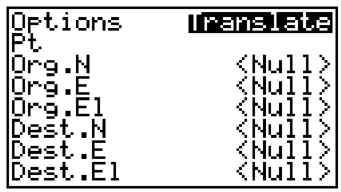
Rotation....... Enter a rotation value.

Scale............. Enter the horizontal scale factor.

✉ **Note:** When calculating the rotation in a linear transformation, you will receive an Invalid Input message if the calculated angle is -100 degrees or more.

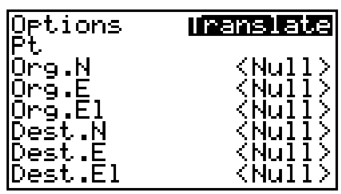
---

7. (*optional*) Press the **<OPTNS>** softkey to review and edit the transformation options. You can perform either a translation transformation, a rotation transformation or both.



Translation

If you wish to perform a translation transformation, toggle the ***Options*** field to **Translate**.



Enter information in the following fields of the ***Transformation Options*** screen:

Pt.................. Enter the starting point ID.

Note: If you enter a point ID that exists in the database, the SDR33 will automatically populate the fields with the stored coordinates.

Org.N .... Enter the original North value.

Org.E............ Enter the original East value.

Org.El........... Enter the original elevation.

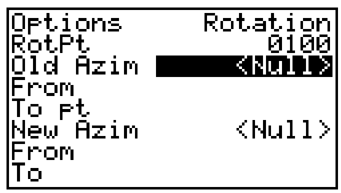
Dest.N.......... Enter the North destination value.

Dest.E........... Enter the East destination value.

Dest.El .... Enter the elevation destination value.

Rotation

If you wish to perform a rotation transformation, toggle the ***Options*** field to **Rotation**.



Enter information in the following fields of the ***Transformation Options*** screen:

RotPt .... Enter a point ID to use as the rotation point. All coordinates will be rotated around this point.

Old Azim .... (*optional*) Enter the original azimuth.

From............. Enter the beginning point ID of the point whose azimuth you wish to rotate.

To Pt .... Enter the ending point ID of the point whose azimuth you wish to rotate.

New Azim... (*optional*) Enter the new azimuth.

From .... Enter the point you wish the SDR33 to use to calculate the azimuth.

To .... Enter the point you wish the SDR33 to use to calculate the azimuth.

✉ **Note**: If you enter a point ID that exists in the database, the SDR33 will automatically populate the fields with the stored coordinates.

8. Press **<OK>** to initiate the linear transformation. The SDR33 will calculate the transformation.

9. A note record is stored stating which job was transformed. The new job (created in step 2-6) will contain the transformed points.

10. Press **<Clear>** to exit the Transformation option.

11

SDR Fundamentals

This section introduces many of the fundamental tasks and concepts necessary to work effectively with the SDR33. This section includes specific information about the SDR database, how to interpret and use coordinate search logic, and navigating through the database.

The SDR Database

- *Viewing the Database*
- *Searching for Coordinates*
- *Using Coordinate Search Logic*

Communications

- *Communications Hardware and Parameters*
- *Printing Data*
- *Transferring Data Files*
- *Using a Modem*

Operating with Keyboard Input

- *Entering Known Coordinates*
- *Entering Known Azimuths*
- *Entering Known Azimuths with Distance*
- *Entering Known Observations*
- *Entering Known Elevations*
- *Entering Latitude, Longitude and Height*

Feature Codes and Attributes

- *Managing Feature Code Lists*
- *Managing Feature Codes in a List*
- *Using Feature Codes*
- *Defining Attributes*
- *Entering Attributes*

Calculator

- *Operating the Calculator*
- *Using the Calculator Memories*
- *Accessing the Current Job*

Measurement of Collimation Error

Chapter 33 The SDR Database

In this chapter

- Database conventions
- Viewing stored data
- Searching for data
- Editing notes and codes
- Observation views
- Coordinate search rules for total station instruments
- Coordinate search rules for elevations when both total station and leveling instrument observations are available.
- Application of total station coordinate search rules.

The SDR33 stores all observations, notes and calculated results in a database. This database is a list of records of different types, stored in chronological order. Each job's database starts with a **JOB** record, which defines the job's name, and continues with records within that job stored in the order they were generated.

The SDR database can contain many different types of records depending on the particular SDR33 software you have installed and the option that produced the record.

✉ **Note:** For more information on SDR RTK and SDR SK, see the appropriate software manual.

Different record types can help you find a specific record or track down an error or blunder. For more information on specific record types, see Appendix B, *Database Records*.

It is not possible to alter data once it has been stored, except for code fields and note records. Because code fields and note records are not used for calculations, you can edit them.

33.1 Viewing the Database

You can view the SDR database at any time by pressing <**View**>. Each line corresponds to one record in the database. Each record in the database displays the record type, the derivation code (which indicates which part of the program generated the record) and the first data field of the record.

New records are added to the end of the database so record order is chronological. The only exceptions are note records which can be added anywhere in the database while viewing the database. A note record is entered in the database immediately before the record that is currently highlighted. For more information on inputting note records, see Section 3.5.5, *Notes,* page 3-19.

When the database screen is first accessed, the most recent record is highlighted. The <↑> and <↓> keys move the highlight bar forward or backward one record at a time. After you have located the desired record, press <**Enter**> or <→>to view the record details. Press **<←>** to return to the database list to search or view more records. Press <**Clear**> at any time to exit the database review.

Several softkeys are available in review mode:

<SRCH> ...... This softkey enables you to search backward or forward for a particular point name or feature code.

<PREV>....... This softkey moves you to the previous occurrence of the currently highlighted record type. For example, if a station (STN) record is highlighted, pressing **<PREV>** moves the highlight bar to the previous station in the database.

<NEXT>....... This softkey moves you to the next occurrence of the record type you have currently highlighted.

<PGUP> ...... This softkey moves you up a full screen (8 lines).

<PGDN> ..... This softkey moves you down a full screen (8 lines).

33.1.1 Searching by point or feature code

After accessing the database with the <**View**> key, you can search the database for records containing a particular point ID or feature code.

Steps to search for a specific point ID or code

1. Press the **<SRCH>** softkey to display the Database Search screen.
2. Enter the point name in the ***Pt*** field and / or the code in the ***Code*** field.

✉ **Note**: If both a point name and a code are entered, the SDR33 first looks for point name matches. If none are found, then it searches for code matches.

3. Press **<PREV>** or **<OK>** to search backward or **<NEXT>** to search forward chronologically. The first matching record is highlighted. You can open the found record or repeat the steps to continue your search.

If no matches are found, a message, “Search failed,” displays.

33.1.2 Opening a record for viewing

You can open any record displayed in the database list to view the stored information. However, you can only edit code fields and notes.

Steps to open a record

1. Press the <**View**> key to access the database.
2. Highlight the record you wish to view and press <→> or <**Enter**> to open the record.
3. If more fields are available for this record, an arrow will display in the last field. To view these fields, press <→>.

4. Use the <**EDIT**> softkey to edit notes and codes.

5. The <↑> and <↓> keys open the next adjacent record in the indicated direction.

6. To return to the database list, press <**Clear**>, <**OK**> or <←>. You can exit the database review by pressing <**Clear**> or <**OK**> from the database list.

33.1.3 Editing notes and codes

Most of the information stored in the database records is not available for editing; however, you can modify codes fields or notes with the exception of program-generated notes such as Traverse closure information.

Steps to edit a record

1. Press the <**View**> key to access the database.

2. Highlight the record to be edited and press <**Enter**>.

3. If the ***Cd*** field is not visible, press <→> to move to the next screen of data that contains the ***Cd*** field, or press the <**EDIT**> softkey to move directly to the ***Cd*** field.

4. Modify the code field or note.

5. Press **<OK>** when you are finished editing. Press **<Clear>** to return to the records being viewed.

33.1.4 Reviewing observation records in the database

When you access an observation record, OBS, the SDR33 displays the observation values.

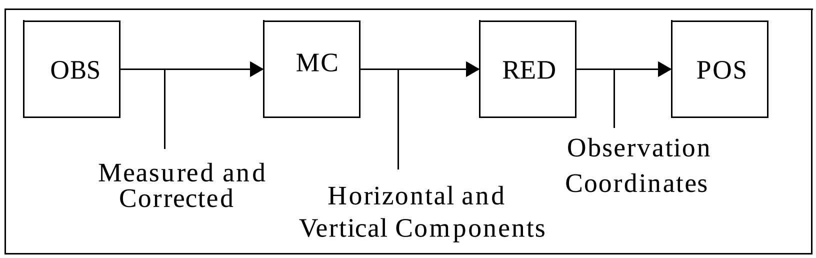
Data shown in an OBS screen has the prism constant (if applied by the SDR33 for the instrument selected) and atmospheric corrections applied. No other corrections, such as instrument/target height, curvature and refraction are applied. If you have applied a transformation to your job, see Section 33.1.5, *Reviewing records with transformation reduction*, page 33-7, for more information.

The last 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 by the ***Topo view stored*** option under the ***CNFG*** (Configure Reading) menu. So when you take an observation and 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 SDR33), atmospheric, curvature and refraction corrections.

<**RED**>......... (reduced) The RED view shows you the observation reduced to its horizontal and vertical components with the sea level correction applied where applicable.

<**POS**> .... (position) The **POS** view shows the observation coordinates relative to the station from which it was observed.



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 the **<RED>** key, the **<EDIT>** softkey changes to **<SAVE>**. Pressing this key will save the view. (The **<SAVE>** softkey will be removed, confirming 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 SDR33 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 SDR33 as a position record. You can change the view back to raw **OBS** at any time.

✉ **Note**: The SDR33 does not permit you to view a backsight observation as anything other than an **OBS**. This avoids problems caused by re coordinating a backsight point.

When you transmit job data, you can transmit observation records in more than one view. Observation records are set to transmit in current view as a default. Use the **<OPTNS>** softkey 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. See Section 34.3.3, *Specifying the format of observations*, page 34-10.

✉ **Note**: The ability to store observations in raw **OBS** view or **POS** view has useful implications when combined with the SDR33's search rules for calculating coordinates. For example, you can store your observation to override or ignore particular observations after they have been sorted. If you feel an observation is especially accurate, store it in **POS** view. The SDR33 uses the **POS** observation view to calculate coordinates.

33.1.5 Reviewing records with transformation reduction

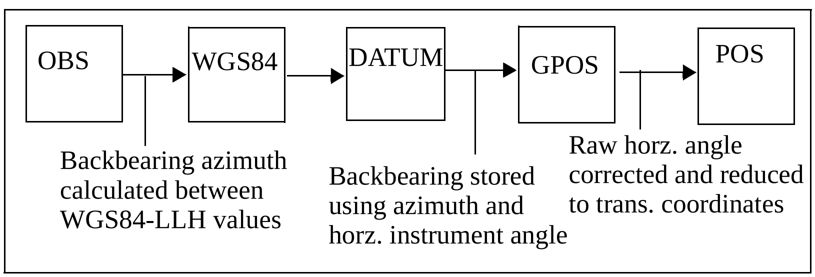
When you access an observation record and have selected a transformation for the current survey job, see Section 11.1, *Selecting Transformations*, page 11-1, your view options begin with the OBS record. Like view options with no transformation selected, see Section 33.1.4, *Reviewing observation records in the database*, page 33-4, this OBS record contains the prism constant (if applied), and applied atmospheric corrections. The last four softkeys at the bottom of the screen refer to different views of the observation.

WGS84......... This view shows the coordinates for the station and backbearing converted to WGS84 ellipsoidal coordinates. latitude, longitude, and height.

DATUM....... This view displays the station and backbearing as WGS84 latitude, longitude, and height.

GPOS........... (GPS position) record. This view is the position of the point before any calibration or has occurred

POS .... (position) The **POS** view shows the observation coordinates relative to the station from which it was observed.



You can store data in any of the views. When you look at the record again, it will be displayed in your selected view. When you press one of the softkeys, such as the **<GPOS>** key, the **<EDIT>** softkey changes to **<SAVE>**. Pressing this key will save the view. (The **<SAVE>** softkey will be removed, confirming the record is saved in **GPOS** view.)

✉ **Note:** If you have selected a transformation for the current survey job, the option to avoid a backsight observation will not be available. If a backbearing point does not exist when entered, the option to key in an azimuth will not be available.

33.2 Searching for Coordinates

If you want to find out what coordinates the SDR33 will use for a particular point name, use the manual entry option **Key in Coords** access from the **Keyboard Input** option in the ***Survey*** menu or the ***COGO*** menu. In the **Key in Coords** screen, specify the point name in the ***Pt*** field. The SDR33 then displays the point coordinates if they are known or can be calculated.

✉ **Note:** To avoid creating a POS record from this action, press <**Clear**> in the **Key in Coords** screen after you review the information.

33.3 Using Coordinate Search Logic

The SDR33 has a set of coordinate search logic it uses to organize records in a hierarchical structure. Different records possess different levels of importance within the SDR33 coordinate search logic “rules.” When searching the database, the SDR33 uses these rules to compute coordinates.

When the SDR33 searches for the coordinates of a point, it uses the latest information. The only exception to this rule is **POS** records**,** which are used before more recent **OBS** records.

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**, **MC** and **RED**) are equal in precedence to true **POS** (or **STN**) records in the coordinate search rules.

The SDR33 searches for the latest coordinates of the station point to calculate the target's coordinates from the observation.

Coordinates are:

- Station records (**STN**)
- Position records (**POS**)

Coordinates can be calculated from:

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

See Appendix B, *Database Records* for information on the records stored in the SDR database.

33.3.1 SDR search rules

When searching for the coordinates of a point, the SDR33 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 SDR33 uses POS, STN and POS view records before using OBS records even if the OBS record is more recent.

The SDR33 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 SDR33 finds a **POS**, or **STN** record, the coordinates are immediately available from that record. If however, the SDR33 finds a **POS** view record, it must reduce that record to coordinates.

Rule 3: If there are no applicable POS, STN, or POS view records, the SDR33 will use the most recent OBS, MC, or RED record. The record's view is no longer significant.

If the SDR33 finds an **OBS**, **MC**, or **RED** record in its search, it will reduce it to coordinates.

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

If the SDR33 cannot find any **POS**, **STN**, **POS** view, **OBS**, **MC**, or **RED** records for the point in question, the search fails and the SDR33 assigns **<Null>** coordinates. An aborted Set may leave **OBS** records on the database, but these **OBS** records are ignored in database searching. (For more information, see Section 15.2, *Traversing with Set Collection*, page 15-3.)

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 SDR33 can perform is limited. The search fails if the SDR33 has to coordinate more than 25 points before it can coordinate the original point in question.

33.3.2 Applying coordinate search rules

The SDR33 search rules have useful results. Understanding the search rules will help you determine the best way to use the SDR33 to solve surveying problems.

Example 1

When setting up on a new station, just enter the point name. The SDR33 finds the coordinates automatically and calculates them if there is one 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.

✉ **Note**: The sideshots are adjusted by the difference between the original coordinates and the new coordinates only. The backsight azimuth is not recalculated.

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 SDR33'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 **Overwrite** option stores the observation in **POS** view, whereas the **Check only** option stores it in a Note. 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 SDR33 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 SDR33 will use the later station information to calculate the corrected coordinates of all the topo points during comms output. The observations do not have to be edited in the office.

✉ **Note**: **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.

Note: If you use **<View>** to search for a point, you see the most recent record defining it. To see the coordinates of a point that the SDR33 will use for calculation, use the ***Keyboard Input*** option and enter the desired point's number and name. The coordinate values appear as defaults. Press **<Clear>** to exit without storing a new record.

Chapter 34 Communications

In this chapter

- Communications hardware
- Printing data
- Transmitting data to a computer
- Receiving computer data
- Setting communications parameters
- Specifying formats for printing or transmitting
- Using a modem
- Binary file transfers

You can print or transfer data from the SDR33 to a personal computer by serial cable or by modem. Using the **Communications** option, you can send and receive SDR jobs, templates, and roads.

Establishing communications between your SDR33 and a personal computer is a simple process. You can transfer data files from your SDR33 to a PC either by connecting a serial cable from the SDR33 to the PC, or with a modem--enabling you to send SDR jobs to the office immediately.

34.1 Communications Hardware and Parameters

When transferring data to or from a personal computer, the SDR33 uses a serial connection. (If necessary use an adapter plug to connect the serial cable to your personal computer.) You can use either the top or bottom port depending on the selection in the Communication screen.

The SDR33's top port is supplied with a serial cable that ends in a Hirose connector. Use this connector to attach directly to many surveying instruments, including Sokkia products. Also supplied is a DB9 to Hirose adapter. This connector is suitable for connecting the SDR33 to a personal computer or serial printer. If you have an AT style computer with a 25 pin serial port, you need to attach a 25 pin to 9 pin adapter (available from any computer shop).

If you are using a generic communications program to communicate with the SDR33, set communications parameters in the program and the SDR33 to:

Baud rate 1200

Flow Control .... Xon / Xoff

Data bit....................... 8

Stop bits 1

Parity........................... None

Parity check .... Off

Carrier detect............. Off

34.1.1 Setting SDR communication parameters

The SDR33 communicates with external devices with the top or bottom serial port. Parameters must be set in the SDR33 to ensure proper communication. The SDR33's top serial port is a small, round Hirose connector. The SDR33's bottom port is a DB25 pin connector. Use either connector, if available, to attach directly to a personal computer or serial printer.

When communicating with the SDR33, review and change the communications parameters in the communications program and the SDR33 to the following:

Baud rate .... Ensure consistent rates on the SDR33 and the PC or device.

Flow Control .... Xon / Xoff

Data bit.......................8

Stop bits 1

Parity...........................None

Parity check ....Off

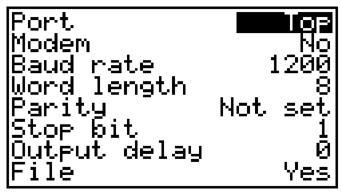
Carrier detect............Off

The communications parameters chosen for your personal computer must match those of the SDR33. You can change the communication parameters using the <**COM**> softkey from the ***Communications*** screen.

Steps for setting SDR communication parameters

1. Select **Communications** from the ***Functions*** menu.

2. Press the **<COM>** softkey. The SDR33 will display the Communications Parameters screen. Use this screen to set the communications parameters for your communications session.



Port.............. This field specifies which serial port is being used. Other documentation may refer to the communication ports as **COM2** and **COM1** rather than “Top” or “Bottom,” respectively. When looking at the SDR33 screen, the port at the top left of the device is **COM2**, and the port at the bottom of the device (under the cover, next to the charger socket) is **COM1**.

✉ **Note:** This field selects the port for communications with a computer only. Always use the top (**COM2**) port for communication with instrument.

Modem .... This field specifies modem use. An extra screen appears whenever any communications are initiated (see Section 34.4, *Using a Modem*, page 34-11).

Baud rate .... This field specifies the speed that characters are sent along the serial line. The baud rate is to the number of bits sent per second; there are typically 10 bits transmitted for each byte or character. For example, 9,600 baud means 960 bytes per second. Available baud rates are: **300; 600; 1,200; 2,400; 4,800; 9,600; 19,200** and **38,400**.

✉ **Note**: The same baud rate must be selected on both the SDR33 and the computer or printer connected to it.

✉ **Note**: This field controls the baud rate for communications with a computer. The baud rate for communications with an instrument is set automatically and depends on the instrument.

Word length.......... This field specifies the number of data bits in each character transmitted or received. The available options are **7** and **8**.

Parity...................... This field specifies the type of parity bit added to each character during sending or checked on each character during 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 bits .... This field specifies the number of stop bits transmitted after each character. The options are **1** and **2**.

Output delay .... This option gives support for serial printers with little or no buffering. When this field is nonzero, it causes any output to pause for the number of milliseconds specified before sending each byte. For example, specifying 10 in this field will cause the SDR33 to pause for 10 milliseconds before it sends each character in the output file.

File......................... This option copies the job to the SDR33 memory and will not send data through the com ports. The stored data can then be used by user programs.

3. Press the **<Enter>** or **<OK>** key to save your settings.

34.1.2 Assessing transmission problems

When transmitting data, the SDR33 responds to both hardware and software flow control. The receiving computer may periodically use either or both of these techniques to slow the SDR33's communications. If this happens, either the "Xon / Xoff Detected" (software control) or "CTS / RTS" Detected (hardware control) messages might display. If these messages do not disappear within a few seconds, the receiving computer may have stopped or become confused. Press **<Clear>** to resume transmission. To abort transmission and begin again (perhaps at a lower baud rate), press **<Clear>** twice.

34.2 Printing Data

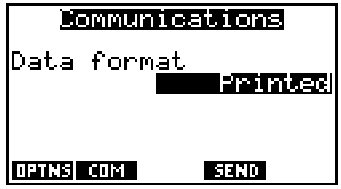
You can print data directly from the SDR33 by connecting it to a printer via the top or bottom serial port.

☒ **Note**: The printer must be set to the same baud rate and parity as the SDR33 for the printout to work properly (see Section 34.1.1, *Setting SDR communication parameters*, page 34-2.)

Steps to print data

1. Select **Communications** from the ***Functions*** menu.

2. Select the **Printed** option in the ***data format*** field.



The softkeys access the following options:

<OPTNS>.... This softkey displays the ***Send Records In*** screen. For more information on transferring observation types, see Section 33.1.4, *Reviewing observation records in the database*, page 33-4.

<COM> .... This softkey displays the Communications parameters screen. For more information, see Section 34.1.1, *Setting SDR communication parameters*, page 34-2.

<SEND>...... This softkey initiates the transfer of data.

3. Press the **<SEND>** softkey to select your data.

4. Choose ***Select jobs***, ***Select roads***, or ***Select template*** and set the each job, road or template you want to print to **Yes**. To print all jobs in the SDR33, choose either ***Select all data*** or ***Select jobs*** and then press the **<ALL>** softkey.

5. Make sure your serial printer is connected and ready, and press the **<OK>** key.

The SDR33 sends a formatted report to the printer and starts a new page for each job.

```
SDR V04-40             Software (C) Point, Inc.   06-Oct-99  10:00
                       Angle DegreesDist Feet     Press Inch Hg
                       Temp Farenht               Coord N-E-Elev
JOB                    7          Point id Numeric(4)

Atmos crn  No          C and R crn NoRefract const 0.14
                       Record elev YesSea level crn No
SCALE                  Scale 1.00000000
NOTE TS                06-Jan-90  14:26
POS KI 1000             North 0.000East 0.000     Elev 0.000
                       Code 0
NOTE                   ABCDEFG
INSTRUMENT             SET        EDM  <No text>EDM serial 97342
                       Theo desc<No text>Theo serial000000     Mount Not applic
                       V.obs ZenithEDM o.s  <Null>Refl o/s  <Null>
                       P.C. mm 0.000
STN TP 0005            North 0.000East 0.000      Elev 0.000
                       Theo ht 0.000
RED KI 0005-0001       Azimuth 0-00'00"H.dist  <Null>  V.Dist  <Null>
                       Code 0
SET SC 0005            Set  # 1   Point count 4
TARGET                 Target ht  0.000
OBS F1 0005-0001       S.Dist 100.000V.obs 90-00'00"H.obs 0-00'00"
POS TP                 North 100.000East 0.000  Elev 0.000
OBS F1 0005-0002       S.Dist 100.000V.obs 90-00'00"H.obs90-00'00"
POS TP 0002            North 0.000East 100.000  Elev 0.000
NOTE TL                EDM tol. error:Pt : 0002  0.050
OBS F2 0005-0002       S.Dist 100.100V.obs 270-01'00" H.obs 270-01'00"
POS TP 0002            North -0.029East 100.100 Elev 0.029
OBS F2 0005-0001       S.Dist 100.000V.obs 270-00'00"H.obs 180-00'00"
POS TP 0001            North 100.000East 0.000  Elev 0.000
BKB TP 0005-0001       Azimuth 0-00'00"H.obs 0-00'00"
OBS F1 0005-0001       S.Dist <Null>V.obs <Null>  H.obs 0-00'00"
```

34.3 Transferring Data Files

You can connect an SDR33 directly to a personal computer to send and receive data files. These capabilities are accessed by selecting **Communications** from the ***Functions*** menu and using one of a variety of communications software.

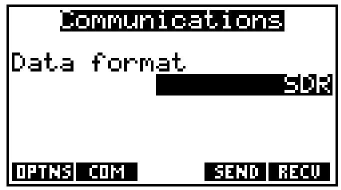
34.3.1 Sending data to a computer

You can send your SDR job files and observational data from the SDR33 to a personal computer.

Steps to send data to a personal computer

1. Select **Communications** from the ***Functions*** menu.

2. Select **SDR** in the ***data format*** field.



The softkeys access the following options:

<OPTNS>.... This softkey displays the ***Send Records In*** screen. see Section 33.1.4, *Reviewing observation records in the database*, page 33-4.

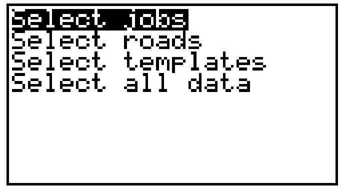
<COM> .... This softkey displays the ***Communications Options*** screen. For more information, see Section 34.1.1, *Setting SDR communication parameters*, page 34-2.

<SEND> ...... This softkey enables the designation of jobs to be sent.

<RECV> ...... This softkey initiates the data reception.

3. Press the **<SEND>** softkey to select your data.

4. Choose ***Select jobs***, ***Select roads*** or ***Select templates*** and set the value of each job, road or template you wish to send to **Yes**. To send all jobs or data in your SDR33, choose ***Select all data*** and then press the **<ALL>** softkey.



5. Make sure your receiving computer is connected and ready. Then, press **<OK>**.

6. The SDR33 sends the selected jobs to the computer. During transmission, a status message displays.

Note: The computer must be set to the same baud rate and parity as the SDR33 for the transmission to work properly. (See Section 34.1.1, *Setting SDR communication parameters*, page 34-2.)

34.3.2 Receiving data files from a computer

You can transfer files from a personal computer to the SDR33. You can transfer SDR job files, feature code lists and roading templates to the SDR33.

Steps to receive data from a personal computer

1. Select **Communications** from the ***Functions*** menu.

1. Select **SDR** in the ***Data format*** field.

2. Press the **<RECV>** softkey. The SDR33 will display a message, “Waiting for input.”

3. Start the communications program you have chosen for your personal computer and begin transmitting jobs from there.

34.3.3 Specifying the format of observations

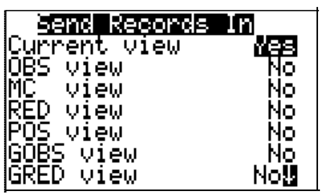
Observation records in the SDR database can be printed and transmitted in the same ways that they can be viewed (see Section 33.1.4, *Reviewing observation records in the database*, page 33-4).

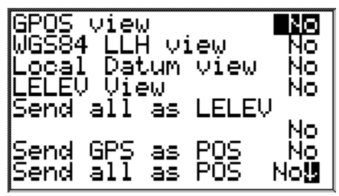
Steps to specify observation formats

1. Select **Communications** from the ***Functions*** menu.

2. Select ***SDR*** in the ***data format*** field.

3. Press the **<OPTNS>** softkey to display the ***Send Records In*** screen.





4. Select the views you want by setting each view to **Yes**. The current view is the view 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 SDR33 transmits 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 SDR33 will transmit a raw observation record followed by a position record.

Send partial job

You can use the **Send partial job** option presented here to indicate that you only wish to send a portion of a job. If you set this option to **Yes** then, whenever you use any output options, you will be given the opportunity to send only part of a job.

After you press any key you will automatically enter data review (as if you had pressed the **<View>** key) allowing you to move through the job data to the position from which you wish to start sending the data. Select <**OK**> to be prompted where to end the output of the file. Use the standard viewing facilities, as covered in Chapter 33, *The SDR Database*. When you press **<OK>**, the data will be sent from (and including) the currently highlighted record.

Send all as POS

Setting the **Send all as POS** option to **Yes** allows you to output job data in the ***Printed output*** or ***Comms output*** options which contains only **POS** records for the points in the selected job(s). The output files obtained using this option have all the points in the job(s) output only as **POS** records with each point output just once and only the latest coordinates for each point used. This differs from the output obtained by setting the **POS** view to **Yes**, where station (**STN**) records, back bearing (**BKB**) records etc. are still sent, but all the observation (**OBS** or **MC**) and reduced (**RED**) records are output as **POS** records.

34.4 Using a Modem

The SDR33 supports the use of Hayes-compatible modems. The SDR33 initializes the modem and uses it to dial the necessary numbers for you to contact a personal computer.

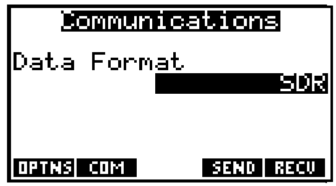
Steps to using a modem

1. Connect the modem to the SDR33 using the modem port in the top of the SDR33.

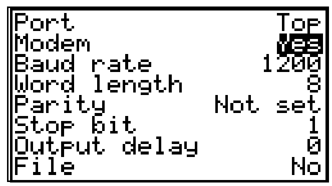
✉ **Note**: You will need to remove the top cap of the SDR33 to access the modem port.

2. Select **Communications** from the ***Functions*** menu.

3. In the ***Data format*** field, select any data format to send or receive.

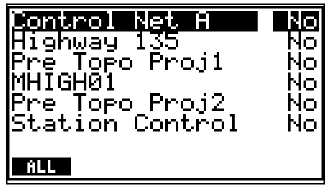


4. Press the **<COM>** softkey to access the ***Communications Parameters*** screen. Select the modem by toggling the field to **Yes**.



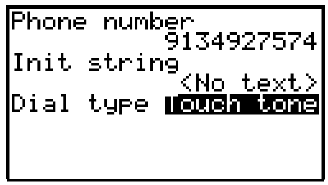
5. Press **<OK>**; the ***Communications*** screen will display again.

6. Press the **<SEND>** softkey and select a job(s) to send entering **Yes** next to the job name.



To select all jobs or data in your SDR33, press the **<ALL>** softkey.

7. Press **<OK>**; the Modem Parameters screen displays.



Enter information in the following fields:

Phone number...... This field specifies the phone number to dial.

You can use a comma or the letter **W** in the phone number to prompt the modem to wait for a dial tone. For example, if your PABX requires a **1** to connect to an outside line, you can enter “1W9134927574.”

Init string .... This field specifies the initialization string that will be sent to the modem. Editing this field can cause communications errors. The meanings of the various codes are described in your modem manual.

Some special characters used in modem initialization sequences (such as &,;,?, etc.) do not appear on the SDR33 keyboard. These can be entered using the **<FUNC>** key.

Dial type................ This field tells the SDR33 whether the phone system uses pulse dialing or touch-tone dialing.

8. Press **<OK>** to initialize the modem, dial the number, and begin communication.

✉ **Note:** When sending to the modem, the SDR33 may display “CTS/DSR detected” on the bottom line. This message has no effect on the data transfer and should be ignored. To eliminate the message, you can use a null modem cable connected from the bottom port of the SDR33 to the modem.

When the communication session is over, the receiving personal computer may send a message to indicate whether the transmission was successful. This message displays on the SDR33's screen so you do not have to make a separate phone call to check validity. The message consists of normal ASCII text, ending with a carriage return character.

✉ **Note**: The bottom port has more lines connected than the top port, try it if you have problems.

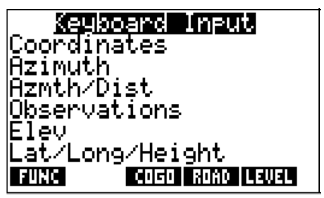
Chapter 35 Operating with Keyboard Input

In this chapter

- Entering coordinates
- Entering azimuths
- Entering azimuths with distances
- Entering observations
- Entering Latitude, Longitude and Height
- Entering known elevations

Using the ***Keyboard Input*** option, you can enter information about a point and store it in the SDR database without ever observing the point. This option is useful when setting up control jobs, initiating a new station, or setting out coordinates. Points entered with the **Keyboard Input** option are added to the end of the database.

This option is available by selecting **Keyboard Input** from the ***Survey*** menu. You can enter five types of records using the ***Keyboard input*** option.

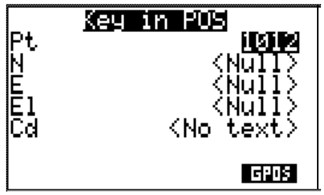


35.1 Entering Known Coordinates

You can manually input coordinates for new or existing POS records by selecting **Coordinates** from the ***Keyboard Input*** screen. If you enter coordinates for an existing point, those coordinates will override any pre-existing POS record coordinates. If the point exists in any other record format, the new POS record coordinates for that point will be established as the preferred coordinates for that point

Steps to manually input coordinates

1. Select **Coordinates** from the ***Keyboard Input*** screen. The ***Key in POS*** screen will display.



2. Enter information in the following fields:

Pt.................. Enter the point name in this field.

N .... If the point exists, this field provides the Northing coordinate. If you entered a new point name, you must enter a value for this field.

E.................... If the point exists, this field provides the Easting coordinate. If you entered a new point name, you must enter a value for this field.

El.................. If the point exists, this field provides the Elevation. If you entered a new point name, you must enter a value for this field.

Cd .... If the point exists, this field provides any entries in the ***Code*** field. If you entered a new point name, you can enter a code in this field.

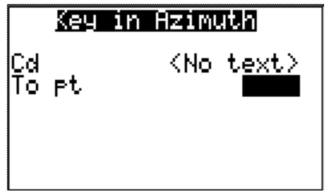
Press the **<OK>** key to add a position record with the **KI** derivation code to the database.

35.2 Entering Known Azimuths

You can use the Key in Azimuth function to define a point by supplying the known direction to that point from a specified point

Steps to manually input an azimuth.

1. Select **Azimuth** from the ***Keyboard Input*** screen. The ***Key in Azimuth*** screen will display



✉ **Note:** As you key in acceptable values for the first two fields, the ***From*** and ***Azimuth*** fields will display beneath the initial fields. If you fail to enter an acceptable value for a field, an error message will display.

2. Enter information in the following fields:

Cd .... This field enables you to assign a code to the record.

To pt .... Enter a new or existing target point name in this field.

from............. Enter a new or existing source point name in the field.

Azimuth ...... If the To and From points are pre-existing, the azimuth will be calculated and displayed in this field. If not, enter the azimuth value in the field.

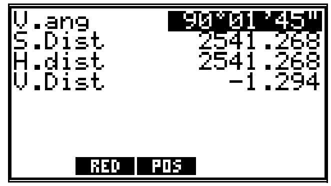
Press **<OK>** to store the azimuth between the target and source points as a **RED** record in the database.

35.3 Entering Known Azimuths with Distance

You can use the ***Key in Azmth / Dist*** screen to define a point by supplying the known direction and distance to it from a specified point.

Steps to manually input Azimuth/Distance

1. Select **Azmth/Dist** from the ***Keyboard Input*** screen. The ***Key in Azmth/Dist*** screen will display.



2. Enter information in the following fields:

✉ **Note:** As you key in acceptable values for the available fields, additional fields will display beneath the initial fields. If you fail to enter an acceptable value for a field, an error message will display.

Cd .... This field enables you to assign a code to the record.

To pt .... Enter a new or existing target point name in the field.

From .... Enter a new or existing source point name in the field.

Azimuth ...... If they To and From points are pre-existing, the azimuth will be calculated and displayed in this field. If not, enter the azimuth value in the field.

V. ang .... Enter the vertical angle in the field.

S. Dist .... Enter the slope distance in the field.

H. dist .... Enter the horizontal distance in the field.

V. Dist .... Enter the vertical distance in the field.

✉ **Note**: When you enter a value in the V. ang or S. Dist fields on the second screen, two of the other fields may be updated. The SDR33 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**. Verify that all fields have been calculated before selecting <**OK**> to ensure that all fields of the RED record are stored.

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

<RED>......... Use this softkey or press **<OK>** to store azimuth and distance data in the database as a **RED** record in **RED** view.

<POS>......... The **RED** record will be stored in **POS** view (making that record the preferred data for that point. See Section 33.3, *Using Coordinate Search Logic*, page 33-8).

35.4 Entering Known Observations

Use the **Key in Obsvn** option to enter a point with a OBS record. The vector is supplied from a specified point to the new point.

35.5 Entering GPS Observations

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

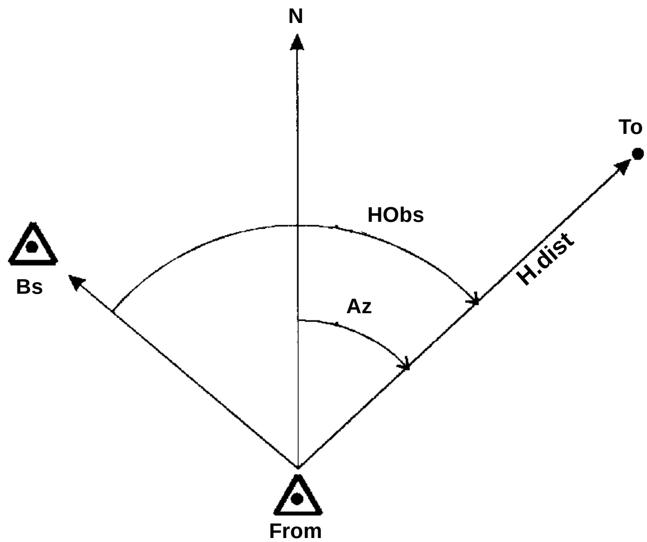
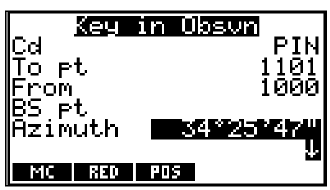
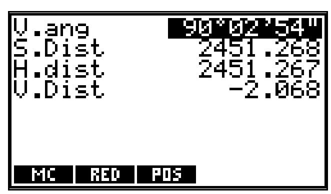


Figure 35-1: Backsight point

Steps to manually input an observation

1. Select **Key in Obsvn** from the ***Keyboard Input*** screen. The ***Key in Obsvn*** screen will display.





2. Enter point information in the following fields:

Cd .... This field enables you to assign a code to the record.

To pt .... Enter the target point name in the field.

From .... Enter the source point name in the field.

BS pt............ If you have a known backsight point, enter the point name in the ***BS pt*** field and press **<Enter>** or **<OK>**. The SDR33 displays the observation information. If no known coordinates exist, leave the field blank.

H.obs........... **If you enter a known backsight point,** The ***H. obs*** field replaces the ***Azimuth*** field. Enter the horizontal angle in the ***H.obs*** field. Go to the second screen and enter values for ***V. ang***, ***S. dist, H. dist*** and ***V. dist*** as before.

Azimuth ...... Enter the azimuth value in the field.

V. Ang .... Enter the vertical angle in the field.

S. Dist .... Enter the slope distance in the field.

H. Dist .... Enter the horizontal distance in the field.

V. Dist .... Enter the vertical distance in the field.

✉ **Note**: When you enter a value in the V. Ang, S. Dist, H. Dist or V.Dist field, two of the other fields may be updated. The SDR33 uses the two most recently entered values to determine the remaining two.

---

3. When all distances and azimuths are correctly entered, use the available softkeys to store the information. For more information on records and views, see Section 33.1.4, *Reviewing observation records in the database*, page 33-4.

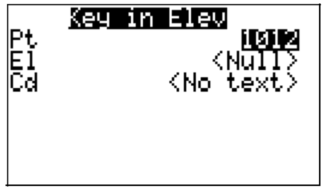
<MC>........... This softkey or the **<OK>** key stores an MC record in **MC** view in the database.

<RED> .... This softkey stores an MC record in **RED** view in the database.

<POS> .... This softkey stores an MC record in **POS** view in the database.

35.6 Entering Known Elevations

You can enter a known elevation using the ***Key in Elev*** option.



Enter information in the following fields:

Pt.................. Enter a point name in this field.

El.................. Enter an elevation value in this field.

Cd .... Enter a feature code, if desired, in this field.

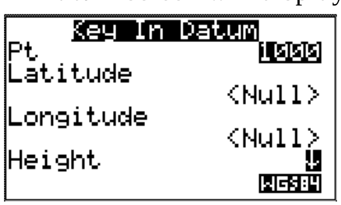
Press the **<OK>** key when the values are correct. The SDR33 will store an LElev record in the database. However, this LElev record will contain only an elevation value; no northing or easting information is included in the record.

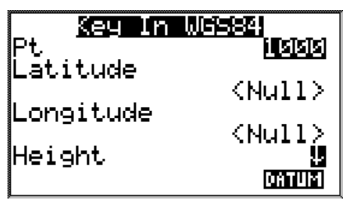
35.7 Entering Latitude, Longitude and Height

The key in options for local datum latitude, longitude, and height values are combined with the option to key in WGS84 values.

Steps to manually input latitude/longitude height values

1. Select **Lat/Long/Height** from the ***Keyboard Input*** screen. The ***Key In Datum*** screen will display.





Note: The **<WGS84>** and **<DATUM>** softkeys act as a toggle between the ***Datum*** and ***WGS84*** screens.

Enter Information into the following fields:

Latitude .... Enter a value in this field for latitude (positive north and negative south). For example, to enter 37°25’42.0000N, type **37** + **<.>** + **25** + **<FUNC>** + **<.>** + **42**.

Note: The **<.>** in the above example represents the period key on the SDR33 keypad.

Longitude.... Enter a value in this field for longitude (positive east and negative west).

Height.......... Enter a height value in this field.

Cd .... Enter a feature code, if desired, in this field.

2. When finished press **<OK>** to store the entered values The SDR33 will store the keyed in values as either a Datum KI or WGS84 KI record. See Section Appendix B, *Database Records*, page Appendix B-1.

Chapter 36 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 a method of describing each observed point with an alphanumeric code. Feature codes are contained within Feature Code Lists on the SDR33. You can add, modify or delete codes from the list and maintain multiple lists of feature codes.

Also, the SDR33 can collect attribute data with feature codes. Attributes are characteristics associated with a specific feature code. For example, you can create a feature code of “tree” with attributes of “type” and “size.” The SDR33 would prompt you to enter the type and size of the tree whenever you use the feature code, “tree.” Feature codes and attributes can help you collect meaningful survey data directly associated with the specific point.

The **Feature Code List** option in the ***Functions*** menu enables you to define feature code lists. You can create multiple feature code lists on the SDR33 with associated attributes. You may want to create several different types of feature code lists for separate jobs.

To use the feature coding option, be sure to set the ***Code list active*** field to **Yes** in the ***Configure Reading*** screen when setting up your job. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

Whenever you are entering a feature code, 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 **<Enter>** or **<OK>**.

36.1 Managing Feature Code Lists

The SDR33 can access multiple lists of feature codes. Each list can be user-defined to provide a specialized set of feature codes in a specific order. Initially, the Feature Code list is named “Default List.” You can populate the Default List with all the feature codes you plan to use or you may want to create several lists for different purposes.

Note: The Default List is sorted alphanumerically, and the sorting properties cannot be changed.

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 currently selected list is Default List).

Press the **<LISTS>** softkey to access the management functions for lists. All the feature code lists available in the SDR33 are displayed. You can manage feature code lists by:

- Selecting a list
- Adding a new feature code list (**<ADD>** softkey)
- Deleting the highlighted feature code list (**<DEL>** softkey)
- Changing the list name (**<EDIT>** softkey)
- Checking list statistics (**<STAT>** softkey)

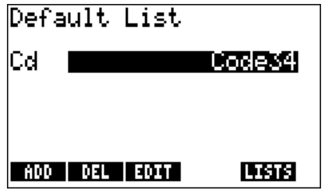
36.1.1 Selecting a feature code list

Selecting a feature code list provides feature codes during data collection. You can select different feature code lists in the same job. However, you can only use one feature code list at a time.

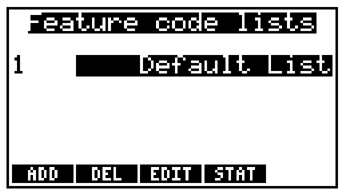
Note: If you do not want to be prompted with a Feature Code List during data collection, set the ***Code List Active*** field to **No** in the ***Configure Reading*** screen. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

Steps to select a feature code list

1. Select **Feature Code List** from the ***Functions*** menu. The currently selected feature code list and associated feature codes will display.



2. Press the <**LISTS**> softkey to access the management functions for lists.



3. Press the <↑> or <↓> keys to highlight the name of the library you want to select.

4. To select the library, press **<OK>**; the ***Feature Code*** screen will display and indicate the feature code list you have selected.

36.1.2 Adding a feature code list

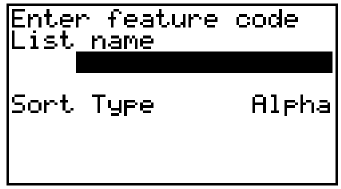
You can add as many feature code lists as required (limited only by available memory). You may want to create separate feature code lists for specific surveys.

Steps to add a feature code list

1. Choose **Feature Code List** from the ***Functions*** menu.

2. Press the **<LISTS>** softkey.

3. Press the **<ADD>** softkey.



4. Enter information in the following fields:

List Name.... This field indicates the Feature Code List name (up to 16 characters).

Sort Type..... This field indicates the sorting option for feature codes in the list. For an example of the different sort types, see Section 36.3, *Using Feature Codes*, page 36-10.

Alpha - As feature codes are enter 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.

5. Press **<OK>** to accept the list. For more information on adding feature codes to your new list, see Section 36.2.1, *Adding feature codes*, page 36-7.

36.1.3 Deleting a feature code list

You can delete a feature code list. All associated feature codes and attributes will be deleted with the feature code list.

Steps to delete a feature code list

1. Choose **Feature Code List** from the ***Functions*** menu.
2. Press the **<LISTS>** softkey.
3. Highlight the list to be deleted.
4. Press the **<DEL>** softkey.
5. The SDR33 will display a confirmation message. Select <**YES**> to delete or <**NO**> to cancel the operation.

36.1.4 Renaming a feature code list

You can rename any feature code list. Feature Code List names are limited to 16 characters.

Steps to rename a feature code list

1. Choose **Feature code list** from the ***Functions*** menu.
2. Press the **<LISTS>** softkey.
3. Highlight the list whose name will be changed.
4. Press the **<EDIT>** softkey.
5. Enter a name and press <**Enter**> to save the changes.

36.1.5 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.

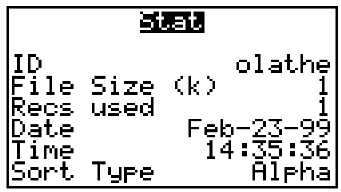
Steps to review feature code list statistics

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

2. Press the **<LISTS>** softkey.

3. Highlight the appropriate list.

4. Press the **<STAT>** softkey to review the feature code list statistics.



ID................. This field displays the name of the feature code list.

File Size....... This field displays the size of the feature code list in kilobytes.

Recs used .... This field displays how many records occur in the feature code list.

Date............. The date the feature code list was created.

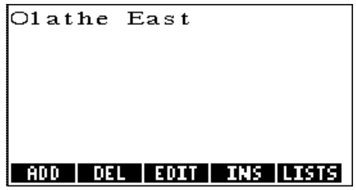
Time .... The time the feature code list was created.

Sort Type..... This field displays the sorting option. For more information, see Section 36.1.2, *Adding a feature code list*, page 36-3.

5. Press **<Clear>** to exit the ***Stat*** screen.

36.2 Managing Feature Codes in a List

A newly created list contains no feature codes. You must add them one at a time. After you finish defining a feature code list, your SDR33 screen will display the Feature Code List screen.



You can manage feature code lists with the following softkeys:

<ADD>........ This softkey adds feature codes to the list to the end of the list.

<DEL> .... This softkey deletes the feature code currently highlighted.

<EDIT>........ This softkey accesses a screen in which the feature code properties can be edited.

<INS> .... (*available on user-sorted lists only*) This softkey inserts a feature code before the currently highlighted code.

<LISTS>...... This softkey displays a list of all feature code lists residing in the SDR33 (see Section 36.1, *Managing Feature Code Lists*, page 36-2).

36.2.1 Adding feature codes

You can add feature codes to a new or established feature code list.

Steps to add feature codes

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

2. The SDR33 provides two methods of adding feature codes to a list, depending on the desired location of the feature code in the list. Select the method that best suits your desired workflow.

Press the **<ADD>** softkey to display the ***Add feature code*** screen. The feature code will be added to the bottom of the list.

— OR —

Press the <**INS**> softkey to insert a feature code within the list. If the ***Sort Type*** is set to **User**, the feature code will be added at the highlighted insertion point. If the ***Sort Type*** is set to **Alpha**, the feature code will be inserted alphabetically.

Cd .... Enter the name of the new feature code.

Join .... The ***Join*** field determines whether points with this code are joined together as linework if the points are plotted.

Note: The SDR33 does not plot points. To use the ***Join*** field feature, you will need to export the SDR33 file and feature code library.

Attributes.... The ***Attributes*** field is used for user-defined attributes. For more information, see Section 36.4, *Defining Attributes*, page 36-12.

3. Press **<OK>** when the feature code definition is correct. The SDR33 will display the ***Feature Code List*** screen.

Note: If your Feature Code List is sorted alphabetically, feature codes will display in alphabetical order, regardless of how the feature codes were added.

36.2.2 Editing feature codes

Individual feature codes can be edited. You can change the name or the join status. Also, you can modify the assigned attributes. For more information, see Section 36.5, *Entering Attributes*, page 36-14.

Steps to edit feature codes

1. Choose **Feature code list** from the ***Functions*** menu.
2. Highlight the feature code to edit.
3. Press the **<EDIT>** softkey to display the ***Edit feature code*** screen.

4. Modify the necessary fields.
5. Press **<OK>** to save the edited feature code.

36.2.3 Deleting feature codes

You can delete feature codes from a list to simplify your workflow or to provide more available memory on your SDR33.

Steps to delete feature codes

1. Choose **Feature code list** from the ***Functions*** menu.
2. Highlight the feature code to delete.
3. Press the **<DEL>** softkey.

36.3 Using Feature Codes

The feature code list is always accessible when editing any ***Cd*** field during your survey if the **Code list** option is set to **Yes**. (You can set the **Code list** option in the ***Configure Reading*** screen. For more information, see Section 6.2.4, *Using Code fields*, page 6-11.) It is also accessible for ***Note*** fields, in this case, if the **Feature code insert** option is turned **On** in the ***Note*** screen. (Press the **<FC ON>** softkey to turn this option **On**. If the **<FC OFF>** softkey 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. The example lists are

Shawnee...... This list is user-sorted in the order in which the codes were just listed.

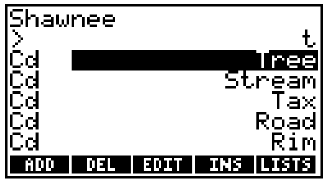
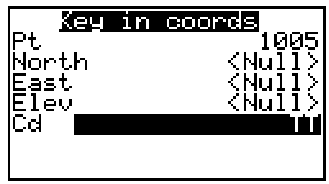
Olathe.......... This list is alpha sorted.

When performing a survey, you follow the steps as show in the following example.

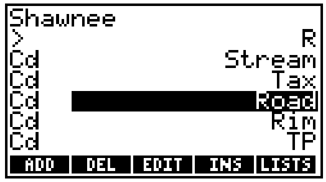
1. Make sure the **Code List Active** option is set to **Yes**. For more information, see Section 6.2, *Determining Configure Reading Parameters*, page 6-6.

2. Access a ***Cd*** (code) field or a note.

3. When typing in a code field or a note, SDR33 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.

Enter	**User-sorted list**	**Alpha-sorted list**
T (one letter)	 The SDR33 displays the first, occurring, feature code starting with the letter entered.	 The SDR33 displays the first, alphabetical, feature code with the letter entered.
TT (two identical letters)	 The SDR33 will display the next occurring feature code starting with the letter entered.	 The SDR33 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.

<table>
<tr><th>Enter</th><th>User-sorted list</th><th>Alpha-sorted list</th></tr>
<tr>
<td>TR

(two different letters)</td>
<td>

The SDR33 searches for a feature code containing the first letter entered and then a second feature code containing the second letter.</td>
<td>

The SDR33 looks for the first entry containing both letters entered.</td>
</tr>
</table>

4. When the appropriate feature code is highlighted, press **<Enter>** and the code will be entered into the code field or note in which you are working.

✉ **Note**: For information on using attributes, see Chapter 36, *Feature Codes and Attributes*.

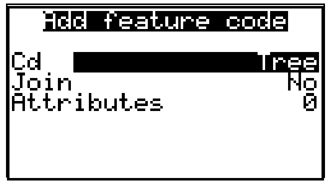
36.4 Defining Attributes

The SDR33 can collect attributes, specific information about a feature code. Attributes are optionally defined as part of the feature code definition. Each feature code can have up to five attributes. Each attribute can have a user-defined name and a type of Alpha or Numeric.

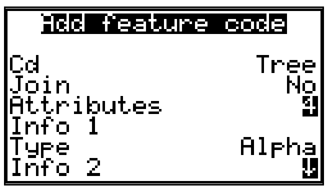
For example, you can create a feature code, “tree” and assign it several attributes: “type, “size” and “health.” When surveying, if you enter the feature code, “tree,” the SDR33 will prompt you to enter the type of tree, its size and the health. Attributes can aid you in collecting multiple types of information about surveyed points.

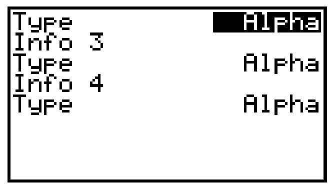
Steps to define attributes

1. When adding or editing a feature code, the ***Add feature code*** screen displays.



2. Enter the number of attributes required for this code into the ***Attributes*** field. Setting the number of attributes to 0 means that you will not be prompted for attributes when the feature code is used. The screen changes to display the same number of attributes as the number of attributes specified. Attributes have a default name of **Info #**.



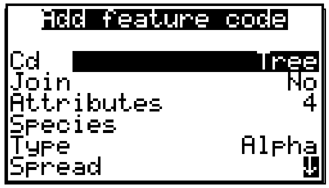


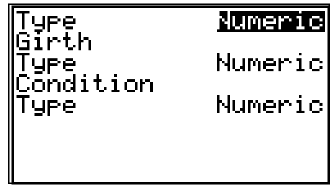
3. Highlight each attribute with a default name of ***"Info #"*** field and change the name to the attribute required — the names entered will display as prompts when a point is assigned this feature code.

4. Assign each attribute a type, **Alpha** or **Numeric,** using the <←> or <→> keys in the ***Type*** field.

   Alpha type attributes can be used to enter descriptive words (the type of tree) and may be up to 16 characters long.

Numeric types attributes can be used for collecting quantitative data (the height of a tree). Numeric attributes may be up to 10 digits long and limited to ±9999999. Three decimal places are displayed for numeric attributes.

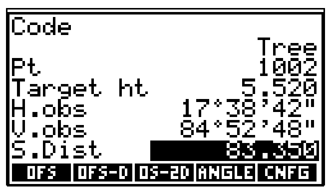




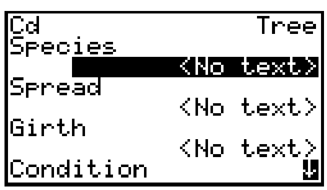
5. Press **<Enter>** to accept this definition. You can then define any other feature codes desired.

36.5 Entering Attributes

Attributes values are entered when taking observations with applicable feature codes. Enter the feature code name in the usual way, by locating the desired feature code by typing the first letter of the feature code. Review the selected feature code, if multiple feature codes with a letter exist, you may need to navigate to the correct feature code using the arrow keys or typing the next letter. Press **<Enter>** to accept the feature code.



When the instrument reading is completed, press **<Enter>** or the **<READ>** softkey as usual to store the reading. If a feature code has associated attributes, you will be prompted for them. Depending on the type of attribute, you may enter a descriptive word or a number.



Once the appropriate attributes have been entered for the point, press **<OK>**. The attributes are stored in separate Note records after the observation with a derivation code of AT (Attribute).

These notes can be printed or transferred to a personal computer to convert the notes and produce a file suitable for direct input into a GIS or other asset management system.

Chapter 37 Calculator

In this chapter

- Operation of the calculator
- Storing and recalling coordinates directly to and from the current job
- Use the special degrees-minutes-seconds angle calculations

The SDR33 calculator eliminates the need to carry a separate calculator in the field. Using the SDR database, you can transfer values from the database to the calculator, perform calculations and transfer the results directly back to the database. This interactivity reduces the amount of manual calculations and recording you need to do in the field. The SDR33 calculator works similarly to a HP (Hewlett-Packard) calculator, making many functions easy and intuitive.

Quick hints

- Press **<Func>+<C>** to pop up the calculator at any time.
- The calculator uses the same Reverse Polish Notation (RPN) found in most Hewlett-Packard calculators.
- Press <←> or <→> keys to show additional softkeys.
- Press **<Func>** to show alternate function softkeys.
- Use the **<RCLPT>** and **<STOPT>** softkeys to directly access points in the current job.
- To enter DMS angles, type the number then press the **<° ' “>** softkey.
- Press **<Clear>** to zero the X register value, and **<Clear>** again to exit.
- Press **<OK>** to exit and insert the X register value into any data entry field you may have been editing when the calculator was popped up.

All common computations can be done with the calculator. In addition, there is no need for tedious and error-prone entry of existing coordinates; the calculator can recall and store coordinates directly to and from the current job.

The calculator can be popped up at any time, ready for use. It is similar in operation to the older HP calculators, such as the 25, 29, 31, 32, 34, 11, 15 and 41 series. The calculator stack has four registers, X, Y, Z and T, which are all shown on the screen.

There are six memories, including two sigma (Σ) memories. Extra features include the ability to display proper degrees-minutes-seconds angles and access coordinates from the job.

37.1 Operating the Calculator

The calculator can be launched by pressing **<Func> + <C>** at any time or by choosing the **Calculator** option in the ***Functions*** menu. The **<F1>** to **<F5>** keys operate softkeys, and calculation functions. The **<Enter>** key acts the same as in a HP calculator, finishing entry of a number and pushing the stack. The <↑> and <↓> keys roll the stack up and down. The **<Clear>** key acts as CLX and zeros the X register value. If pressed twice, it exits the calculator.

The **<OK>** key also exits the calculator, but, in addition, places the calculator's X register value into the data entry field you were in when the calculator started. If the number in the X register is in numeric format, and the entry field is numeric (for example, a distance field) no conversion will take place. The number will be copied as is.

If the number in the X register is in angle format and the entry field is numeric, no value will be returned to the entry field. It is illegal to insert an angle into a numeric field (for example, 123°47'23" is not a valid distance).

If the X register is holding a decimal number and the data entry field is an angle field, the calculator will assume the number is in decimal degrees (DD.dddddd), convert it to DD.MMSS format, and put it into the data entry field. For example, 10.5000 in the X register will be converted to 10.300000 (10.5 degrees converts to 10 degrees, 30 minutes, 0 seconds).

If the X register has a number in DMS format (DD°MM'SS”), and the data entry field is an angle field, the number will be written to the data entry as DD.MMSS (e.g., 10°30'30” will be 10.3030).

The yellow +, =, x and ÷ keys (found on the SDR33's S, T, Y and Z keys) perform the usual arithmetic functions; you do not have to press the **<Func>** key first. The <←> and <→> keys switch between the three groups of function softkeys. In addition, pressing **<Func>** will show an alternate row of softkeys. These are arranged so they are the inverse of the normal function. For example, press **<F1>** for SIN, and **<Func>+<F1>** for ASIN.

Angle operation

When the angle unit is Degrees or Quadrant bearings, the SDR33 calculator displays angles in proper degrees-minutes-seconds format.

When keying in a DMS angle, press the special **<° ' “>** softkey to tell the SDR33 that this is DMS, and not just a decimal number. For example:

Display	Press	Result
0.0000	12.30 <° ' “>	12°30'00”

To switch display mode from DMS to a number or vice versa, press the **<↔DMS>** softkey (**<FUNC><° ' “>**). Note that the number is the same, but it is displayed in different forms. For example:

Display	Press	Result
12°30'00”	<↔DMS>	12.5000
12.5000	<↔DMS>	12°30'00”

Angles do not need to be converted to decimal numbers before calculations are performed. Similarly, numbers do not need to be converted to angles. The conversions are done automatically as required. For example:

Display	Press	Result
1°00'00”	2 +	3°00'00” and
30.0000	COS	0.86603

When the result of a function is an angle, it is automatically displayed in DMS form. For example:

Display	Press	Result
0.5000	ACOS	60°00'00”

37.2 Using the Calculator Memories

The six user memories are named 1 through 6. To store a number (or angle), press the **<STORE>** softkey and enter the memory number. To add, subtract, multiply or divide with a memory, press the **<STORE>** softkey, the +, =, x and ÷ key, then enter the memory number. To recall a memory, press the **<RCL>** softkey (**<FUNC>+<STORE>**) and enter the memory number.

Memories 5 and 6 are the sigma (Σ) memories. If they are non-zero, they are displayed on the top two lines. The **<Σ+>**, **<Σ->**, **<ΣRCL>** and **<ΣCLR>** softkeys operate on both these sigma memories at once. To clear all memories, including sigma memories, press **<CLRM>** (**<Func> + <LASTX>**). To clear just the sigma memories, press **<ΣCLR>** (**<FUNC>+<ΣRCL>**).

37.3 Accessing the Current Job

The SDR33's calculator performs math operations based on coordinates stored in job files. The **<RCLPT>** and **<STOPT>** softkeys enable you to move northing and easting values between the current job and the calculator stack. After pressing **<RCLPT>** you are prompted for a point number. If the point does not exist, you may key in the appropriate coordinates. The northing corresponds to the Y register on the stack and the easting to the X register. After pressing **<STOPT>** (**<FUNC>+<RCLPT>**) you are prompted for the point number, code and elevation before the point is stored in the job.

Useful applications for the calculator

- Unit conversions - for example, entering distances in chains from an old plan. Enter the conversion factor from chains to feet (or meters), and press <+>. Then exit and select ***Keyboard Input***. When prompted for the distance, press **<Func> + <C>**, then enter the distance in chains. Press the **<LASTX>** softkey to retrieve the conversion factor into the X register. Press <x>, then **<OK>** to convert the value and enter it into the distance field. A memory (numbers 1-6) can be used if this is a repetitive calculation.

- Calculating coordinates from a starting position and a series of azimuths and distances off a plan. Use **<RCLPT>** to get the starting position coordinates. Clear the sigma registers using the **<ΣCLR>** softkey then the **<Σ+>** softkey to add the coordinates into the sigma registers. Use the **<RECT>** softkey to convert entered azimuths and distances to rectangular ordinates, and **<Σ+>** softkey to sum the ordinates in the sigma registers. The **<ΣCLR>** softkey will retrieve the new coordinate values from the sigma registers and, if desired, the **<STOPT>** softkey can be used to save the computed point in the SDR's database.

Note: The SDR33 also carries out these computations automatically. When a series of azimuth and distance records are keyed in, the coordinates of any point in the series are calculated when needed. See Section Appendix D, *Observational Calculations*, page Appendix D-1 for more information.

Chapter 38 Measurement of Collimation Error

In this chapter

- Collimation error measurement

When using a total station instrument, you may need to measure collimation errors and correct for errors in observations. The SDR33 can calculate errors and include corrections in the job files.

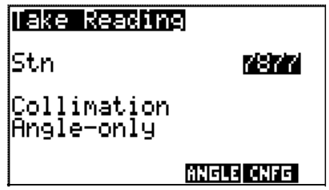
The **Collimation** option in the ***Survey*** menu lets you measure the collimation error in your instruments to correct subsequent single face observations. The error is measured by making angular observations using both faces of the instrument to one or many points. The minimum required data is a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

✉ **Note**: If no station has been setup in the current job, the SDR33 automatically displays the ***Station*** and ***Backsight*** screen. For more information, see Chapter 7, *Setting Up a Station and Backsight*.

Steps for completing collimation error measurement

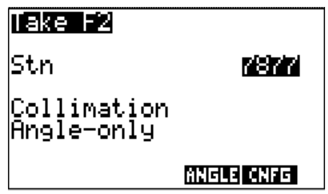
1. Choose **Collimation** from the ***Survey*** menu.

2. The SDR33 prompts you to sight the first point using Face 1 of your instrument.



3. Press **<READ>** or the **<ANGLE>** softkey to observe the point using Face 1.

4. The SDR33 prompts you to sight the same point using Face 2.



5. Press **<READ>** or the **<ANGLE>** softkey 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.

> **Note:** Observing two or more points with significant vertical separation will improve the result.

6. Press the **<OK>** key to see the calculated collimation error.

7. Press **<OK>** if you want to accept the result and store a collimation (**COL**) record in the database. Press **<Clear>** key to discard the results. The SDR33 will display a confirmation message.

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 2.6, *Collimation correction*, page Appendix D-7.

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

12

Appendices

This section is a complete reference to instrument settings, system messages and observation calculations. The Database Records Appendix lists all of the SDR database records and associated fields. You can also find an appendix about running a user program on the SDR33.

Instrument settings

- *Sokkia Instruments*
- *Non-Sokkia Instruments*

Database Records

Understanding Database Messages

System Messages

Observational Calculations

- *Correction Categories and Order of Application*
- *Instruments, Environmental and Job-Related Corrections*
- *Geometric Reductions*
- *Professional Positioning calculations*
- *Other Formulas*

User Program

- *Writing Your Own User Program*
- *Loading Programs into the SDR33*
- *Running a User Program on the SDR*
- *Deleting Programs from the SDR*
- *Disclaimer*

Appendix A Instrument settings

In this appendix

- Communication with instruments
- Sokkia and non-Sokkia instruments

The SDR33 supports a variety of instruments. When using Sokkia instruments with the SDR33, most instrument settings will already be established. If you are not using a Sokkia instrument, refer to your instrument's documentation for specific information.

A.1 Sokkia Instruments

When using the SDR33 with Sokkia theodolites and total stations, there are simple guidelines to store data correctly. There are also operational differences between two-way SETs and older instruments. This information is discussed in the following sections.

A.1.1 Single direction communication

Prior to creating a survey job, certain parameters must be set on the SDR33 and the instrument it communicates with.

Units

Both the SDR33 and the total station or theodolite must be set to the same measurement units (feet / meters, gons / degrees and vertical angle zenith / horizontal).

Prism constant

The prism constant should be set on *either* the SDR33 or the instrument, but *NOT* both. Otherwise, the correction is applied twice. If the prism constant is entered in the SDR33, a record of this will display in the printout.

PPM correction

PPM should be set *either* on the instrument or via SDR33 pressure and temperature entries at the station setup, but NOT both.

Tracking

The tracking mode on the instrument can be switched on or off; it does not affect the SDR33. However, if the SDR33 tracking parameter in the ***Configuration*** menu is set to **Yes**, the SDR33 does not stop the EDM after a distance measurement. If the instrument is set to a single EDM measurement, the tracking mode will not be available.

A.1.2 Two-way SETs

The two-way SETs have full two-way communications. Target height, backsight azimuth, temperature and pressure and other values can be manually entered. Avoid confusion about where to enter information by *entering all your survey information into the SDR33, not the SET.* The SDR33 creates a permanent record of your field work, sends this information to the SET and checks to make sure no data has been inadvertently changed.

The values such as the PPM and prism constant will be set the same in both the SDR33 and the SET, contrary to the instructions for non-two-way SETs. Configure the SET and SDR33 using the following parameters:

Parameter	**SET**	**SDR33**	**SDR33 location**
Baud rate	**1200** or **2400**	SDR33 will automatically detect setting	Comms
Parity	NO	set in SET	Comms
Checksum	**On** or **Off**	set in SET	N/A
Curvature and Refraction	set in SDR33	**On** or **Off**	Job Settings
Instrument		Two-way SET	Configure Reading

✉ **Note**: For information on setting parameters in the SET, refer to the SET documentation.

Steps for setting parameters on the SDR

1. Set up the SDR33 with the correct angles and distance units for your survey requirements.

2. In the ***Instrument*** screen, choose **Two-way SET**. If the SDR33 is connected, it immediately sends its serial number, vertical angle type and prism constant. The latter two settings may be changed if required.

3. Choose the orientation option required.

4. Set up on a station and take a backsight reading. The SDR33 sends all relevant unit settings and values to the SET and gives an **INSTR PARAMS SET** message.

5. On each subsequent reading, the units and PPM are checked.

A.2 Non-Sokkia Instruments

With all non-Sokkia instruments, it is recommended you enter corrections in the SDR33 rather than the instrument. By using this method, a record of corrections is maintained in the SDR database.

A.2.1 Geodimeter

The standard SDR33 (top) cable with a male DB25 connects to the female 25-pin connector on the Geodimeter's Y-cable. Plug the connector at the junction of the "Y" into the Geodimeter. You also can plug the remaining connector into an external battery pack.

When using a Geodimeter, you will need to select several settings on the SDR33, including:

- Instrument setting (***Func*** / **Instrument**)
- Prism constant (Set all parameters in the SDR33) (***Func*** / **Job Settings**)
- Serial number (***Func*** / **Hardware**)
- Atmospheric corrections (***Func*** / **Job Settings**)
- Vertical observation mode
- Units (***Func*** / **Units**)

If you have a Geodimeter 440, press the following keys; otherwise consult your Geodimeter manual. The interface to the Geodimeter uses the standard table 0 so you do not need to set up any tables on the Geodimeter.

Geodimeter Display	**Key to press**	**Comments**
Menu 1 Set 2 Editor 400 3 Coord Menu 4 Data com 5 Test	MNU ENT 4	Menu selection Select data communications menu
Data com 1 Select device 2 Create table	1	
Data com 1 Geodat 2 RS232 3 Ext. mem	2	Select serial communications
RS232 ON? COM = 1.7.2.1200 U.D.S.? Table No = Request?	YES ENT NO 0 ENT YES	1200 baud, even parity No recording program required Select standard table 0

✉ **Note:** It is not necessary to enter an accurate HA ref; zero will suffice because the SDR33 considers the backsight azimuth.

A.2.1.1 Operating the Geodimeter

Steps for making observations include:

1. Aim the Geodimeter at the target.
2. Press the **<READ>** key on the SDR33 to initiate a full (angles + EDM) reading.
3. Store the reading by pressing **<OK>**.
4. For an angles only reading, press the **<ANGLE>** softkey on the SDR33's ***Take Reading*** screen.

When the Geodimeter 440's noncoaxial EDM is used with a combined prism / target at short range and the theodolite is aimed at the target's center, the EDM beam misses the prism. Use the SDR33's offset-reading facility to record the angles and distance to the target separately.

A.2.1.2 Test setup on the Geodimeter

As a shortcut for testing purposes only, press the keys in the list below to set up the Geodimeter quickly. This procedure avoids setting up compensation and leveling.

Geodimeter Display	Keys to press
	Switch <ON>
The electronic level is displayed	F22 ENT
Comp = 1	0 ENT
Temp = 22.0	ENT
Press = 760.00	ENT
Offset = 0.000	ENT

Geodimeter Display	Keys to press
Hz Ref =	0 ENT

The standard table will display. Connect the SDR33 to the Geodimeter 440 and take simple readings to verify that the connection is working.

A.2.1.3 Tracking with the Geodimeter

Tracking can be performed by setting the Geodimeter to its tracking mode (TRK). The SDR33 tracking mode does not have to be enabled. Press **<READ>**, then A / M. The Geodimeter will take continuous readings, which can be stored in the SDR33 by pressing **<READ>**.

A.2.2 Laser Atlanta Optics

The SDR33 supports the ProSurvey 1000 laser range finder from Laser Atlanta Optics, Inc. Configure the ProSurvey 1000 to communicate in standard mode (4800 baud, no parity, 8 bits, 1 stop bit).

A.2.3 Laser Technologies

The SDR33 supports the Criterion 300 and Criterion 400 laser range finders from Laser Technologies, Inc. Configure the Criterion 300 / 400 and SDR33 using the following parameters:

Parameter	Criterion	SDR33
Baud rate	4800	
Parity	NO	
Stop bits	1	
Vertical observations		Horizontal (refer to instrument settings)

When **<Read>** is pressed on the SDR33, the last reading on the Criterion 300 / 400 is downloaded to the SDR33. This enables the user to perform several readings with the laser range finder but to download only the most recent to the SDR33. The sequence is to initiate a reading, or readings, on the Criterion 300/400, then press **<READ>** on the SDR33 to download the last Criterion reading.

A.2.4 Nikon instruments

The SDR33 supports the Nikon DTM-A series of instruments and the Nikon D-50 instrument.A special cable (Sokkia Product No. 5306-66) is required to convert the Nikon pin configuration to the SDR33 pin configuration. Even though the same type of connector is used, do *not* connect the SDR33 connector directly to the Nikon instrument.

The SDR33 and Nikon instrument must be set up to use the same angle and distance units. Corrections should be applied in the SDR33 *only*, so that a permanent record is maintained.

Note: Inconsistent unit or correction settings cannot be detected by the SDR33, but *will* result in erroneous data. No automatic unit conversion is done in the SDR33.

The SDR33 cannot shut off the Nikon's EDM. Select the desired cutoff time from the Nikon setup to preserve battery time.

A.2.4.1 Nikon D-50

The Nikon D-50 instrument does not automatically send data when a distance reading is complete. When the Nikon finishes the reading (usually signalled by an audible beep), a message will display. Press **<OK>** on the SDR33. It will then retrieve the data from the instrument.

Note: It is important to wait for the instrument to complete the reading. If **<OK>** is pressed too soon, it will abort the reading and return the distance of the *previous* measurement.

A.2.4.2 Nikon DTM-A Series

The Nikon DTM-A series instruments will automatically send data to the SDR33 when a reading is complete, so no operator interaction is required beyond pressing **<Read>**.

To set up the Nikon A-Series instrument, press and hold the second key, turn on the power and release the second key. This should put the instrument in its mode setting screen. Configure the Nikon DTM-A and SDR33 using the following parameters:

Parameter	**Nikon**	**SDR33**
Comm Mode	NkRS	N / A
	SET	N / A
Baud Rate	SET = 1200	4800
	NkRS = 4800 or 9600	4800

When you have establishing the settings, press the **<ENT>** key on the Nikon to accept the new setting.

A.2.5 Pentax instruments

The SDR33 provides software to interface with the Pentax PTS-10, PTS-II, PTS-III, PTS-V and PCS. A special cable is required to convert Pentax cabling to the SDR33's Hirose standard cabling configuration.

The Pentax instruments operate in the same way, but the older PTS-10 instrument is slightly different.

- To record distance observations, the PTS-10 *must* be in distance mode.
- Angles only measurements can be taken in any mode, but take considerably longer if the PTS-10 is in distance mode. Use ***angles*** mode if you need to make many angles only observations.
- When taking distance readings, the SDR33 automatically puts the PTS-10 into **AIM** mode until the signal is satisfactory. The SDR33 captures the reading from the PTS-10 when it is available.

Operation

Instrument checks include the following:

- The SDR33 checks that the prism constant and / or atmospheric correction(s) are not set on *BOTH* the SDR33 and the Pentax instrument(s). If they are, an error message is displayed.
- You need to manually check that the Pentax is not applying the curvature and refraction correction. It is not transmitted by the Pentax instruments.
- The SDR33 checks that the instrument is operating in the appropriate vertical angle mode (zenith or horizontal).
- The SDR33 also checks the instrument's units and raises an error message if units are different than expected.

✉ **Note:** The SDR33 does *NOT* automatically convert from the Pentax's units to its own.

The SDR33 can not turn off the EDM after a distance reading. Manually turn off the EDM after each reading to conserve the PTS batteries if it needs to remain aimed at a prism.

Communication Parameters

On the PTS-II / III / V / PCS, make sure the instrument is configured to communicate in standard mode (1200 baud, no parity, 8 data bits, 1 stop bit). Consult your Pentax operations manual for information on setting parameters.

A.2.6 Topcon Instruments

The GTS-3 setting supports the older GTS-3 instruments, although a special hardware interface is required (Sokkia product no. 5306-40).

The GTS / ET1 / ET2 setting is used for any of the following: GTS-3B, GTS-4, GTS-6 and ITS-1. The GST-3000 applies to the GTS-300 series.

Cabling

No special cabling is required; the SDR33's top cable has a Hirose connector that plugs directly into the Topcon data port.

Operation

The Topcon can work in any combination of units. The SDR33 checks each reading transmitted by the Topcon and warns you if the Topcon units are incompatible with the SDR33's. If necessary, alter the total station or SDR33 units.

✉ **Note:** The SDR33 will *NOT* automatically convert the units of transmitted values into its own units.

Set up the Topcon in slope distance mode, when EDM is selected.

Configure the Topcon's basic distance mode as ***Slope Distance*** (SD). Otherwise it will not work with the SDR33. Set this parameter by holding down the **<F2>** key while turning on the total station. The SDR33 will set the slope distance mode of the GTS300 itself so it is not necessary to set it on the topcon at start up. The SDR33 cannot change the GTS3 from theodolite mode to slope distance mode or vice versa, thus the mode must be set in the instrument to reflect the type of reading being taken.

Atmospheric corrections may be applied in either the SDR33 or the total station. The SDR33 issues an error message if corrections are applied twice. It is recommended that corrections be applied in the SDR33. If you have trouble maintaining 0 PPM in the Topcon, set the SDR33 to not apply atmospheric corrections.

Similarly, the prism constant may be set in either the SDR33 or the total station. An error message displays if it is non-zero in both.

Set the Topcon to communicate in standard (1200 baud, even parity, 7 bits, 1 stop bit) mode. Consult your Topcn manual for information on setting parameters.

A.2.7 Wild instruments

The SDR33 supports the following Wild (Leica) instruments:

T1000	T2000	TC / TCM series
T1000+DI	T2000+DI	T1600+DI
T1600	T1010 / 1610	T1010 / 1610+DI

The DI selections support either an external EDM or integrated Total Station (TC series). For example, the T1000+DI supports either a T1000 with DI connected or a TC1000. A special cable (Sokkia Product No. 5306-12) is required.

The SDR33 and the Wild instrument must be set up to use the same angle and distance units. Corrections may be applied in one or the other, but not both.

Note: Inconsistent unit settings result in an SDR33 message. The SDR33 does *NOT* automatically convert data from the Wild into SDR units.

Wild instruments will operate in the fast reading mode (referenced in the Wild manuals). If you are using a TC series instrument, configure the units to work with a GRE and not the Rec module.

Before using a Wild instrument, configure it to communicate with an external device in standard mode (2400 baud, 7 bits, even parity, 1 stop bit). Consult your Wild manual for information on setting parameters.

A.2.8 Zeiss

The SDR33 provides software to interface with the Zeiss Elta 2, Elta 3, Elta 46R, Elta RL, Elta 50 and DiNi 10 / 20. A special connector (Sokkia product No. 5306-30) is required to connect the SDR33.

With the Elta 46R the SDR33 cannot initiate a reading automatically, this must be done by pressing the read lever on the Elta 46R. It is advisable to press **<READ>** or **<ANGLE>** on the SDR33 before starting the instrument. On other Elta instruments the SDR33 automatically sets the correct mode for observations and initiates each reading. Supported modes are **M1** (slope distance, vertical angle, and horizontal observation) and **M2** (angles only). **<READ>** and **<ANGLE>** on the SDR33 work in the normal way.

The SDR33 and Elta must be configured to use the same angle and distance units, or the SDR33 issues an error message. Corrections may be applied in either the Elta or in the SDR33, but not both; an error message occurs if corrections are applied twice.

On the Elta 2/3/46R, make sure the instrument is configured communicate in standard mode (1200 baud, odd parity, 7 bits, 2 stop bits).

On the Elta RL, configure the instrument to communicate in standard mode (2400 baud, no parity, 8 bits, 1 stop bit).

On the Elta 50, configure the instrument to communicate in standard mode (2400 baud, no parity).

On the DiNi 10/20 configure the instrument for 2400 linespeed, input/output mode, no parity, no flowcontrol, 8 bits, 1 stop bit, and ASCII protocol. Consult your Elta manual for information on setting parameters.

Appendix B Database Records

The SDR33 stores all observations, notes and calculated results in a 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 (see Section 3.5.5, *Notes*, page 3-19). For more information on navigating the database, see Chapter 33 *The SDR Database*.

The SDR33 uses many different record types to describe data such as station setup details, backsight orientation, target heights, observational measurements and other observational data.

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.

This appendix describes the use of records in the database and the fields within each record. They are listed in alphabetical order.

ANT HT

Antenna height record. This record specifies the height of the antenna pole (defined as the distance from the point on the ground to the center of the antenna).

```
Ant ht            2.000
```

APPLY SUPER

This record defines superelevation at a particular station on the road.

```
Apply super
Sta..ing      3+67.600
L super       %-3.000
R super       %-3.000
L widen         3.000
R widen         5.000
Pivot          Centre
```

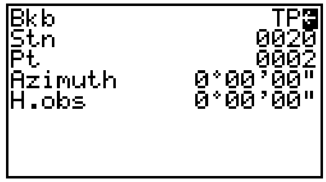
ATMOS

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 when applying atmospheric corrections.

```
Atmos               TP
Pressure          30.0
Temperature      75.00
```

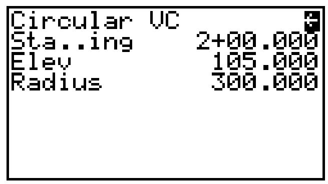
BKB

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 the corresponding azimuth. The orientation correction is the difference between the last two fields.



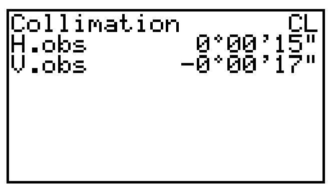
CIRCULAR VC

This record is part of a road’s vertical alignment; it defines a circular vertical curve (arc).



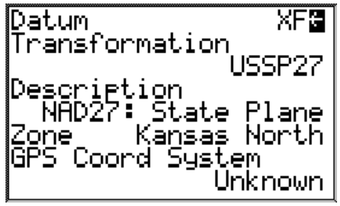
COL

Collimation record. Fields define the vertical and horizontal angle correction required to compensate for collimation error in the current instrument.



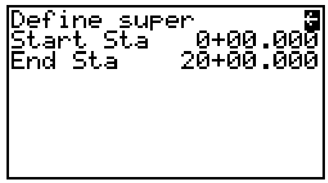
DATUM

This record specifies the type of datum selected.



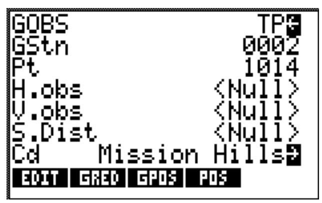
DEFINE SUPER

This record specifies the limits of superelevation application.



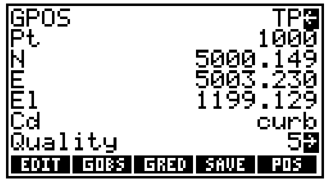
GOBS

GPS observation record. Fields include source point name, azimuth, vertical angle, slope distance and a description code. These records appear in review as type RK.



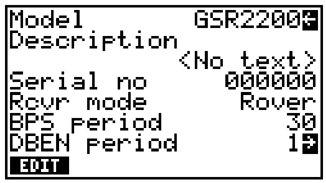
GPOS

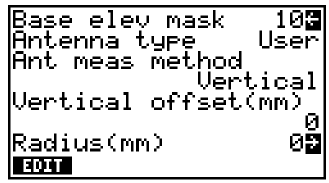
GPS position record. This record is the position of point before any calibration or transformation has occurred.

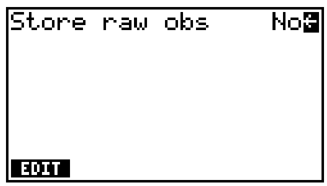


GPS INST

GPS instrument record. The fields describe the type of instrument and various instrument parameters.

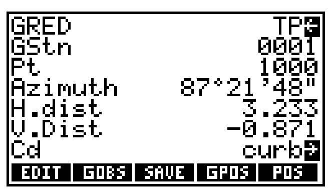






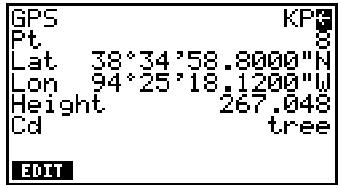
GRED

GPS 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. A GPS observation record in **GRED** view looks the same as a **GRED** record.



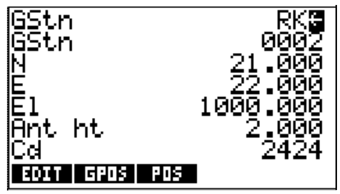
GPS

GPS record containing latitude, longitude and height values.



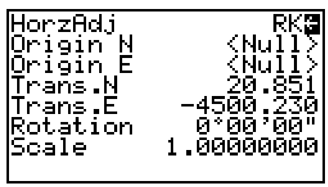
GSTN

GPS station record. This contains a point name, point coordinates, antenna height 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.



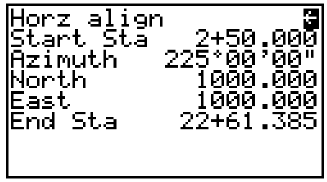
HORZ ADJ

Horizontal adjustment record. This record contains values for a horizontal calibration. A new record will be generated each time a calibration is performed.



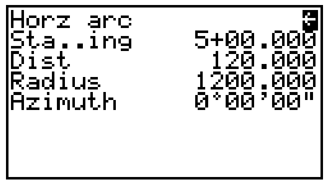
HORZ ALIGN

This record marks the start of a road’s horizontal alignment definition. The end station field is filled in automatically by the SDR33.



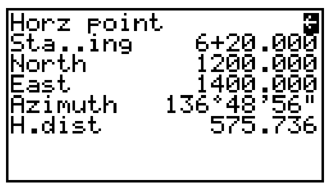
HORZ ARC

This record is part of a road’s horizontal alignment; it defines an arc.



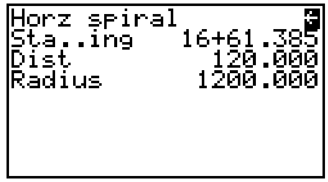
HORZ POINT

This record is part of the road’s horizontal alignment and specifies the coordinates of a point the alignment passes through.



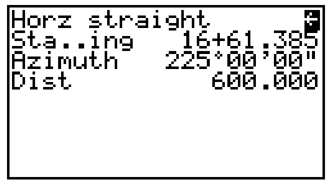
HORZ SPIRAL

This record is part of a road’s horizontal alignment; it defines a portion of a spiral.



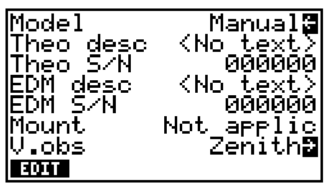
HORZ STRAIGHT

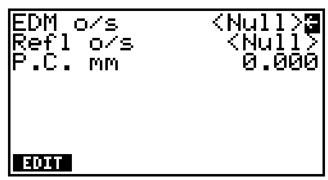
This record is part of a road’s horizontal alignment; it defines a straight section.



INSTR

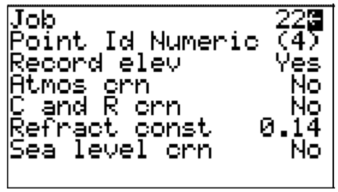
Instrument record. The fields describe the type of instrument, and various instrument parameters. See Section 3.4.1.2, *Selecting instrument type*, page 3-14, for field descriptions.





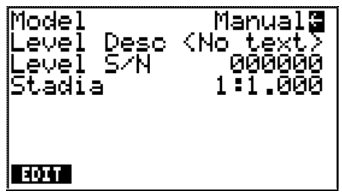
JOB

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 (four-digit numeric or 14-character alphanumeric) and which corrections are applied.



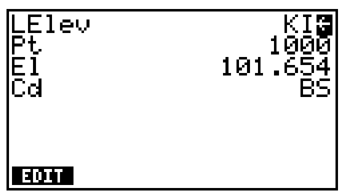
LEVEL INSTRUMENT

This record is generate when using the leveling the program and store specific information about the level being used.



LEVEL ELEVATION

This record is generated during the leveling process and indicates the point elevation and feature code.

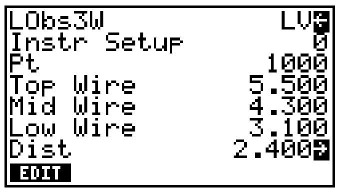


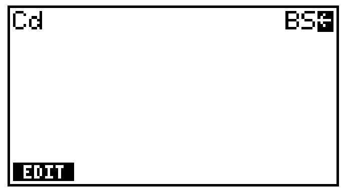
LEVEL STATION

This record is generated during the leveling process and stores the instrument setup (the number of current leveling setups in the current job) and the backsight point ID.

LEVEL OBSERVATION

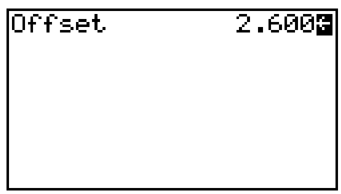
This record displays observations from the leveling program.





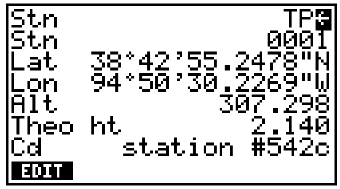
LEVEL OFFSET

This record is generated during the leveling program and represents the target height.



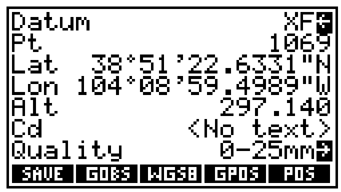
LLH STN

This record is generated when ellipsoidal coordinates are selected for a job and displays Stn ID, latitude, longitude, altitude and theodolite height values.



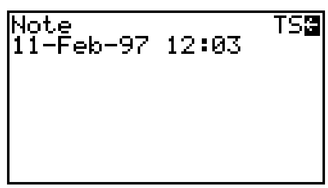
LOCAL LLH

This record displays latitude, longitude, height and altitude values when a Datum transformation type, other than WGS84, is utilized.



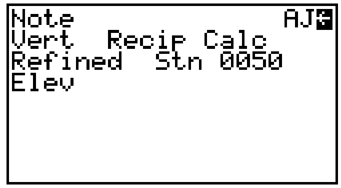
NOTE

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 5-4.



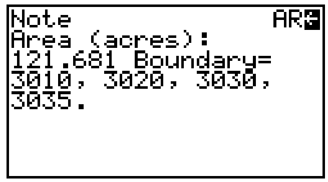
NOTE AJ

Note record showing reciprocal calculation



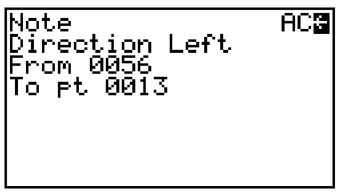
NOTE AR

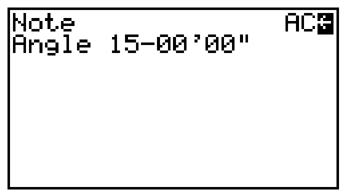
Note record showing area calculation.



NOTE AC

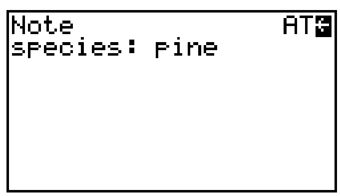
Note record showing information entered when defining an arc.





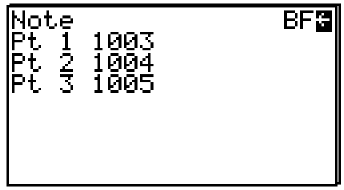
NOTE AT

Note record showing the attribute for a code.



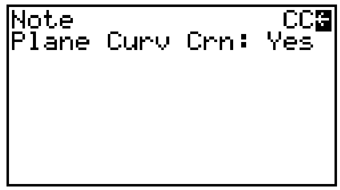
NOTE BF

Note record showing the points used to define a plane.



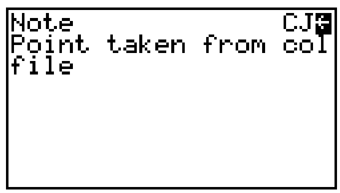
NOTE CC

Note record showing plane curvature correction



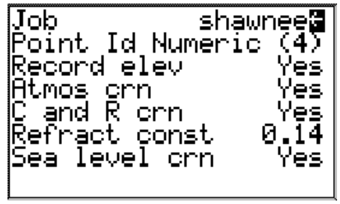
NOTE CJ

Note record showing displaying a point taken from a control file.



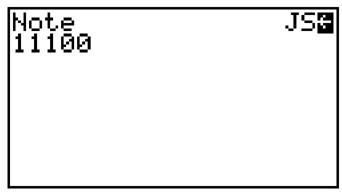
NOTE CP

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*.



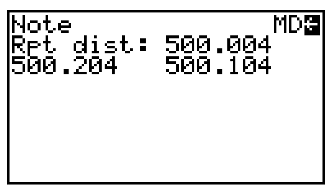
NOTE JS

Note record generated when applying job setting parameters.



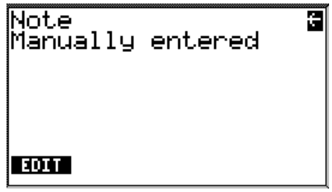
NOTE MD

Note record showing the individual distance measurements from a multi distance observation is made using set collection. It is followed by an OBS record containing the average distance.



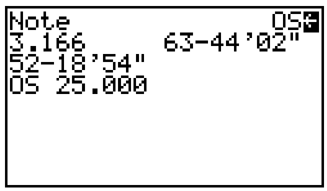
NOTE KI

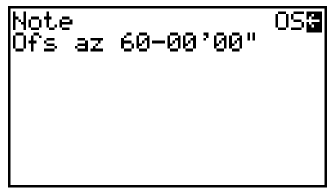
This record represents a note that can be entered at any time while working with the SDR33.



NOTE OS

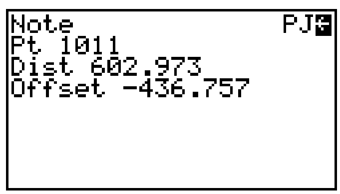
Note record generated by an offset observation. It contains the raw observation details and offset direction. It is generated before the observation record that contains measurements adjusted for the offset.





NOTE PJ

Note record showing the results of a projected point.



NOTE RE

Note record showing results of a remote elevation calculation.

```
Note                RE
Height: 48.739
```

NOTE RO

Note record generated in roading.

```
Note               RO
Temp element
Grade %-3.000
H.dist 26.000
```

NOTE RS

Note record generated by the resection calculation option.

```
Note               RS
1012       DValues
0.072       0-00'10"
0-00'01"
```

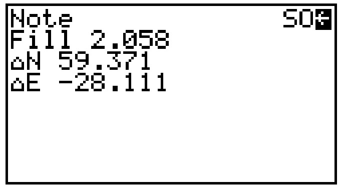
NOTE SC

Note record generated by the set collection procedure.

```
SET                SC
Stn              0008
Point count         6
Set #               2
```

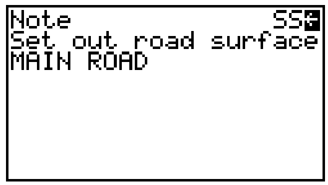
NOTE SO

Note record generated during the set out process.



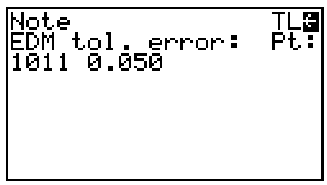
NOTE SS

Note record generated when setting out road surface.



NOTE TL

Note record generated whenever a tolerance error message is displayed and accepted.

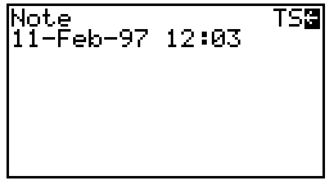


NOTE TP

Note record generated in topography.

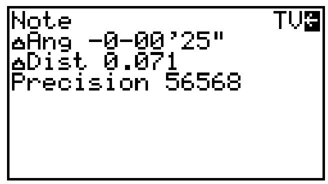
NOTE TS

Note record with a timestamp. It contains the date and time of the note creation.



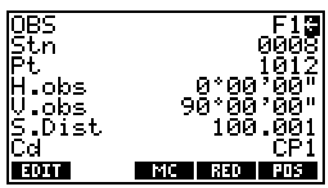
NOTE TV

Note record generated by the traverse calculations. It lists information about how the calculation was performed.



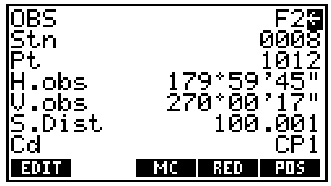
OBS F1

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.



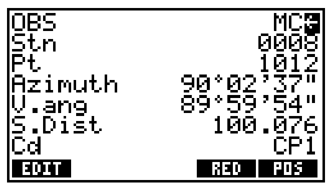
OBS F2

Observation record measured on instrument face two. See **OBS F1** (above).



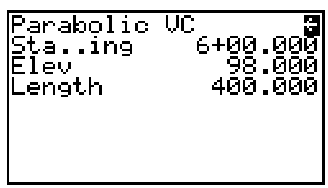
OBS MC

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.



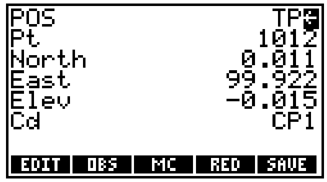
PARABOLIC VC

This record is part of a road's vertical alignment; it defines a parabolic vertical curve.



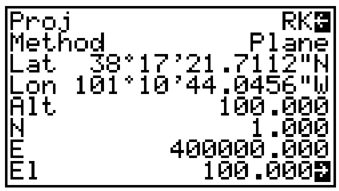
POS

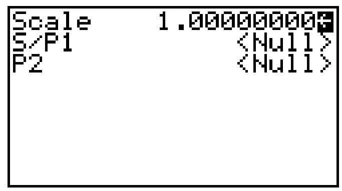
Position record. This record contains a point name, the point's coordinates and a descriptive code.



PROJ

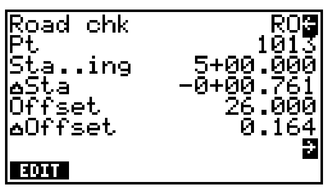
The Plane Projection record contains the origin coordinates including, latitude, longitude and height values.

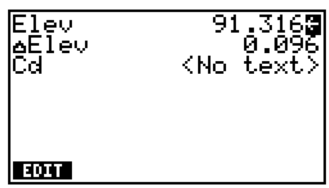




RCHK

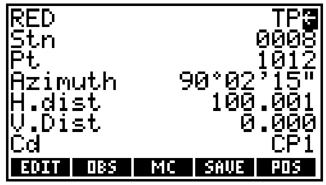
Road check. This record defines a point on a road by station and offset, not coordinates. It also contains fields showing the difference between the station and offset set out and the design point's station and offset.





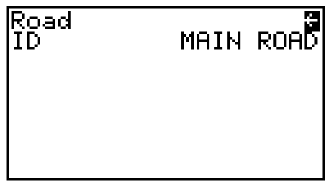
RED

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.



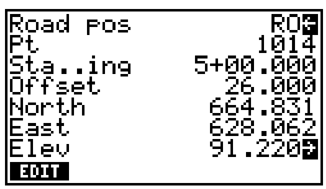
ROAD NAME

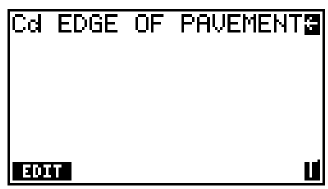
This record marks the start of a road definition. It contains the name of the road.



RPOS

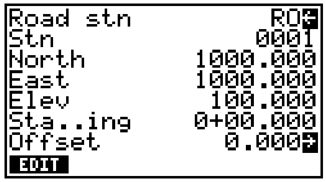
Road position. Like a position record, this record defines the position of a point but also includes the station and offset of the point relative to the current road definition.

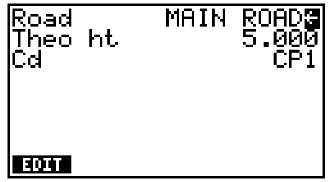




RSTN

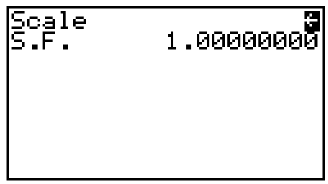
Road station. This record defines the position on which the instrument was set up (similar to a station record). In addition to the standard station fields, it lists the station and offset of the point relative to the current road definition.





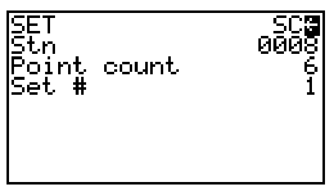
SCALE

Scale factor record. The field specifies a plane scale factor. Only one scale factor record is generated per job.



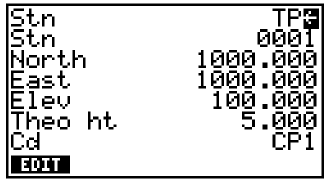
SET

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. A field, *BAD*, is used to indicate an inaccurate set of data.



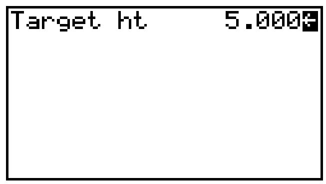
STN

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.



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).

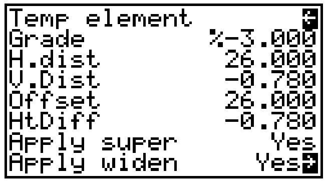


TEMP

This record marks the start of the definition of a road cross-sectional template. The template definition is independent of any specific road.

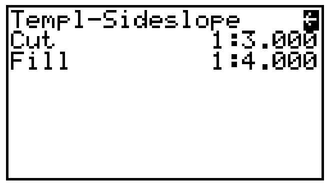
TEMP-ELEMENT

This record is part of a road template, it defines a point on the cross-section.



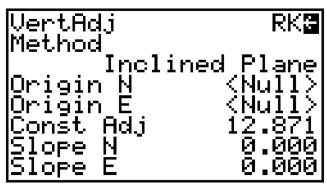
TEMP-SIDESLOPE

This record is part of a road template; it defines the grades for sideslopes at the edge of the road.



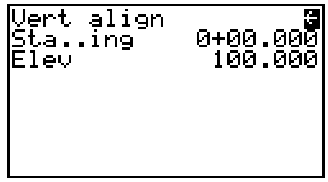
VERT ADJ

Vertical adjustment record. This record contains the information for a vertical calibration. A new record will be generated each time a calibration is performed.



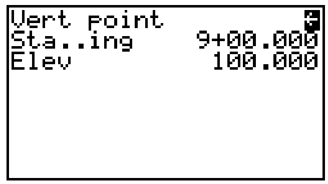
VERT ALIGN

This record marks the start of a road's vertical alignment definition.



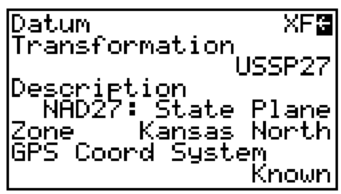
VERT POINT

This record is part of a road's vertical alignment and specifies the station and elevation of a point that the alignment passes through.



XFORM

This record, which displays transformation types, is generated when a transformation sequence ends with a projected coordinate system.



XSEC

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    10+00.000
Lt. Template     STNP
Rt Template      STNP
```

B.1 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 tone sequence.

Memory nearly full

This message displays when there is room left for about 15 observation records. You should finish 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 SDR33 operation. The SDR33 automatically returns to the front screen of the program. The only operations you can perform are printing, transmitting, and deleting jobs, roads, or templates.

Appendix C System Messages

<10Kb recvr memory

Less than 10 kilobytes of memory remain for a GPS survey.

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.

Area too large

The area you attempted to subdivide is larger than the original polygon.

Backup lithium dead

The backup battery is discharged. All data may be lost if the main battery is removed.

Bad record order

An invalid SDR file has been detected during comms input.

BATTERY IS DEAD!

The main battery is discharged.

Battery is low

The main battery is low.

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, reading from an instrument, or 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 SDR33 and the other instrument or computer.

CTS/DSR detected

Comms output has paused. The CTS and / or DSR line is not enabled.

Curve overlap

The vertical curve overlaps with the previous one.

Delete all jobs before upgrading

You must output and delete all jobs in the SDR33's memory before upgrading the SDR33's software.

Diverging azimuths

An intersection was attempted but failed because the azimuths did not converge.

Branch In Route

A branch is in the Level Loop

Distance Tolerance Error

The distance entered is out of tolerance with the wire readings and stadia constant

Elevation Tolerance Error

An elevation tolerance error is located in the Level Loop.

Inverted Rod Siting

The rod is unable to be read by the NA2000. This situation could occur because not enough of the rod is in the sights or that the rod is inverted when the SDR33 is expecting it to be non inverted.

Null Distance

A distance for the reading has not been entered.

Null Low Wire Reading

The Low Wire of a three wire reading was not entered.

Null Midwire Reading

The Mid Wire of a three wire reading was not entered.

Null Reading

A reading has null values.

Null Top Wire Reading

The Top Wire of a three wire reading was not entered.

Wire Tolerance Error

A wire reading entered is out of tolerance.

Duplicate crns

Corrections are set in both the SDR33 and the instrument.

Duplicate point

An attempt was made to enter the same point twice in the list of preentered points for set collection.

EDM error

The instrument failed to take a distance reading.

EDM tol. error

The distance is not within the specified tolerance.

Elev not enabled

A GPS survey requires a job with Record Elev set to Yes when it was created.

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.

Incompatible Units

When the SDR33 is connected to a surveying instrument, it reports an error if the instrument's units (angle, distance, pressure, temperature and so on) are incompatible with the SDR33's.

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.

Linear

The three points selected to define a plane in Building face survey are colinear, and do not uniquely define a plane.

Low receiver battery

The GPS receiver battery is low.

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.

Mils Not Allowed

Two-Way Sets do not support mils as an angle unit.

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.

Modem Error

An unidentified modem error occured.

Modem Trans Cancel

You canceled a modem transmission.

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>).

Null not allowed

A value must be entered in this field.

Null position

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.

Offset too small

You cannot define templates that fold back.

P.C. too large

The prism constant is out of the range -99 to 99 mm.

Parallel Azimuths

An intersection failed because the specified azimuths were parallel.

Point exists

Coordinates for the point already exist.

Poor position

The GPS record just stored in the database does not have good values because of high PDOP.

Print or send first

Before a job can be deleted from the SDR33'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.

Pt id not numeric 4

GPS jobs MUST have 4-digit point IDs (alphanumeric IDs are not yet supported for GPS surveys).

PTS-10 in angle mode

The Pentax PTS-10 instrument must be set manually in EDM mode before a reading may be taken.

RAM disk error

An error occurred while writing to or reading from the RAM disk.

Receiver memory full

The memory in the GPS receiver is full.

Receiver not ready

The GPS receiver is not ready.

Receiver mode error

The GPS receiver is not in the expected mode.

Restart survey

You need to restart the GPS survey.

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.

SET is in a menu

The two-way SET is not responding, probably because it is in a menu. Press **<I/O Clear>** on the set keyboard to put an older instrument in Basic mode or a newer instrument in Select operation.

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.

Station too small

A larger station value must be entered.

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 SET 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.

Unable to execute

Insufficient space to execute program.

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 SDR33 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.

Appendix D Observational Calculations

In this appendix

- Correctional categories, order of application
- Instruments, environmental and job-related corrections
- Geometric reductions
- Professional positioning calculations
- Other formulas

This appendix presents the formulas and constants used by the SDR33 for calculations.

D.1 Correction Categories and Order of Application

The SDR33 performs several corrections to readings as it makes conversions **POS** records. 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, mounting eccentricity 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 SDR33 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.

The SDR33 applies the prism constant and atmospheric parts per million (PPM) corrections as soon as the observation is accepted. This reading can be from a total station instrument or it could be manually input from the keyboard.

The SDR33 applies six different corrections when it converts an OBS record to a measured and corrected (**MC**) record. The order is face one/face two, mounting eccentricity, instrument and target height, collimation, orientation, arc curvature and refraction.

The SDR33 corrects for sea level and projection 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 1.

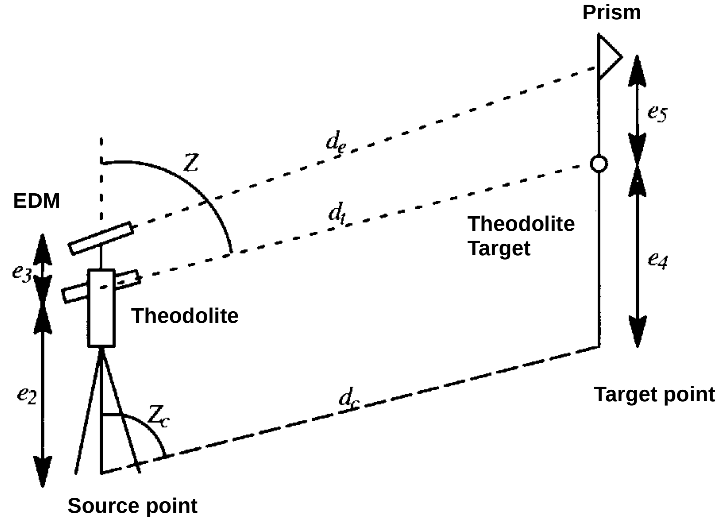


Figure C-1: An instrument configuration where the EDM is distinct from the theodolite, and the prism is distinct from the theodolite target.

e_1=prism constant

e_2=theodolite height

e_3=EDM offset

e_4=theodolite target

e_5=EDM reflector offset

d_e=EDM slope distance

d_t=theodolite slope distance

d_c= slope distance, source to target point

Z=theodolite vertical angle

Z_c=corrected vertical angle

If you are using a total station with a simple prism on a pole, the EDM and theodolite are coincident; the prism and theodolite target are also coincident. In other words:

$e_3=0$

$e_5=0$

$d_e=d_t$

D.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
- mounting eccentricity corrections
- instrument and target height reductions
- collimation corrections
- orientation corrections

D.2.1 Prism constant correction

This correction is applied to all slope distances:

$$S_2 = S_1 + e_1$$

S_1=measured slope distance

e_1=prism constant

S_2=resulting slope distance

☒ **Note**: Prism constants are usually negative.

D.2.2 Pressure and temperature correction

Pressure and temperature corrections are applied to all electronically measured distances if the ***Atmos crn*** field is **Yes** during job creation, and pressure and temperature values are entered. The correction applied is:

$$S_3 = S_2 + S_2\left[J - \frac{NP}{273.2 + T}\right] \times 10^{-6}$$

S_2=slope distance

S_3=corrected slope distance

J=group refractive index for the EDM's carrier

N=constant for the EDM's carrier

P=atmospheric pressure in mmHg

T=dry air temperature in 5C

D.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.

D.2.4 Mounting eccentricity correction

The slope distance measured by the EDM is corrected for the vertical eccentricity between the EDM and theodolite axis. This correction depends on the type of mounting system and is not applicable to total stations. Three common combinations of mounting systems and target / reflector systems are as follows:

- Standards-mounted EDM with nontilting reflector. The slope distance measured by the EDM (d_e) is reduced to the slope distance between theodolite and target (d_t). The EDM offset is e_3; the EDM reflector offset is e_5.

$$d_t = (e_3 - e_5)(\cos Z + \sqrt{d_e^2 - (e_5 - e_3)^2 \sin^2 Z})$$

- Telescope-mounted EDM with nontilting reflector. The slope distance measured by the EDM (d_e) is reduced to the slope distance between theodolite and target (d_t).

$$d_t = \sqrt{d_e^2 + -(e_3 - e_5 \sin Z)^2} - e_5 \cos Z$$

- Telescope-mounted EDM with tilting reflector. No correction for eccentricity is required. If you are using a tilting reflector system, set both the EDM offset and reflector offset to zero.

D.2.5 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 symbols represent the following:

e_z=theodolite height

e_4 =theodolite target height

d_t=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:

$$d_c = \frac{d_t \sin Z}{\sin Z_c}$$

D.2.6 Collimation correction

The instrument collimation error, determined from the collimation program, is applied in the following manner:

Face one: $a_2 = a_1 + V_c$ $b_2 = b_1 + H_c$

Face two: $a_2 = a_1 - V_c$ $b_2 = b_1 - H_c$

a_1=measured vertical angle

a_2=corrected vertical angle

b_1=measured horizontal angle

b_2=corrected horizontal angle

H_c=horizontal collimation correction

V_c=vertical collimation correction

D.2.7 Orientation correction

If you have completed the normal procedure for establishing a backsight, an orientation correction is applied to the horizontal angle observation:

$$A = H + BKB_{azmth} - BKB_{h.obs}$$

A=azimuth of the observation

H=horizontal angle (circle reading) of the observation

BKB_{azmth}=azimuth field of the applicable backbearing record

$BKB_{h.obs}$=horizontal angle observation (circle reading) field of the applicable backbearing record

Note: The Backbearing (BKB) record is computed as geodetic when using Projected Grid Coordinates.

D.3 Geometric Reductions

The following geometrical reductions and corrections may be applied to observations by the SDR33.

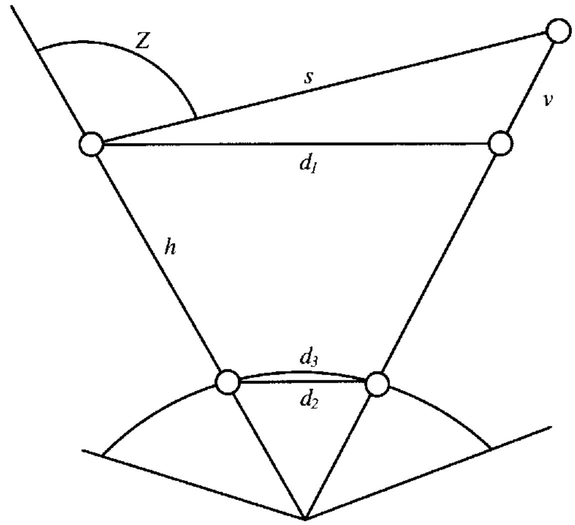


Figure C-2: A reference figure for some of the reductions

Z=zenith angle

v=vertical distance

h=elevation of source point

s=slope distance

d_1=horizontal distance at elevation of source point

d_2=sea level chord

d_3=spheroidal arc

d_4=projected distance (not shown)

D.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.

$$a_3 = a_2 - \frac{(1-k)S_3}{2R} \times \frac{180}{\pi}$$

k=coefficient of terrestrial refraction (either 0.14 or 0.20 as selected when the job was created)

R=approximate spheroid radius of 6,370,000 (meters)

S_3=slope distance from Section 2.2, *Pressure and temperature correction*, page Appendix D-5

a_2=vertical angle from Section 2.6, *Collimation correction*, page Appendix D-7

a_3=corrected vertical angle

D.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_2) using the mean height of the vector:

$$d_2 = d_1 - \left[\frac{(h_1 + h_t)d_1}{2R}\right]$$

d_1=horizontal distance at the elevation of the source point

h_1=elevation of the source point

h_t=elevation of the target point

R=radius of the spheroid

Reduction of the sea level chord (d_2) to the spheroidal arc (d_3) involves a correction of:

$$\frac{d_2^3}{24R^2}$$

R=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:

$$d_3 = d_2$$

D.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 SDR33, 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:

$$d_4 = d_3 + sf$$

sf=scale factor in the current scale record

D.3.4 Slope reduction

Refer to Figure 2, 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

d_1=Ssin(Z) S=the slope distance

v_1=Scos(Z)

Z=the zenith angle

D.4 Professional Positioning calculations

The method of Least Squares minimizes the sum of the squared residuals. The Least Absolute Value Estimation (LAVE) minimizes the sum of the absolute residuals. To demonstrate, consider the data set below:

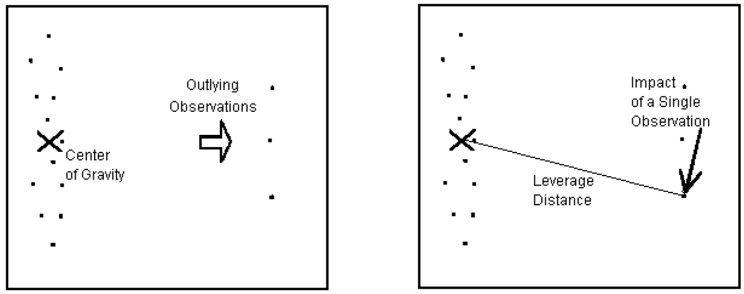
No.	1	2	3	4	**5**
Size	3.0	3.0	3.0	3.0	**30.0**
Arithmetic Mean	8.4				
Median	3.0				

The fifth observation is an obvious outlying observation. The *arithmetic mean* is determined by summing all observations and dividing by the total number of observations (42 / 5 = 8.4). The *median* is found by ordering the observations by their size and taking the middle one. The following table shows the residuals of the data set to the arithmetic mean and to the median.

No.	1	2	3	4	**5**
Arithmetic Mean (Least Squares)	5.4	5.4	5.4	5.4	**21.6**
Median (LAVE)	0.0	0.0	0.0	0.0	**-27.0**

As seen in the table above, LAVE, by using the median, is able to determine the outlying observation by the size of the residual. However, it is not effective in cases of more than one unknown parameter.

In contrast to LAVE, the Least Squares adjustment procedure is subject to “smearing effects” due to its utilization of the arithmetic mean as shown above. An outlying target point observation, or blunder, may therefore totally spoil an ordinary least squares adjustment. The outlying observations occur at a distance from the bulk of observations, from its center of gravity, thereby holding the character of "leverage". The data set shown below illustrates this point.



It can be seen that the bias of these leverage points would adversely affect the formulation of the initial X,Y position, or estimation. A more comprehensive adjustment procedure *must* determine this estimation by considering all observations without any preliminary selection or bias. To achieve this result, robust statistical techniques have been developed which are minimally affected by these outlying observations, or blunders. These techniques have been incorporated into the Balanced Least Absolute Value Estimation (BLAVE) adjustment procedure which is the essence of Professional Positioning. To better understand the BLAVE technique, further explanation of least squares is needed.

An ordinary least squares procedure begins with the linear model:

$$\mathbf{A}\ \mathbf{x} = \mathbf{l} + \mathbf{v} \text{ with } \mathbf{D}(\mathbf{l}) = \sigma^2\ \mathbf{P}^{-1}$$

Let n = number of observations and u = number of unknowns. **A** = (nu) matrix of coefficients, **x** = (u,1) vector of unknowns, **l** = (n,1) vector of observations, and **v** = (n,1) vector of corrections, or residuals. The determinant of **l**, **D**(**l**) = (n,n) variance-covariance matrix of observation, σ^2 the variance or error of unit weight and **P** = (n,n) matrix of observational weights.

The unknowns may be computed by:

$$\mathbf{x}_{\text{adjusted}} = (\mathbf{A}^{T}\,\mathbf{P}\,\mathbf{A})^{-1}\,\mathbf{A}^{T}\,\mathbf{P}\,\mathbf{l}$$

and the adjusted observations are given by:

$$\mathbf{l}_{\text{adjusted}} = \mathbf{A}\,(\mathbf{A}^{T}\,\mathbf{P}\,\mathbf{A})^{-1}\,\mathbf{A}^{T}\,\mathbf{P}\,\mathbf{l} = \mathbf{A}\,\mathbf{x}_{\text{adjusted}}$$

—or—

$$\mathbf{l}_{\text{adjusted}} = \mathbf{C}\,\mathbf{l} \text{ with } \mathbf{C} = \mathbf{A}\,(\mathbf{A}^{T}\,\mathbf{P}\,\mathbf{A})^{-1}\,\mathbf{A}^{T}\,\mathbf{P}$$

C, the orthogonal projection, can be used to determine the influence of each observation to the adjustment result. The diagonal elements of this matrix are the partial redundancies. Although the residuals suffered from least squares (arithmetic mean) smearing affects, the diagonal elements indicate a single leverage point by a large value and vice versa.

However, since the diagonal elements differ from each other, the matrix does not possess an equal distribution of the partial redundancies. The degrees of freedom are not shared in equal portion which introduces the bias, or leverage of any outlying observation.

Further least squares evaluation can be performed by considering the equation:

$$\mathbf{I} - \mathbf{C} \text{ with } \mathbf{I} = (n,n) \text{ unit matrix}$$

Summing the diagonal elements of this matrix yields an integer value which is the redundancy or degree of freedom of the adjustment; exactly n **-** u. This is the Ansermet check when using the least squares procedure.

The BLAVE procedure differs in two fundamental areas. First, the initial linear model ($\mathbf{A\ x} = \mathbf{l} + \mathbf{v}$) is developed by utilizing LAVE (median) to determine $\mathbf{v}$, the vector of residuals. Second, a matrix $\mathbf{P}_G$ that enables the same numerical values to the diagonal elements of the orthogonal projection is determined by

$$(\mathbf{A}\ (\mathbf{A}^T\ \mathbf{P}_G\ \mathbf{A})^{-1}\ \mathbf{A}^T\ \mathbf{P}_G) = \text{Constant}$$

The matrix $\mathbf{P}_G$, which now represents the matrix of *balanced* observation weights, is introduced to the LAVE creating a BLAVE (**B**alanced **L**east **A**bsolute **V**alue **E**stimation).

The aforementioned differences between the least squares and BLAVE procedures minimize the smearing effect by using the principle of the median and minimize the leverage effects of outlying observations by equally distributing the partial redundancies. These are the characteristics which give BLAVE, and subsequently Professional Positioning, its robust error detection capabilities.

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

D.5 Other Formulas

The two formulas covered in this section include coordinate and inverse calculations.

D.5.1 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 using:

$$N_2 = N_1 + d_4 \cos(A)$$
$$E_2 = E_1 + d_4 \sin(A)$$
$$Z_2 = Z_1 + v_4$$

N_1, E_1 & Z_1=coordinates of the source point

N_2, E_2 & Z_2=coordinates of the target

d_4=projected distance between the two points

A=azimuth

v_2=vertical distance

The calculation yields null results if the coordinates of the source point are unknown.

D.5.2 Inverse calculation

The distances and angles associated with a line between two points are calculated from the coordinates of those points as follows:

$$v = Z_2 - Z_1$$
$$B = \tan^{-1}\left[\frac{E_2 - E_1}{N_2 - N_1}\right]$$
$$h = \sqrt{(N_2 - N_1)^2 + (E_2 - E_1)^2}$$
$$a = \tan^{-1}\left[\frac{h}{v}\right]$$
$$S = \sqrt{\frac{((h^2 + v^2)R) \Big/ \left(R - \frac{Z_1 + Z_2}{2}\right)}{sf}}$$

N_1, E_1 & Z_1=coordinates of the source point

N_2, E_2 & Z_2=coordinates of the target point

v=vertical distance from source to target point

B=azimuth of the line

a=zenith angle of the line

h=elevation of the source point

S=slope distance at the height of the station with slope reduction, sea level correction, and projection correction applied in reverse

R=radius of the spheroid

sf=scale factor

D.5.3 Compass rule

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

The Compass rule formula is:

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

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

Where:L = length of the traverse line to the point
TL = sum of the traverse line lengths

D.5.4 Transit rule

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

The Transit rule formula is:

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

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

Where:ΔN =change in northing for the traverse line
ΔE =change in easting for the traverse line
Σ│ΔN│ =sum of the absolute value of all the changes in northings of all the traverse lines
Σ│ΔE│ = sum of the absolute value of all the changes in eastings of all the traverse lines

Appendix E User Program

In this appendix

- Writing user programs
- Loading programs
- Running programs

The user program option allows you to load and run your own programs on the SDR33. The user program is not associated with the SDR software.

The user program will display a list of executable *.EXE or *.COM program files and any associated files they require.

E.1 Writing Your Own User Program

Writing a user program for the SDR33 is essentially the same as writing a stand-alone program. You will need to have the Symbol PDT3300 Application Developer's Kit (available through your Sokkia distributor) and Microsoft's V6.0 Ccompiler.

The only difference required for a program running on the SDR33 is the program must return control to the SDR33 when it has finished. A nice way to do this is to “execl” the SDR33 with the call:

EXECL(_B:SDR.EXE”, _B:SDR.EXE”, NULL)

You can also perform a warm boot, via **BiosWarmBoot ()**; as an alternative method.

The user program feature is not available on SDR33 units with less than 640 Kilobytes of RAM. User programs and data files are loaded onto RAM disk. Therefore less space is available to store information in SDR job files.

✉ **Note:** Some IBMPC programs will also run under the SDR33, however these will not be common. If you have problems with a user program that has apparently locked up, then a warm boot should return you to the SDR.

E.2 Loading Programs into the SDR33

The **<LOAD>** softkey allows you to load user program files into the SDR33. Files loaded, or files created by a user programs must not fit the file name pattern, SDR*.*, reserved for use by the SDR33's standard application program.

To load a program into your SDR33 you will need to install the FILELOAD.EXE program on your personal computer. The FILELOAD.EXE program can be found on the program diskette shipped with your SDR33.

1. Press the **<LOAD>** softkey. Your SDR33 prompt you to connect the top port (of the SDR33) to your computer.

2. Connect the SDR33 to the COM1 or COM2 port on your computer using a null modem cable.

3. The SDR33 will display a **Waiting for input** message.

4. Type **FILELOAD <FILENAME> [COM1 OR COM2]** on your personal computer. If you do not specify a COM port, the program defaults to COM1.

5. Press the **<Enter>** key on your personal computer to start the transfer.

E.3 Running a User Program on the SDR

You can run a separate program on the SDR33.

Steps to run a user program

1. Highlight **User program** on the ***Functions*** menu and press **<Enter>** or **<OK>**.

2. The SDR33 will display all programs you have loaded and any ancillary files.

3. Highlight a program name and press either **<Enter>** or **<OK>** to run the program on your SDR33.

E.4 Deleting Programs from the SDR

The **<DEL>** softkey allows you to delete any user programs or files. The currently highlighted file will be deleted.

E.5 Disclaimer

Since control is passed to the user program without restriction, it is possible to alter the state of the SDR33's data files. Any changes caused to these program files will likely result in invalidation of the database and loss of data. Sokkia and Point, Inc. accept no responsibility for such problems.

Glossary

almanac

Message transmitted by each satellite which gives the approximate location of all GPS satellites. The almanac is provided so that the signals for individual satellites can be acquired rapidly. It is also a tool for predicting satellite conditions for planning purposes.

ambiguity

The uncertainty inherent to an initial measurement which biases all measurements.

antenna height

The distance between the position of the observed point and the antenna.

atmospheric correction

Correction applied to account for atmospheric conditions effecting the EDM light beam to only OBS vectors.

azimuth

A horizontal angle measured clockwise from a reference source. The reference, typically north, is defined as zero.

backsight

A reading taken to avoid any major directional errors in the survey. A backsight also improves the accuracy of the survey by providing a basis for all future observed angles.

baseline

A three-dimensional vector between two receivers with concurrently tracked data.

C/A (Course/Acquisition) code

Standard GPS code transmitted on the L1 frequency. The sequence contains 1023 modulations per signal at a rate of 1.023 MHz. The code reiterates every millisecond.

calibration

Calculated corrections applied when a transformation is performed from one coordinate system to another.

carrier

Radio wave with the characteristics of frequency, amplitude and phase — any one of which may be varied by modulation.

carrier phase

GPS observable which measures the phase difference of the transmitted radio wave carrying the GPS signal and a signal generated on the receiver.

carrier phase pseudorange

GPS observable which measures the phase difference of the transmitted radio wave carrying the GPS signal and a signal generated on the receiver.

cartesian coordinate system

Also known as rectangular. Based on three dimensions (x, y, z) and orientation axes.

catch point

A point on a slope that intersects with natural ground. Catch points are used in roading applications.

centroid

The point in a system of masses, each of whose coordinates is a mean value of the coordinates for each dimension of all points within the system.

channel

Refers to the components of a GPS receiver necessary to track the signal from one GPS satellite. Those components consist of the radio frequency, hardware and software.

clock errors

Offsets inherent to the accuracies of the receiver clocks (typically quartz), as well as the drift of the atomic clocks on board the satellites.

code pseudorange

GPS observable which involves using the code broadcast by the satellites to measure distance. The shift in time required to correlate a replica of the code generated on the receiver with the code being received from the satellite is determined. Essentially, this is the difference between emission (satellite time frame) and reception (receiver time frame) of the satellite signal. This time is multiplied by the speed of light to yield the distance from the satellite to the receiver.

collimation error

Error measured by making angular observations using both faces of an instrument to one or many points.

COM1, COM2

Serial communication ports on a personal computer.

constellation

See satellite constellation page Glossary-13.

coordinate geometry

A set of procedures for encoding and manipulating bearings, distances and angles of survey data into coordinate data.

coordinate system

A reference frame used to express a position, usually in the form of ellipsoidal coordinates or cartesian coordinates.

curvature correction

Correction applied to account for the curvature of the earth.

cycle

Wavelength of the radio wave.

cycle slip

A discontinuity of an integer number of cycles resulting from a temporary loss-of-lock in the carrier tracking loop. Often caused by an obstruction.

data files

Information file collected by a GPS receiver.

datum

Mathematical surface used as a reference.

datum transformation

See transformation page Glossary-15.

differential processing

See relative positioning page Glossary-12.

dilution of precision (DOP)

The geometrical contribution to the uncertainty in a position. The DOP factor is related to the volume of the geometric figure whose apex is the receiver and whose sides are defined by the vectors from the receiver to each of the satellites being tracked.

- GDOP General (Three-dimensional coordinates plus clock offset)
- HDOP Horizontal (Two-dimensional coordinates)
- PDOP Position (Three-dimensional coordinates)
- VDOP Vertical (Height only)
- RDOP Relative (average of the instantaneous PDOPs over observation time)

DoD

United States Department of Defense.

double difference

When two receivers track the same satellite at the same epoch, the difference of the single differences between the satellites is calculated as the double difference.

elevation

The angle of a satellite above the horizon. Directly overhead equals 90° elevation.

elevation mask

The lowest elevation (in degrees) at which a receiver will track a satellite.

ellipsoidal coordinate system

Coordinate system based on an ellipsoid definition with the parameters of semi major axis and flattening. The positions are described by (ϕ, λ, h); latitude, longitude and height.

ephemeris

Orbital data broadcast by a satellite to give its precise position. This positional data is used for subsequent calculations.

epoch

An instant in time chosen as a reference for which a set of satellite measurements is recorded. There will be only one measurement per satellite per epoch for every satellite being tracked.

fixed solution

The carrier phase observation model in which the ambiguities have been fixed to their integer values.

float solution

The equation found by normalizing the pseudorange distance and the carrier phase observation in which the ambiguities are real values.

GDOP

See dilution of precision (DOP) page Glossary-5.

GIS (Geographical Information System)

A database which is used to input, sort, analyze and display geographical data.

GMT (Greenwich Mean Time)

A time system based on the measure of the earth's rotation using the Greenwich Meridian as the reference frame.

GOBS

The planar vector displayed as a GPS derived north azimuth, vertical angle, and slope distance.

GPS (Global Positioning System)

A ranging system from known positions of satellites in space to unknown positions. GPS, developed by DoD, was conceived to determine position, velocity, and time on or near the earth on a continuous basis. Ranging is accomplished by receiving and processing signals transmitted by satellites with a receiver at the position to be determined.

GPOS

The delta north, east, and up as projected on a plane with an origin at the original GPS station.

GPST (GPS time)

A time system based on atomic scales. UTC was coincident with GPS time at the standard GPS epoch. In early 1994, the UTC differed by nine seconds.

GRED

The reduced horizontal plane distance, vertical distance, and azimuth.

GSTN

A point occupied by a GPS base receiver.

HDOP

See dilution of precision (DOP) page Glossary-5.

Helmert transformation

A transformation method using the least squares method to transform coordinates.

initialization

The technique used at the start of a kinematic survey to determine the phase ambiguities. The techniques include known, unknown and antenna swap.

ionosphere

The charged outer region of the earth’s atmosphere, from approximately 60 to 1,000 km.

ionospheric refraction

Carrier phase advance which occurs as satellite signals pass through the ionosphere.

kinematic survey

A survey technique where one receiver remains fixed while a second receiver alternatively stops and moves between points during the observation period.

known coordinate

A point whose coordinates have been determined to the required accuracy.

L-band

Radio frequencies between 390 MHz and 1550 MHz. The frequencies used by GPS are 1227.6 MHz and 1575.42 MHz, known as L1 and L2 respectively.

latitude

The angle measured at the center of the earth from the equator to the point of interest. The latitude is 0° at the equator and 90° at the North pole; -90° at the South pole.

level

A digital or manual instrument used to perform differential leveling. Levels aid in collecting accurate elevations, thus improving the accuracy of a survey job.

linear transformation

A transformation computed without using least squares adjustment - performing translation, rotation or both to a job’s coordinates.

local plane

A plane tangent to the earth at the initial GPS station, which is also has its origin as the initial GPS station.

longitude

The angle measured at the center of the earth from the Greenwich meridian to the meridian of interest. East longitudes are positive; west longitudes are negative.

loss of lock

A discontinuity of an integer number of cycles resulting from a temporary loss-of-lock in the carrier tracking loop. Often caused by an obstruction.

meridian

A north-south line on the earth's surface connecting the poles.

multipath

Radio frequency interference caused by satellite signals which have traveled different paths to reach the receiver. Most often caused by reflective objects in proximity to the receiver antenna.

network

The geometric consideration of the family of points which are yet to be or have been previously observed.

observables

Ranges, or distances, which are derived from measured time or from phase differences between received signals and receiver-generated signals.

observation session

Period of time over which GPS data is simultaneously collected by two or more receivers.

PDOP

See dilution of precision (DOP) page Glossary-5.

plane curvature correction

Correction applied to account for the curvature of the earth to GOBS. This allows vertical heights to be calculated.

plane (3D) transformation

See transformation page Glossary-15.

point positioning

Technique that uses pseudoranges from several satellites to determine the position of a receiver, in contrast to relative positioning.

points

A specific location of interest.

position

The coordinates of a point.

POS

The reduced coordinate of any SDR measurement type, applying all appropriate corrections that might exist.

preparative measurement

See initialization page Glossary-7.

pressure

Measurement of atmospheric pressure, which varies primarily due to elevation.

professional positioning

A balanced absolute value estimation and mathematical technique used to determine the coordinates of an unknown point and any observational errors.

projection

See transformation page Glossary-15.

propagation

The process by which a wave travels through a medium.

pseudorandom noise (PRN)

A code transmitted by GPS satellites which is unique to each satellite. The code is used for identification of satellites, as well as for pseudoranging. Its near-random characteristics allow it to be economically differentiated from normal background noise so that it might be correlated with the code generated on the receiver.

pseudorandom noise (PRN) number

An identification system in which a satellite is referred by the pseudorandom noise (PRN) code it transmits.

pseudorange

Range between a satellite and receiver, which was deduced from measured time and biased by satellite and receiver clock errors.

RDOP

See dilution of precision (DOP) page Glossary-5.

receiver

The physical device used for GPS signal collection and signal processing.

rectangular coordinate system

See cartesian coordinate system page Glossary-2.

reference satellite

A specified satellite, against which the measurements of other satellites are differenced, eliminating various systematic errors.

relative humidity

Measurement of moisture content in the air.

relative positioning

Method of determining a point's coordinates by adding a vector to the coordinates of a known point.

resection

Method used to determine the coordinates of an unknown point using least squares adjustment techniques.

residual graph

Graphical representation of the residual associated with individual satellites.

rms

Root mean square, a mathematical expression comparing the number of measurements and corresponding values against the average measurement (to account for any large inaccuracies), resulting in a value (displayed in meters) representing any possible unaccountable or random error.

$$\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}$$

Variable	Definition
n	number of measurements
$\bar{x}$	average of all measurements
x	individual measurement
i	index factor

where x_i is the individual observation and n is the number of observations in the series.

RINEX (Receiver Independent Exchange)

Standard file format for data collected on a receiver. This file format facilitates data sharing between various post-processing programs. SDR33 can use as RINEX files as input and can provide receiver file output to this format.

SA (Selected Availability)

Method used to limit full navigational use of GPS to civilians. This is accomplished by dithering the satellite clocks and manipulating ephemerides.

satellite constellation

The arrangement of satellites in space. GPS satellites orbit the earth once every 12 hours. With this constellation, at least four satellites can be visible simultaneously from virtually anywhere in the world.

satellite coverage

The arrangement of satellites in space visible to a GPS receiver at a given time. The optimum coverage for calculating receiver position is one that minimizes PDOP.

scale factor

A scaling calculation factor applied to terrestrial vectors.

set collection

A structured method of collecting multiple sets of observations from a station.

simultaneous observation

Multiple receivers tracking satellites at the same time; GPS time tags are the same for observations from the receivers.

single difference

When two receivers track the same satellite at the same epoch, the difference of the phase observables between the two receivers is calculated as the single difference.

static survey

A surveying technique where two receivers remain fixed in position during the observation period.

station

An instrument's location and backsight.

stationing

A distance measured along a link from a single node. Also referred to as chainage.

SV

Space Vehicle.

theodolite

An optical instrument used for high precision alignment and measurement.

time zone

A location based on the number of hours east of UTC (Coordinated Universal Time). SDR33 uses an incremental factor of +1 for every time zone east of the GMT line and a factor of -1 for every time zone west.

topography

Method of collecting data on physical elements within an area such as site features, relational information about points, points for contouring or other applications, and detailed information about location and attributes of desired points

transformation

The conversion of one type of coordinate system to another. The transformation of one type of coordinate system to a coordinate system of the same type is defined as a *datum transformation* (ellipsoidal to ellipsoidal) or a *plane transformation* (rectangular to rectangular). A transformation between two different coordinate systems (ellipsoidal to rectangular) is defined as a coordinate transformation which usually contains some variation of a *projection*.

traverse

An operation in which points are collected to create a relationship between points in a survey.

triple difference

When two receivers track the same two satellites for two or more epochs, the difference of the double differences between the epochs is calculated as the triple difference.

tropospheric

The moisture-laden layer of the atmosphere closest to the earth's surface.

UTC

Coordinated Universal Time. A time system based on atomic time scales. This system is coordinated with universal time (UT) and other civil time with the insertion of integer leap seconds.

VDOP

See dilution of precision (DOP) page Glossary-5.

vector

Mathematical expression possessing magnitude and direction.

wavelength

The distance between two identical and successive positions on a radio wave (i.e., crest to crest). The L1 carrier has a wavelength of approximately 19 cm; L2 is approximately 24cm.

wet temperature

Temperature with consideration for the latent heat of vaporization of moisture content.

WGS84 coordinates

World Geodetic System (1984); the ellipsoidal coordinate system used by GPS.

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