

Training Guide for SDR Level 5

Rev.2

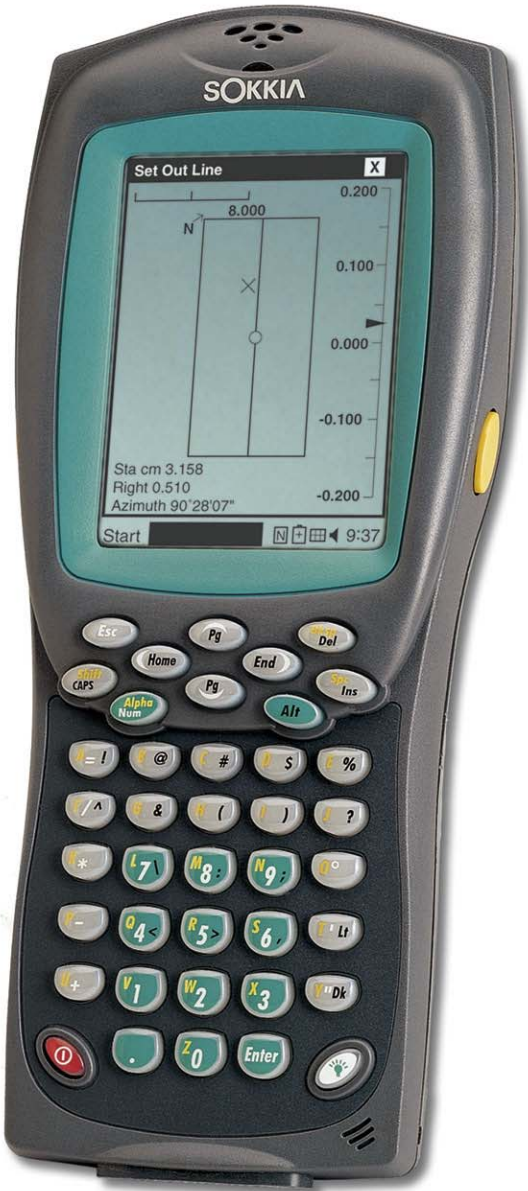


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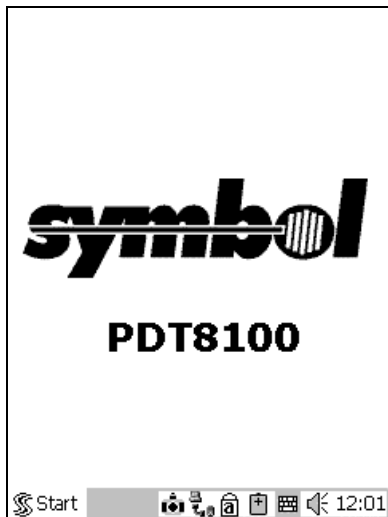
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The following Training guide is designed to provide End User training for SDR Level 5 and supported CE devices. The User upon completion should be capable of navigating through the program and have a working knowledge of each SDR function and its use.

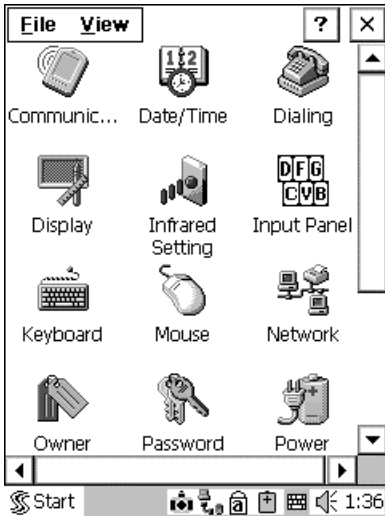
Topics presented in this training guide are designed with tutorials for the User to complete after each discussion.

CE Devices

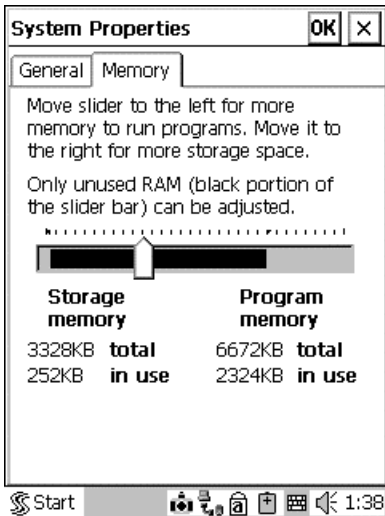
A working knowledge is required for all CE devices capable of running the SDR program. In this training session we will focus only on the SDR 8100. All CE devices offer similar utilities as discussed here.



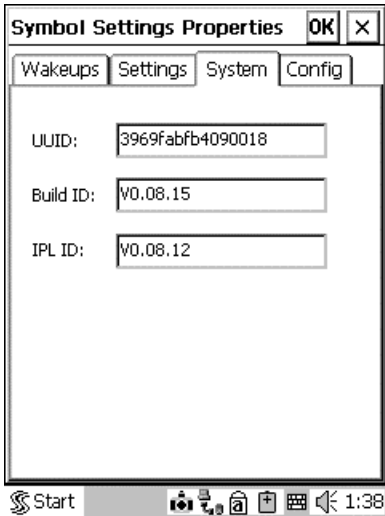
The SDR 8100 provides several system utilities and can be accessed from the Start Settings menu. The provided Options allow for setting system level functionality to optimize the SDR 8100 for effective use.



One of the most critical settings to verify is that there is enough RAM allocated for program use to allow the SDR program to run correctly. When programs are installed to the device such as the SDR program the 8100 will alter its default RAM settings as necessary. The provided RAM on the SDR can be utilized both for storage as well as program use. The settings is accessed from the Settings icon and is under the memory TAB. The recommended memory allocation is depicted below.

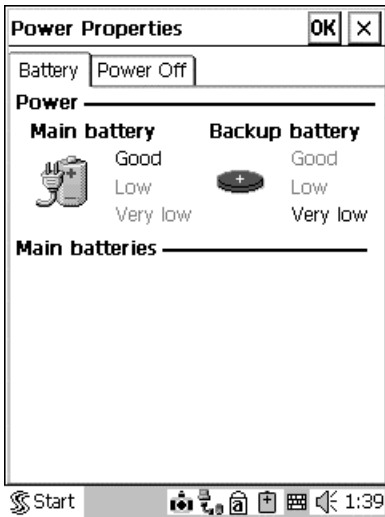


When requesting support for the SDR 8100 please provide the BIOS version information of the SDR 8100 as the BIOS is upgraded from time to time. Access the information from the Symbol Setting icon and selecting the System tab. The numbers to provide when requesting support are the Build ID and the IPL ID.

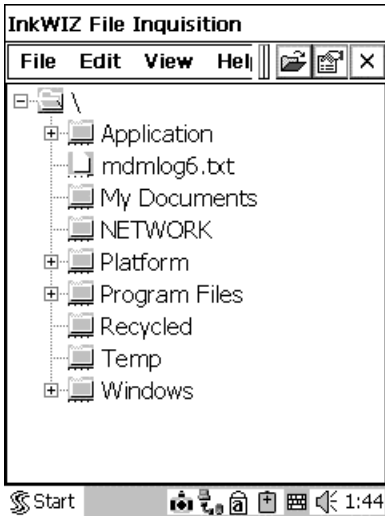


Power properties menu will display both the Main battery and the Backup batteries. The menu may be accessed from within the Start Systems settings or from the battery icon on the task bar.

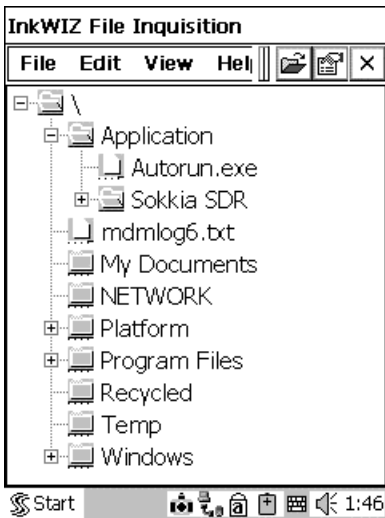
Prior to the initial use of the 8100 the battery should be charged for 2.5 hours. And additional 10 hours is required to fully charge the backup battery. Data stored in RAM will be effected by the total discharge of the backup batteries and by performing a Hard Reset.



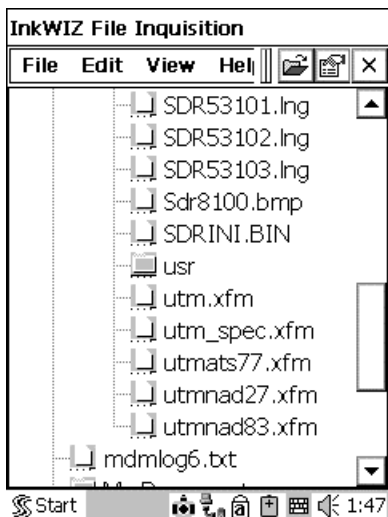
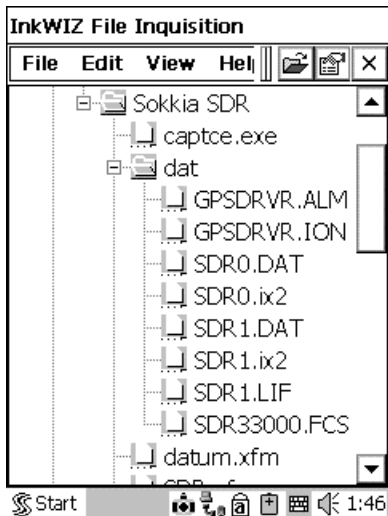
A file explorer is provided on the SDR 8100 for use in file maintenance and file transfer via serial or infrared communications. The Explorer is accessed from the Start Menu.



Note that there is two areas or disk partition that are protected Non Volatile memory the Application and platform directories. The SDR program is installed by default to the Application partition by default. All jobs are protected from power interruptions due to the NVM segment used to store the program and data to.



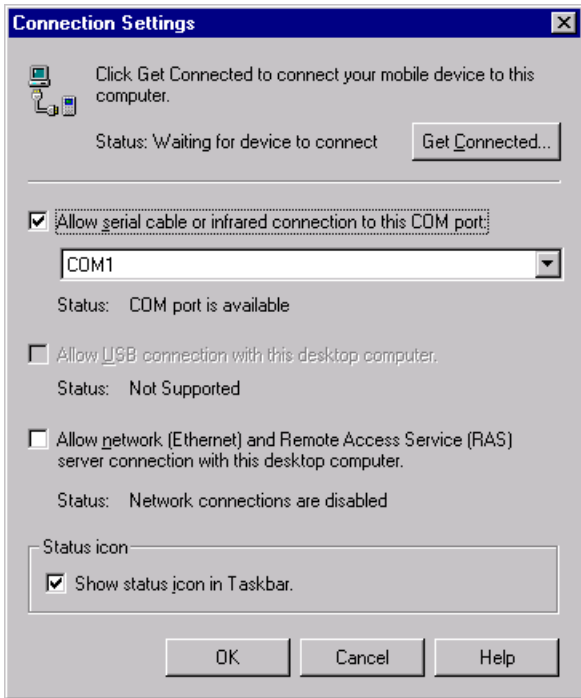
Subdirectories are created under the Sokki SDR root directory. The SDR uses the dat subdirectory to save the SDR job databases to and the usr directory to save the communication files the SDR is capable of creating.



The SDR may be installed on Compact flash also. However the Compact Flash will need to have a de-fragmentation program ran on it on a semi regular basis.

Using ActiveSync with the SDR 8100

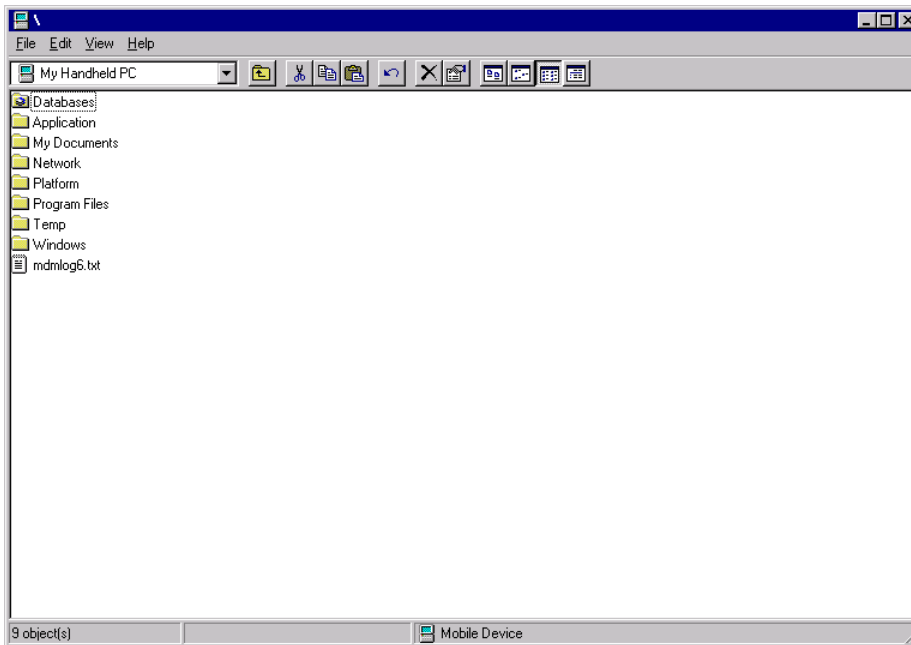
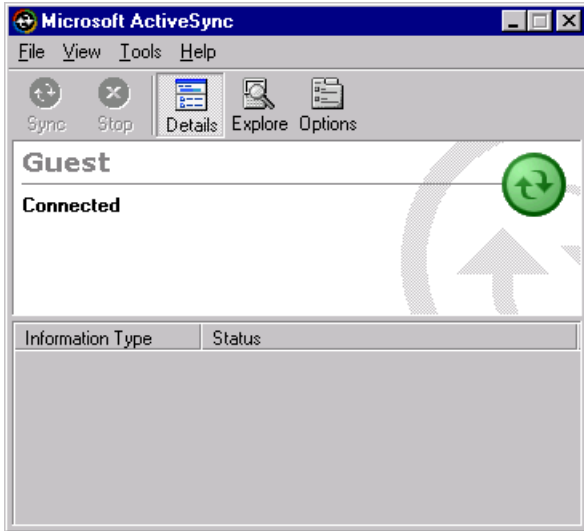
ActiveSync settings will have to be changed from time to time. Active Sync will take control of the computers serial port to allow communication only to a CE device. By selecting the Status icon to be displayed on the Windows task bar the User will be notified whether or not Active Sync has control of the Serial port.



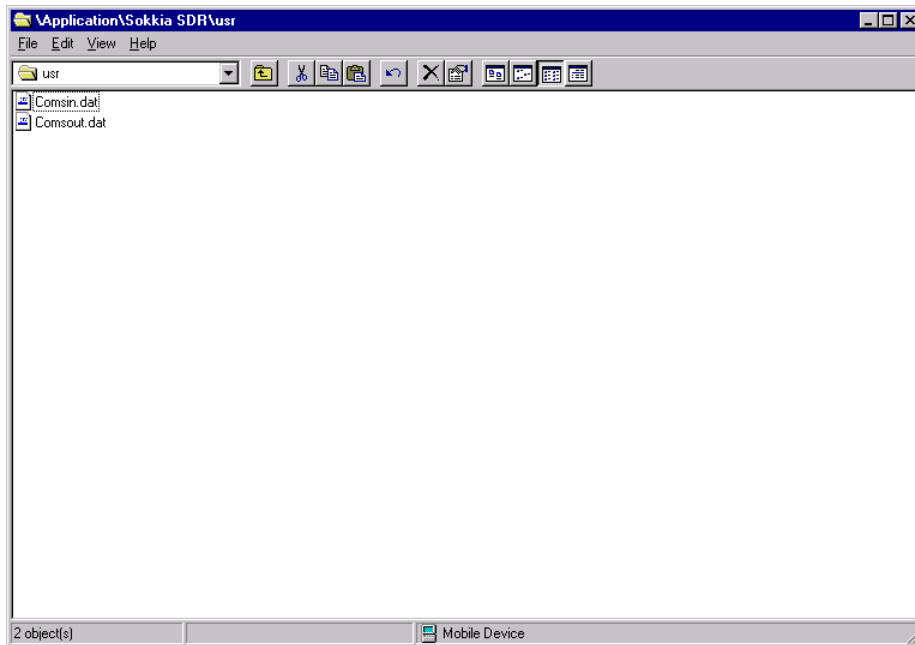
When communicating with the SDR with Active Sync do not create partnerships, as this will interrupt the ability to modify the SDR version via the program Setup utility.



Upon establishing a communication link between the SDR and the computer through Active Sync a Explore menu will be displayed and allow files to be transferred to and from devices.



To be discussed later the SDR provides two files that can be created on the device for transferring data to the SDR program. The files are the Comsin.dat and the Comsout.dat.



SDR

The SDR consists of five separate Modules'. Each organized such that easy navigation and Job management is made possible.

The primary use of each module is as follows:

- Function module:** Allow access to Job management functions
- Survey module:** Allow access to Topography Functions.
- Cogo module:** Allow access to Coordinate Geometry functions.
- Roading module:** Allow access to the Roding functions.
- Leveling module:** Allow access to the Level functions.

Certain items contained in any of the modules may be instrument specific. In such cases when the current instrument is not applicable to that menu item the user will be notified to change instrument to proceed.

II. Function module

Func | Job

Data collection methodology for your project should be determined prior to creating an SDR job and establishing certain parameters for that job. This requires some forethought of the survey data collection techniques that will be employed prior to creating a job. The SDR job creation process requires some predefined settings to be selected initially—some of which may not be changed after the initial setup.

Therefore data collection techniques that will be utilized throughout the project must be accounted for at the time the job is created.

When terrestrial data (ETS) and GPS (RTK) data are to be collected in the same SDR job it is especially important that the appropriate settings are made at the time the Job is created. The order in which data is collected is important to some of the selections made during job setup.

Example: If non XFM coordinates were selected for the job but the coordinates were of a map projected type, ETS data was to be included after RTK data collection, the scale factor for the ETS data must be entered at job creation.

The scale Factor for a Job or a Road Job should not be confused with that of a calibration scale factor. The scale factor set for a Job will only be applied to the ETS observations and not to the RTK observations as well the calibration record will only be applied to RTK observations.

All distance input fields must be entered using the ground distance (No Scale applied). This is also true for all Cogo routines and Road alignments, for either input or display information.

SDR Level 5 allows for an XFM to be selected during the creation of a new job. As a function of the selected coordinate system reduction method (either XFM or No XFM) the SDR makes specific setup options available for the coordinate system.

A job containing an XFM may be created with Known or Arbitrary starts. This feature offers flexibility in selecting the optimal initial STN or GStn location. When an arbitrary start is utilized, a single point calibration is available to compute the initial STN or GStn coordinates.

SDR Level 5 currently supports the following map projections:

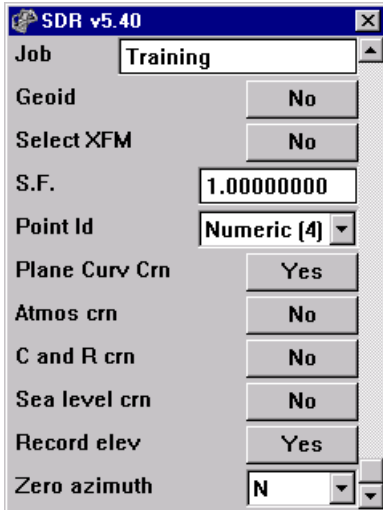
- Lambert 2 parallel
- Lambert 1 parallel
- Transverse Mercator
- South Facing Transverse Mercator
- Double Polar Stereograph
- Oblique Mercator
- Mercator

The SDR supports three methods in which to produce coordinates:

1. Simple Plane Projection.

2. Mapping Projections with Unknown Starts.
3. Mapping Projections with Known Starts.

When terrestrial data (ETS) and GPS (RTK) data are to be collected in the same SDR job it is especially important that the appropriate settings are made at the time the Job is created.



Certain options will only be made available relative to certain Job Selections and once set may not be changed.

Geoid Option

SDR Level 5 supports the use of a Geoid file for interpolating Orthometric heights when utilizing a XFM file. The Geoid grid file must be referenced to WGS 84 ellipse, and also must be rectangular to be considered a valid file for use with the SDR. In addition it must adhere to the NGS binary file format. When moving from the WGS view to the Local LLH the SDR will do an interpolation of the n value to produce the orthometric height by subtracting the n from the WGS ellipsoidal height.

The geoid file (*.und) must be placed in the directory the SDR.exe exist. In addition the file must adhere to the NGS binary file format. If no geoid file is contained on the device the option will not be present in the Job Menu list.

Locations that do not fit within the supplied Geoid file will produce a 0 (n) value.

XFM Option

SDR Level 5 allows for an XFM to be selected during the creation of a new job. For a xfm file to be selected it must be placed in the directory of the SDR.exe.

As a function of the selected coordinate system reduction method (either XFM or No XFM) the SDR makes specific setup options available for the coordinate system. A job containing an XFM may be created with Known or Arbitrary starts. This feature offers flexibility in selecting the optimal initial STN or GStn location. When an arbitrary start is utilized, a single point calibration is available to compute the initial STN or GStn coordinates.

Point ID

SDR Jobs are distinguished in one of two ways, either Numeric 4 (SDR 20) or Alpha 14 (SDR 33). The significance of Numeric 4 or Alpha 14 goes beyond the length allowed for the Point Id. The input and output precision is also effected. Numeric 4 allows for a numeric field entry not to exceed a Real 10 value. However, full precision is maintained in the database. Where as Alpha 14 allows for entry of Real 16 value. So when deciding on which type of job will be created knowledge of the magnitude of coordinates desired should be taken into consideration.

Scale Factor

SDR Level 5 allows a single Scale factor to be applied to all terrestrial data collected or data entry. When using a Scale factor all Cogo functions will display the ground distance rather than Grid distance. All distance input fields defining a specific geometric shape also require ground distance.

Plane Curvature Correction

SDR Level 5 RTK uses a local tangent plane just as in terrestrially collected data. The origin of the plane is tangent to the earth's surface at the initial Stn or GStn. In terrestrial data, the curvature corrections are calculated and applied to the vertical angle to allow for vertical reductions. In RTK, plane curvature corrections may also be applied to the RTK vectors to allow for vertical reduction when not using an XFM.

Atmospheric Correction

SDR Level 5 allows the use of Temperature and Pressure for terrestrially collected data. This correction is applied to the distance readings in the form of a ppm (Parts Per Million) correction. 1ppm is equal to 1mm per 1000.00 meters in correction. This option can be turned on or off anytime after the job is created by accessing this option in the Job Settings menu item.

Curvature and Refraction Correction

SDR Level 5 allows the use of Curvature and Refraction correction for terrestrially collected data. This correction accounts for the curvature of the earth and this correction is applied to the Vertical Angle. This option can be turned on or off anytime after the job is created by accessing this option in the Job Settings menu item.

Sea Level Correction

SDR Level 5 allows Sea Level Correction to be applied to terrestrially collected data. This correction is applied to the horizontal distance and reducing it to the seal level chord. When using scale factors from drawings it is important to determine if this scale factor as the sea level included in the factor, also known as a combined scale factor. If this is the case then not only a Scale Factor should be entered, the Sea Level Correction should also be applied. This option can be turned on or off anytime after the job is created by accessing this option in the Job Settings menu item.

Record Elevations

SDR Level 5 will allow elevations to be turned on or off, when collecting terrestrial data. This can only be set when the job is first created. This option needs to be turned on when GPS/RTK data is to be collected.

Zero Azimuth Option

SDR Level 5 supports User defined Orientation for use with RTK Jobs that do not contain XFM files. The User may enter a rotation value to be applied to all created GOBS produce by the receiver. An application Example of this might be if all GOBS were required written and displayed, as a Magnetic North azimuth then the User would select the User defined North and enters the magnetic declination when creating the SDR Job. This option is available for use with the Topo, Cogo and Roding modules.

Control Jobs

Control jobs allow data to be shared with an existing job. When a point id is entered that has not been used in the current job but exist in the Job marked control, the point will be added to the current Job.

To be added to an existing job this data needs to exist as a POS record or an observation in POS view. Changing the view from the database current view to a POS view is required when the point is derived by an observation.

When utilizing a Control Job with an RTK instrument in GOBS mode, upon entering the Point Id of the initial GStn a search is made in the control job. If the point exist the non-calibrated coordinates of the Point, the projection record and the last horizontal and/or vertical adjustment records will be brought over from the Control Job into the current Job.

When using points for Resection, whether they are drawn from a control job or exist in the current job, points need to be either a POS record or an observation stored in the POS view.

Coordinates

For coordinates to be shared between Jobs the Point must be in a POS view in the SDR Job that is being used as a Control Job.

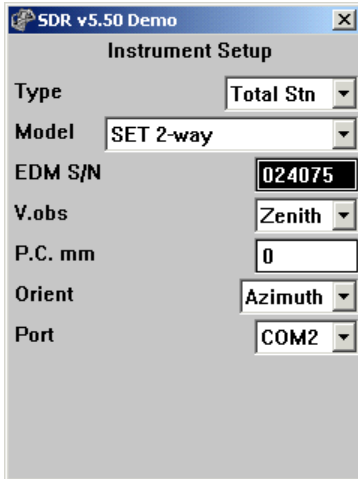
If the current job does not have a Projection record, then the user is prompted to store the Projection record from the Control Job.

Calibrations

If the current job does not have horizontal and/or vertical adjustment records then the user is prompted to store or discard the adjustment records from the control job.

Func | Instrument

The Instrument menu allows the User to be able to select from of all supported instrument types. Depending upon the instrument selected different options will be presented as either information about the instrument or options that may be selected or controlled by the User.

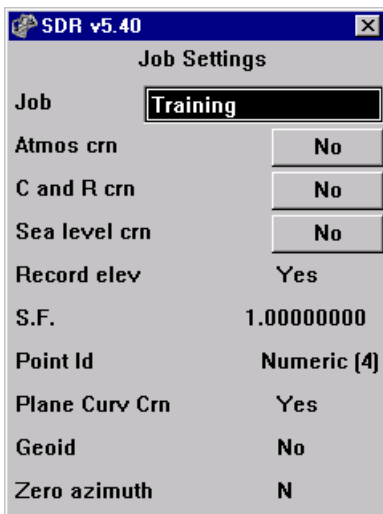


SDR will establish communication with a device and verify that a valid instrument is attached before allowing the user to proceed with further interaction with the selected device.

toggling off of the desired device and then back on the desired device then leaving the field will initiate the handshaking process. The SDR will try to establish communication with the device. As the initial communication occurs between devices a dialog box will appear with the messages “Working” then “Connect” letting the User know communication has been established.

Func | Job Settings

The Job Settings menu is primarily used for ascertaining the current Job Settings. Certain settings may be changed at any time while working within a SDR Job database. These options will be displayed by buttons, which may be toggled as Yes No. All other settings may not be changed after the Job is created.



Func | Config Reading

SDR Config Reading Option allows default Instrument Reading settings for all supported instrument types. These settings will remain as default until a Cold Boot is performed on the SDR. At which time all settings will return back to defaults contained in the SDR.cfg file.

When configuring RTK instruments only settings applicable to a specific receiver model will be displayed. Navigation display options are also controlled in this menu. There are two types of Navigation options, Point Navigation and Alignment navigation.

All Cogo functions that deal with the navigation relative to a point are set independent of Alignment Navigation as well as Line navigation.

Alignment Navigation allows for the use of Stationing and offset as a Navigation value.

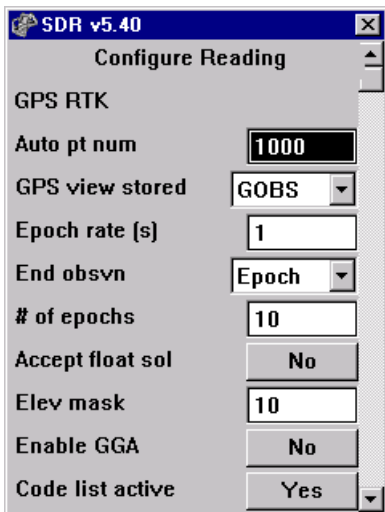
GPS view store determines what Record view is stored to the database when a point has been accepted from a Read.

Receiver settings allow the User to set a recording interval while collecting RTK readings.

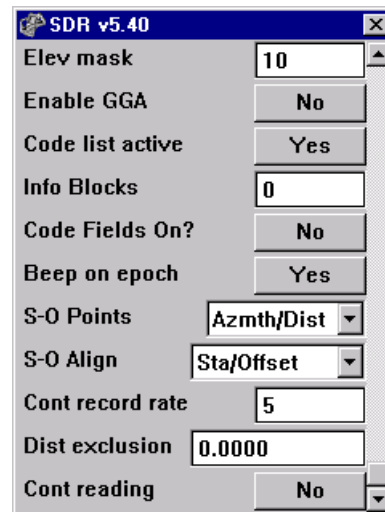
Feature coding allows the User to determine if Feature codes will be used and the method in which they will be entered.

The option Enable GGA, when set to Yes the user may select a rate in which to broadcast its GGA position through the radio port.

The primary use of this option is in conjunction with VRS and physical Reference networks, which require the position of the rover receiver prior to supplying corrections to the rover via a data link.



CONFIG READING – GPS RTK



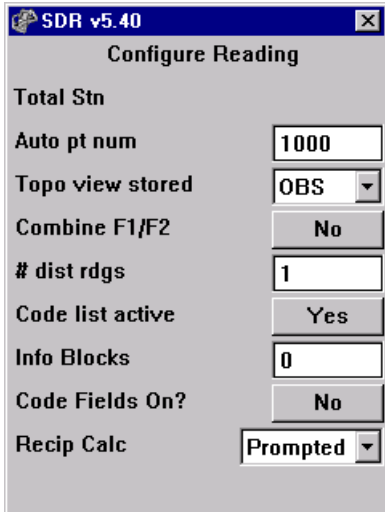
CONFIG READING – GPS RTK

The ability to perform Continuous RTK readings may be turned on or off as well. The continuous reading capability may be controlled in one of two manners.

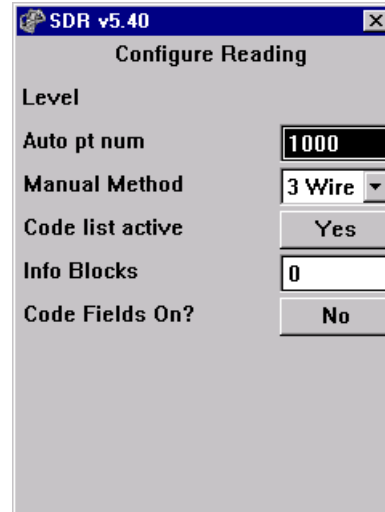
First, Distance exclusion, when set to zero the continuous epoch rate will determine when an observation will be stored to the database. If the exclusion is not zero the SDR will check to see if the antenna has moved the exclusion distance prior to storing the record. No record will be stored until the distance criterion has been met.

Second, data rate, when set at a rate points will be stored continuously on the data rate entered. This rate is independent of the Epoch rate for normal Reads.

When either the epoch interval or the elevation mask is changed the SDR will present the Instrument screen and upon acceptance of the screen will communicate with the receiver and change the desired setting on the receiver.



CONFIG READING – ETS



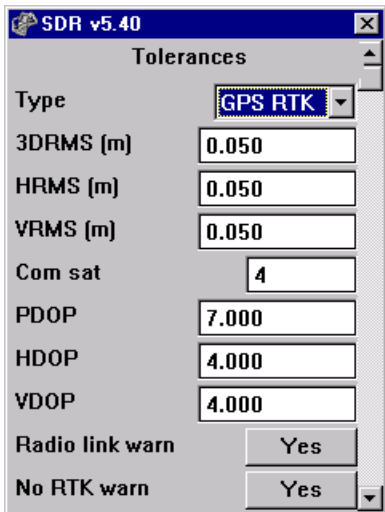
CONFIG READING - LEVEL

The User may also decide whether to use a feature code stack by setting the code list active. If the Code field is set to no the code field will not be presented in any screen in which gives access for code input.

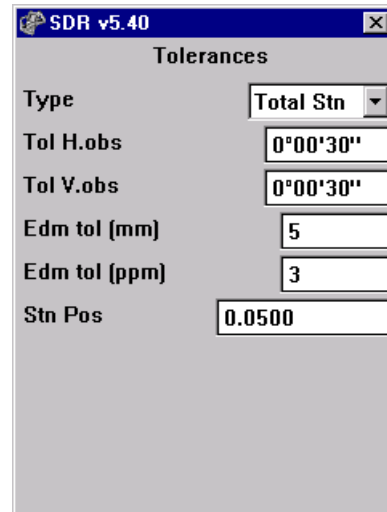
The SDR can perform Reciprocal calculations when full observations have been made when taking all backsight readings. When the tolerance values have been exceeded the SDR will use the setting of configure reading screen to determine how to prompt the user. Prompt before performing the reciprocal calculation, automatically perform the reciprocal calculation, or never perform reciprocal calculations.

Func | Tolerances

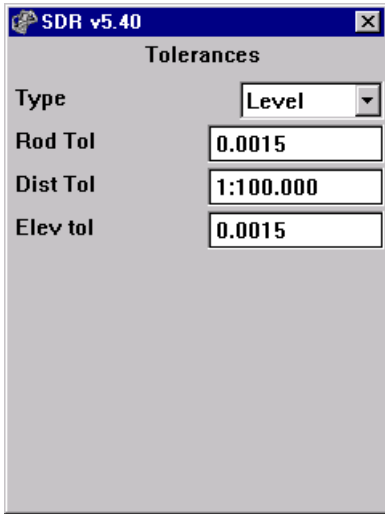
SDR gives the user full control on when they wish to be alerted for those observations that do not meet a predefined set of criteria. Verify all alarms settings work as expected RMS, Dops etc.



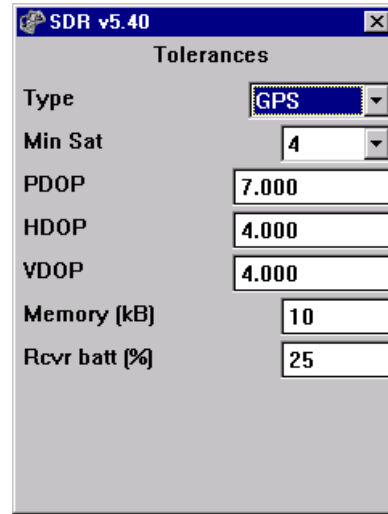
TOLERANCES – GPS/RTK



TOLERANCES - ETS



TOLERANCES – LEVEL

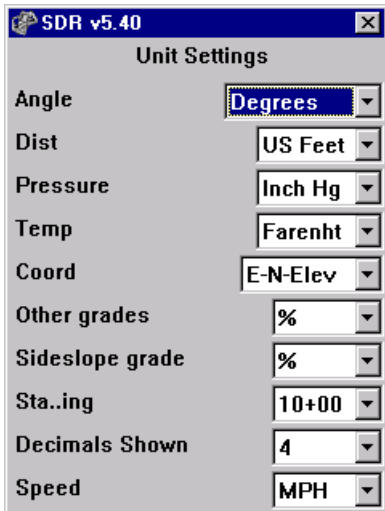


TOLERANCES – GPS (S/K)

Func | Units

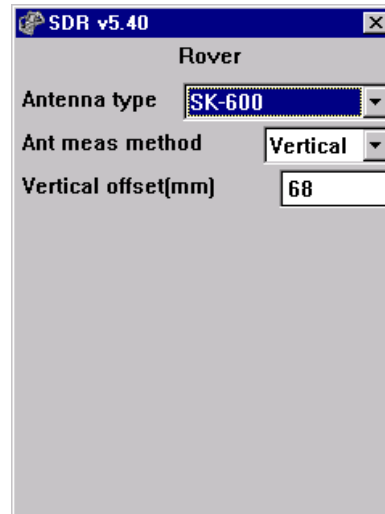
SDR Level 5 allows the User to select the distance and angle Units they wish to work in. As well the Coordinate order for display and entry may be defined.

The User is also allowed to select how certain distance fields will be presented. These items being line gradients, batter slopes, and Stationing (Chainage) display formatting. The User may change these settings at any time. However note records produced by any given setting will not be updated, as Note records are **static** records.

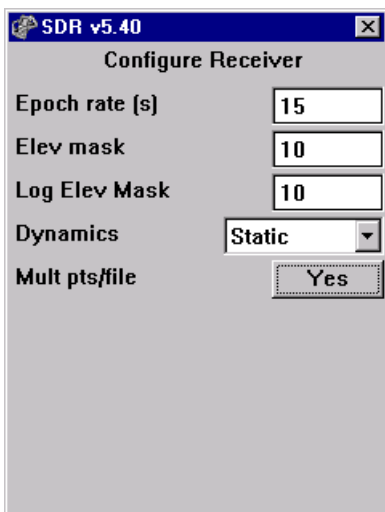
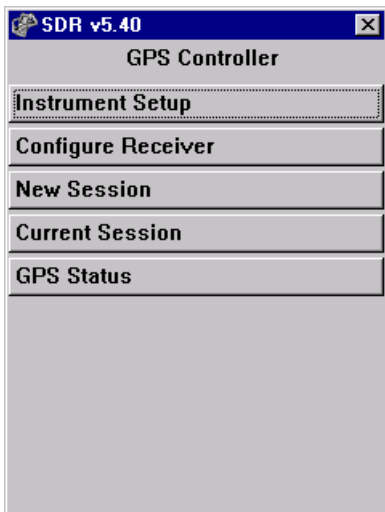


Func | GPS Controller

The SDR provides a GPS controller menu to allow a GPS receiver to be configured to collect Static GPS data. The Controller operations are outside the context of the SDR Job database. The basic operation flow is the same as used when utilizing a GPS S/K instrument type.



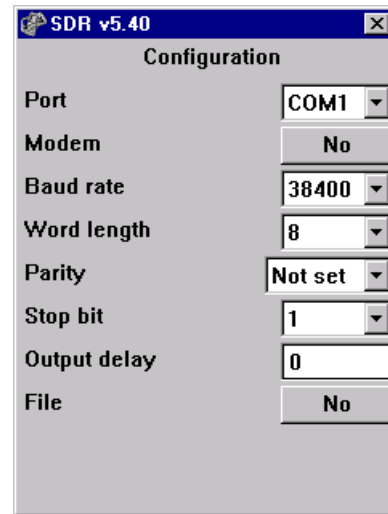
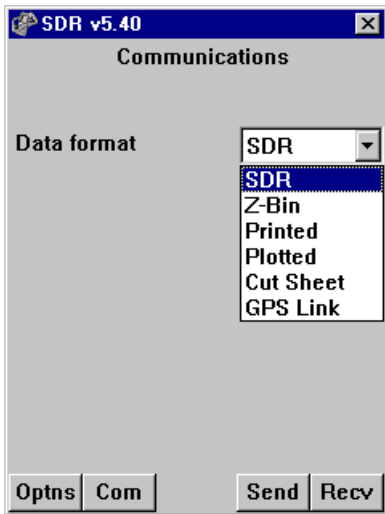
Upon having communicated with the instrument the User will be presented with a default file name to be stored on the GPS data card.



As long as the controller stays connected with the GPS receiver all status options are made available. Upon disconnecting from the receiver operations is giving back to the current SDR job. The receiver is powered down to end a observing session that was started by the Controller menu.

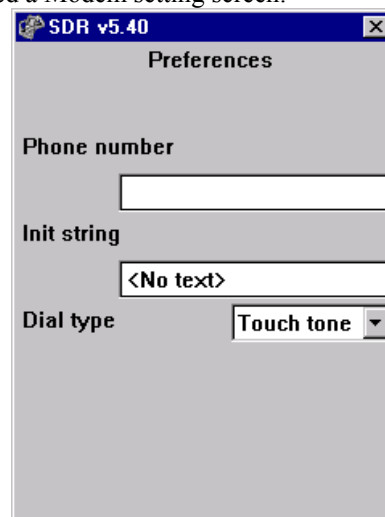
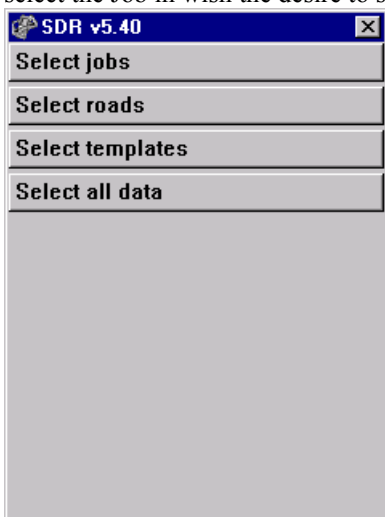
Func | Communications

SDR Level 5 uses the Communication Menu to give access to Import and Export Routines. As well allow the ability to establish a GPS communication link via cellular technology. The communication link can be between serial devices or output to a text file on the controller. Depending on the type of communication selected the User will be presented with screens to prompt the continued workflow.



In the Communication Configure the User can select a communication device, Modem, or File in which to send the selected data. When the File option is used the SDR will create a file named comsout.dat in which the selected file will be written. The comsout.dat will be saved in the directory of SDR\Usr.

When the communication is via a modem upon selecting the Send softkey the User will be required to select the Job in wish the desire to send after they will be presented a Modem setting screen.



The User will be prompted for the telephone number in which the wish to dial and any AT initialization string that may be required for that particular phone or modem being used.

The modem screen will also be presented when the Option of GPS Link is selected. The User is first required to select the GPS RTK instrument prior to accessing the Preference screen in which to initiate the call to the base receiver. The basic setup sequence for either Base or Rover is as follows:

1. Base Setup

Connect Cell phone to Cell phone data cable
Connect Cell phone data cable to special Radian/RadianIS cable
Connect special Radian/RadianIS cable to Radian/RadianIS Receiver Com2

---- Step 1---Select Instrument menu item from “FUNC” menu
Query the Receiver using the down arrow on the Model
Accept the Instrument after receiving the Serial no from the Receiver

---- Step 2--- Select Communications menu item from “FUNC” menu
Set Data format menu item to “GPS Link”
Select “Send” softkey from Communications menu
Turn on Cell phone
Set “Init string” menu item to
 &f (Motorola P280 with VoiceStream)

Set “Dial type” menu item to Touch-tone
Accept Settings

Wait (up to 90 sec’s) for base mode activity on Receiver
Return to Step 1 if unsuccessful

2. Rover Setup

Connect Cell phone to Cell phone data cable
Connect Cell phone data cable to special Radian/RadianIS cable
Connect special Radian/RadianIS cable to Radian/RadianIS Receiver Com2

---- Step 1--- Select Instrument menu item from “FUNC” menu
Query the Receiver using the down arrow on the Model
Accept the Instrument after receiving the Serial no from the Receiver

---- Step 2--- Select Communications menu item from “FUNC” menu
Set Data format menu item to “GPS Link”
Select “Send” softkey from Communications menu
Turn on Cell phone
Set “Phone number” menu item to the Base Phone number
Set “Init string” menu item to

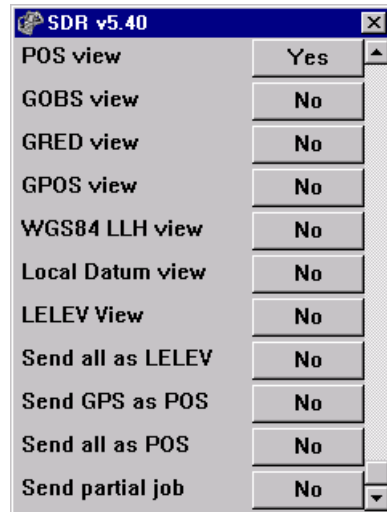
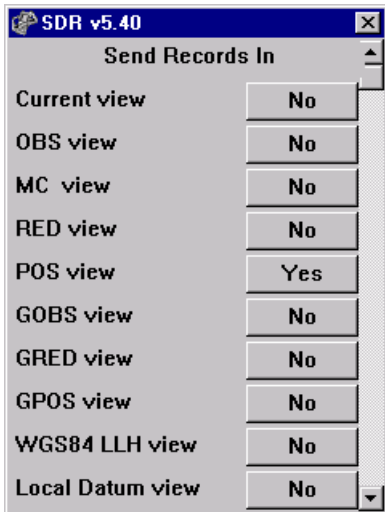
&f	(Motorola P280 with VoiceStream)
&f0+ipr=9600	(Motorola i700plus with Nextel)
&f0+ipr=9600	(Motorola i1000plus with Nextel)
&f+ms=11,0,9600,9600	(Samsung SCH-3500 with Sprint PCS)
&f0&N=6&U=6	(US Robotics with analog line)

Set “Dial type” menu item to Touch-tone
Accept Settings

Select GPS Status menu item from “SURV” menu
Select Geometry Status screen to check for Corrections through cell phones

Return to Step 1 or Step 2 if unsuccessful

The initialization strings listed are examples for the phones listed. This may vary depending on the device being used.



When sending a SDR Job the User may select which view will be sent. The User may also select multiple views in which to send. Some of the views will be dependent on the type of Job that is being sent.

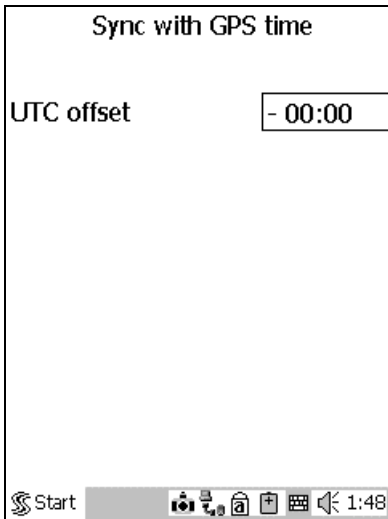
In addition to the different record views, a Partial Job can also be sent. This option allows the job to be output starting and stopping from anywhere within the file

Files in SDR format can be appended to the currently selected job in the SDR by sending an SDR file that does not contain a header record or job ID in the file that is sent.

Func | Date and Time

SDR provides the ability to sync the data collector's systems time to a GPS receiver. To access this functionality select the soft key SYNC to update the system time from a GPS receiver.

SDR automatically provides time stamps for any SDR Job. The default value may be changed in this menu as well as System time out values.



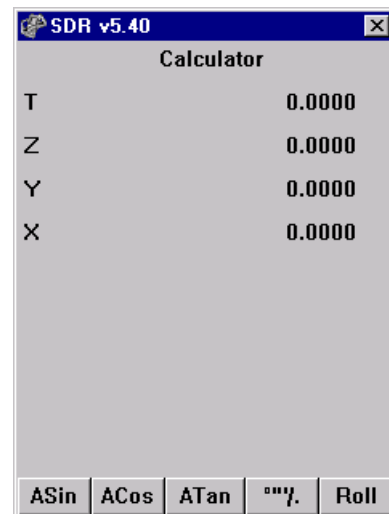
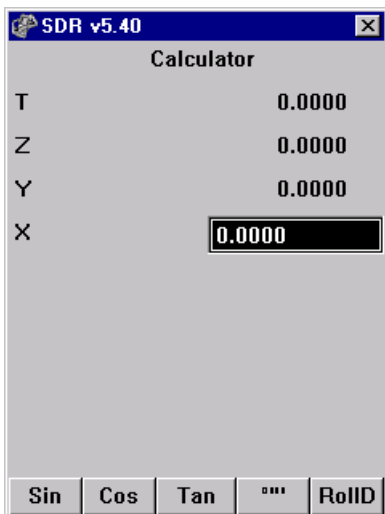
Func | Job Deletion

When a Job is to be deleted the SDR will first check to see if the Job has been transferred as of yet. If the Job has not been transferred the SDR will warn the User that the Job has yet to be transfer and will require the User to confirm prior to the Job being deleted. The Delete All option will only prompt the User once prior to deleting all jobs contained on the controller.

Func | Calculator

SDR Level 5 provides a RPN calculator. Each set of soft key functions has a corresponding inverse function which is accessed by using the up arrow key. Using the right arrow key accesses a new set of mathematical functions.

Any field in the SDR program that requires a numeric entry may be populated from the calculator by selecting Alt Enter. The value in the x register will be used to populate the field the cursor was in when the calculator was launched.

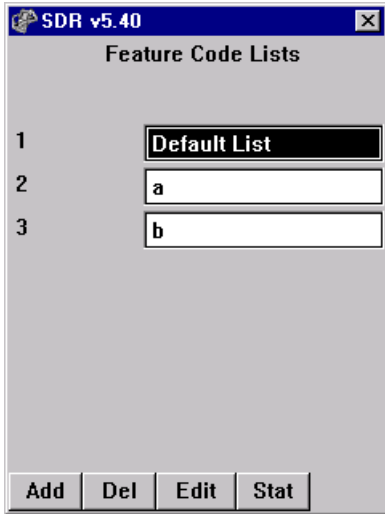


RPN allows equations to be entered algebraically. For example to enter the equation $2*(3+2)$ the user would key in the following 2 Enter 3 Enter 2 + *.

Func | Feature Code List

SDR Level 5 provides the capability to create and select multiple feature code stacks. In addition the ability to review the statistics of individual feature code stacks. SDR initially uses the default stack, which the User can add to. The user may define new stacks and add to them at any time.

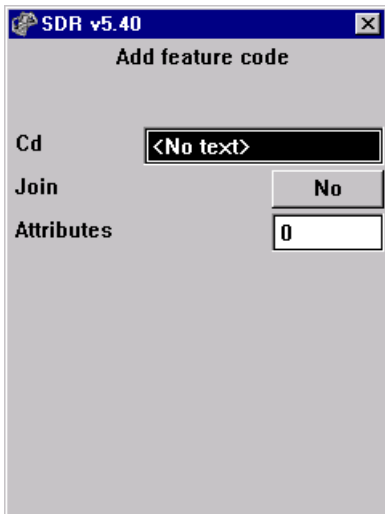
The Join Point option controls how feature code processing will be performed for the Plotted output option in the Communication Menu.



CHOOSE CODE LIST



ADD A NEW CODE LIST



ADD A FEATURE CODE



CODE LIST STATS

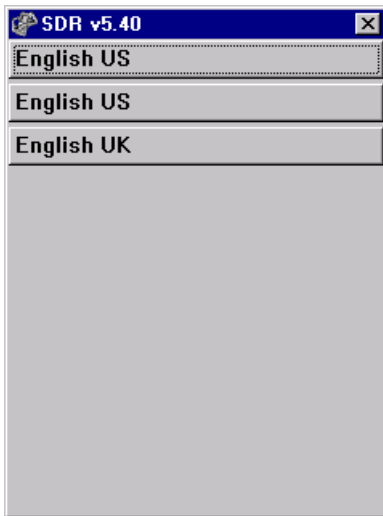
Sample ASCII feature code file as produced by Prolink.

```
00NMSDR20 V03-05 02-Apr-01 11:59 122211
10NMFeature Codes
13FCCP
13FCVALVE
```

13FCBANK1
13FCTBK
13FCGS
13FCCURB
13FCBCABLE
13FCTREE
13FCFCE

Func | Language

SDR Level 5 supports use of multiple Language files. A list will be populated with all language files contained on the device.



CHOOSE LANGUAGE

III. Survey module

SDR RTK Reduction

The GPS RTK solution, as solved by the rover receiver, is first reduced from its WGS84 LLH to a vector formed between the base receiver position and the rover receiver position. This initial vector is in the form of delta ECEF Cartesian coordinates. By performing two rotations, the SDR places the derived vector onto a local tangent plane in which the initial GStn becomes the Origin of the local tangent plane. Like terrestrial observations, RTK vectors are then stored in the SDR database as raw observations. The observations are comprised of horizontal angle (GPS derived North azimuth), vertical angle, and slope distance. In the case of a User defined orientation the observation will have the rotation added to the Azimuth produced by the receiver.

As in a terrestrial SDR job, RTK data may be reviewed and stored in various states, or record views. These views are expressed as follows:

No XFM selected	GOBS, GRED, GPOS and POS or RPOS (Roading Record)
XFM selected	GOBS, WGS84, Local Datum, GPOS and POS

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

With terrestrial data or RTK, the reduction process takes place when changing between one [view](#) to the next. Actual reduction will be a function of the current job settings, attached XFM and any calibration records that may exist. Desired views of individual records may be saved to allow for certain search routines to find the specific record. Review of the SDR manual on Search Rules may be necessary to fully exploit this feature.

With the additional support added in SDR Level 5, terrestrial data may now be truly treated in the same manner as RTK data and may seamlessly be integrated into the same job file. By orienting the instrument in geodetic North azimuth rather than traditional Grid azimuth when applying Scale and Sea level corrections for Grid surveys, SDR Level 5 orients both RTK and ETS coordinate systems in the same direction.

The other factor that must be considered is the measured slope distance. When moving from the MC to RED view in conventional terrestrial data collections utilizing a mapping coordinate system, distances are often corrected for scale and may have a sea level correction applied.

When utilizing an XFM the distance should not be corrected for curvature, scale or sea level height differences. The distance required is the shortest route between the instrument and the target. This is the equivalent of the RTK derived slope distance after antenna height differences are taken into account.

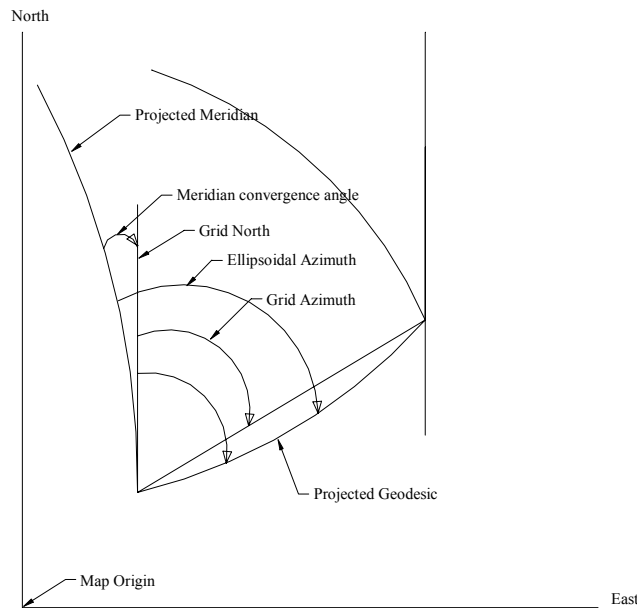


Figure 2: Relationship between the grid and the conformal sphere

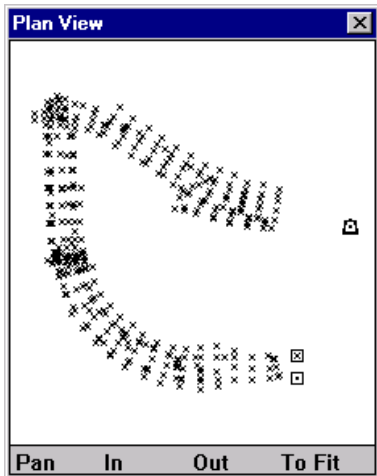
As explained above, because the raw RTK and terrestrial observations are in the same measurement reference frame the data may be seamlessly reduced and transformed together to ellipsoidal systems and placed on to a map projection.

When utilizing an [XFM](#) all calculated inverses, BKB records and Set Out functions will display the geodetic values required for the applicable use.

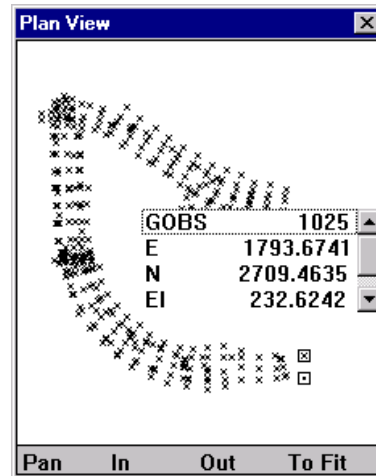
NOTE: If multiple Jobs are utilized on the same Project special caution should be exercised. Remembering that the rotation terms to produce GOBS for each unique job come from the Projection records. Calibrations contained in one job are only valid for that Job unless the Projection records of subsequent jobs are the same.

To assist the User SDR Level 5 provides a graphical view of all collected points, stations, and positions contained in the current Job database. Thus allowing the User a visual aid in which to determine if the site location data has been collected satisfactorily. Further the ability to ascertain point information by graphically selecting points. These screens may be accessed by pressing <ALT>+<W> from TOPO screen.

All observations are depicted with a x, positions a square, and all stations with a triangle. When an RTK instrument is connected the current position will also be represented in the graphic with a large x.



PLAN VIEW

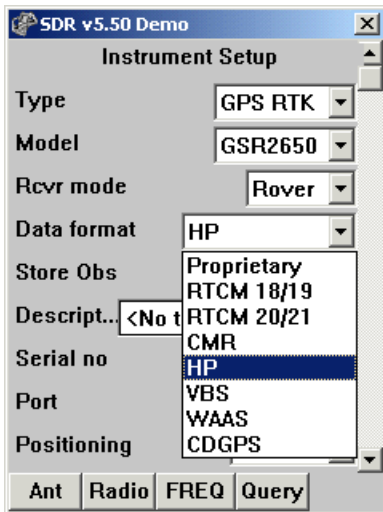


PLAN VIEW

FUNC | INSTRUMENT – RTK SETUP *****

When performing RTK surveys the User is required to select a RTK instrument Type. Upon successful communication between the SDR and receiver the user will see the Data format field appear. The data format will be the RTK correction format supported by the GPS receiver. Valid data types for the Radian family of receivers is as follows:

- Propriety = RTCA. Normal RTK mode between two Sokkia GPS receivers.
- RTCM 18/19
- RTCM 20/21
- CMR – Trimble data format
- HP – Omnistar HP (High Precision) decimeter-level service. Only available to GSR2650LB receivers with paid Omnistar subscription.
- VBS – Omnistar submeter-level service. Available to GSR2650LB and Axis3 (subscribed users only).
- WAAS – (Wide Area Augmentation System) A “DGPS” position option.
- CDGPS – RTCM 1/3

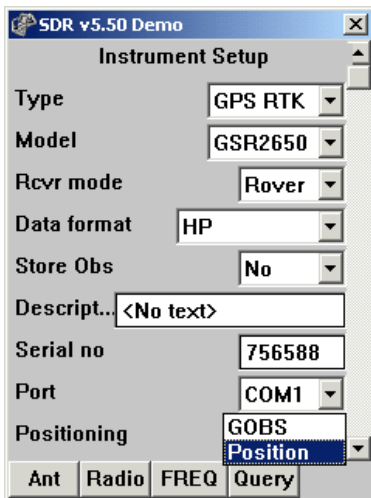


DATA FORMAT

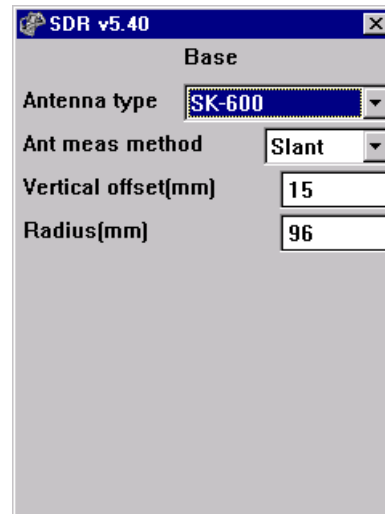
The antenna softkey <Ant> gives access to the antenna type and measurement method. The SDR requires this information to reduce vertical correctly. Upon acceptance of the screen the Base Antenna screen will be presented if the user did not hook directly to the base receiver. The User will be required to determine the type and method of the base as well.

The <FREQ> softkey allows users of the GSR2650LB to be able to change OmniStar Satellite Frequencies. It will only be seen when a successful query to the receiver is achieved.

A Radio softkey <Radio> is supplied to allow The User to change the broadcast and receive channels for Pacific Crest RFM radios.



INSTRUMENT SETUP



BASE ANTENNA (GOBS)

The “Query” softkey is there so that users may highlight their correct receiver model and tap on “Query” and it will begin the initial connecting process. This is an alternative to highlighting the model and toggling off the model to initiate communications.

SDR now offers two modes in which to collect GPS RTK data. The methods are Position or GOBS. SDR will still maintain a view of the raw data. However, the raw data now will reflect the method in which it was collected either a vector or a WGS Position will be stored to the database. Each method still reduces to a Northing Easting, and elevation. As well all reduction is

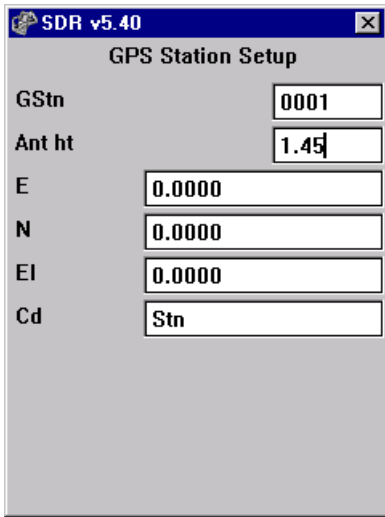
Upon a successful query of the GPS receiver, a new field will also appear at the bottom of the Instrument Setup screen labeled, "Positioning". There are two options available:

- GOBS
- POSITION

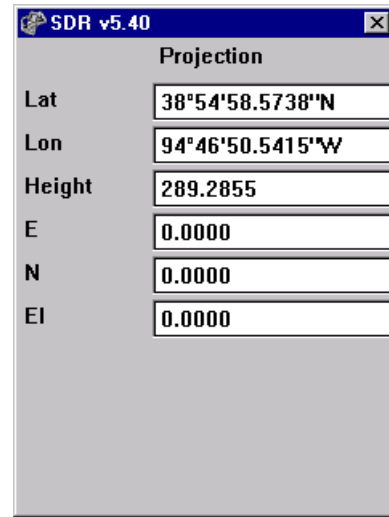
PROCEEDING WITH "GOBS" POSITONING MODE:

Upon completion of the Instrument setup and the User enters the Topography menu the User will be asked to supply information about the Location of the GSTN if GOBS positioning mode was selected.

If it is the initial GSTn for the current Job the user will be presented with the Projection record. The Latitude, a Longitude and Height fields of this record are editable. Care should be taken if this record is edited. Once the record is written to the database it may not be edited further.

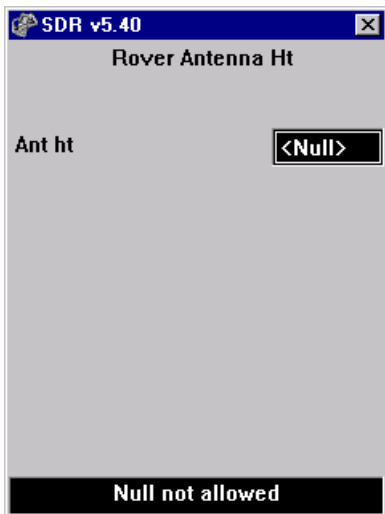


GOBS MODE – GSTN

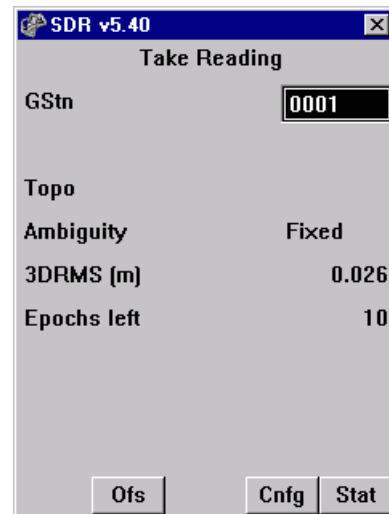


PROJECTION GOBS MODE

Upon acceptance of the projection record the user will be prompted for the Rover antenna height. After acceptance of the antenna the idle screen will be presented.



GOBS MODE – ANT HT



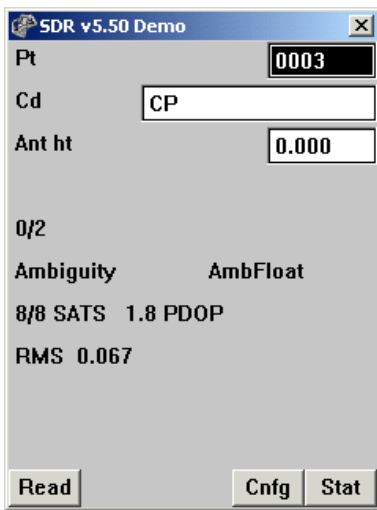
GOBS MODE – TAKE READING

PROCEEDING WITH “POSITON” – POSITONING MODE:

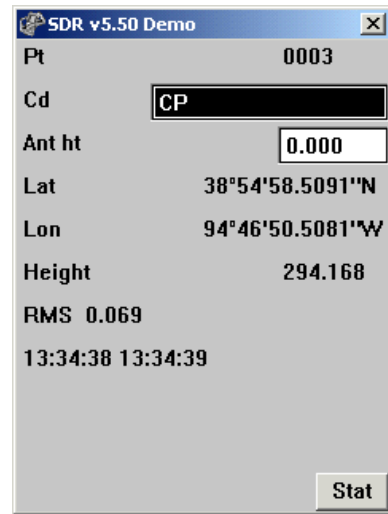
Upon completion of the Instrument selection screen, the user will be taken back to the <FUNC> menu once again. From here users may go directly into TOPOGRAPHY and begin taking readings, no GSTN is necessary in Position mode.

Users will be presented with a “Take Reading” idle screen in which they must enter the starting point id and the antenna height in order to proceed. As you can see on the screen on the next page, that the TOPO idle screen looks slightly different than that of the GOBS positioning mode. Because all readings are reported from the receiver as a position there will be no GSTN.

Position mode would be utilized when using correction sources that do not supply a reference position. For example when the GSR2650LB is using an OmniStar satellite for HP differential corrections there will be no reference position associated with the incoming corrections. The same thing goes for the Axis3 receiver using OmniStar.



POSITION MODE - READ



POSITION MODE - STORE

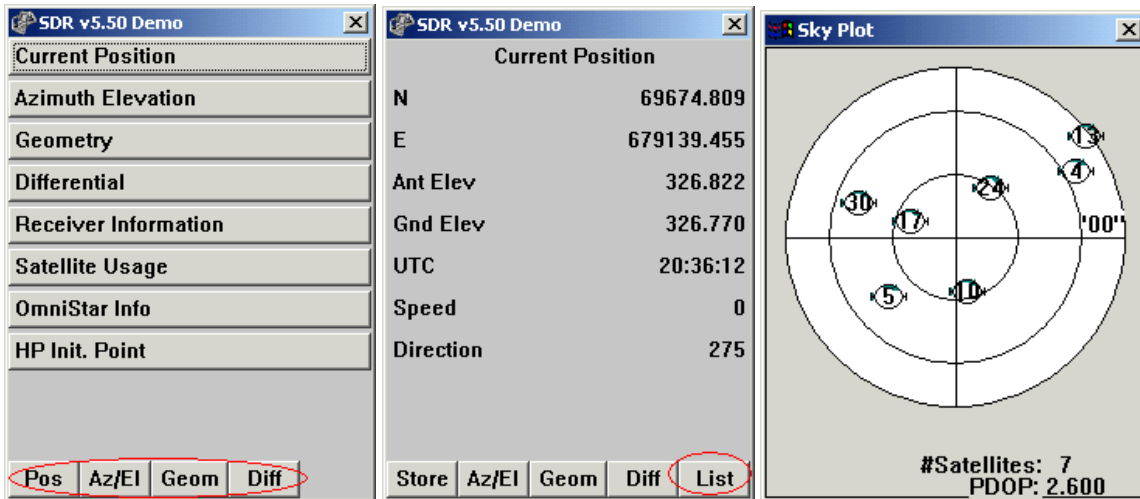
However, in order to do any kind of navigation in this mode, the SDR still will utilize a projection record. In addition, a RTK calibration would be necessary if must translate their data to a known mapping system. Please see <Func> <GPS Coordinate System> section in this training guide for further details regarding calibrations.

SURVEY | RTK STATUS

The GPS Status module allows the User to set and monitor the status of their GPS receiver. The options made available will be dependant on both correction types being utilized and specific receiver models.

GPS Status may be accessed either from the Main Survey Menu or from all GPS idle screens including Navigation Screens.

Notice there are two forms in which the Status options are displayed List view and soft keys. When the User is in the List view a Sky plot may be accessed and displayed by using the key sequence of Alt <P>.



GPS STATUS – List View

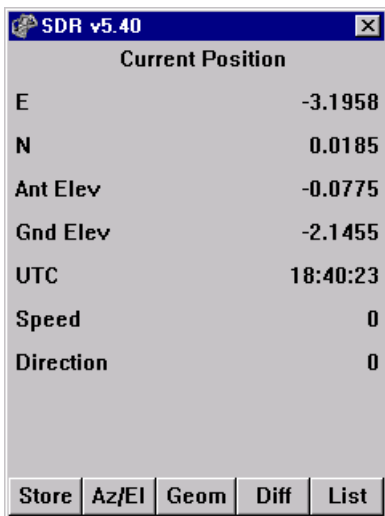
GPS STATUS – Soft Keys

SKY PLOT – ALT+P

Current Position

The Rover's current position or GS_n position may be displayed as North, East and Elevation or Latitude, Longitude and Altitude on the WGS 84 ellipse. To toggle between coordinate system use the Right Arrow Key. To move from base and rover positions use the Enter Key.

The position displayed may be saved to the database as a note record by using the Store soft key. The note record will be saved in the current coordinate reference frame displayed.



CURRENT POSITON



CURRENT POSITON

GPS Stn Position	
E	0.0000
N	0.0000
Ant Elev	0.0150
Gnd Elev	0.0000
UTC	18:41:31

CURRENT POSITION

Base Position	
Lat	38°54'58.5738"N
Lon	94°46'50.5415"W
Alt	290.7474
UTC	18:41:57

CURRENT POSITION

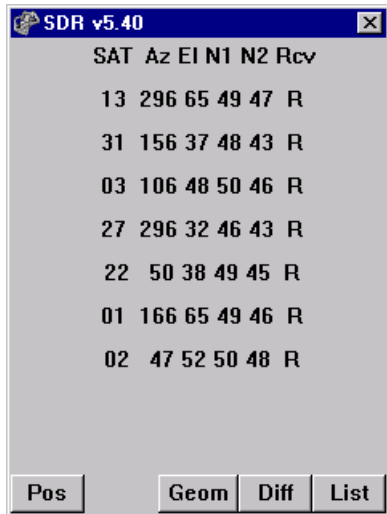
Geometry

Status allows access to useful information concerning the satellite constellation being currently observed. Information that may be displayed includes the Geometry screen, which displays geometry values that are being calculated from the constellation as seen by the rover receiver.

Geometry	
PDOP	3.300
HDOP	1.500
VDOP	3.000
HRMS (m)	0.015
VRMS (m)	0.026
3DRMS (m)	0.030

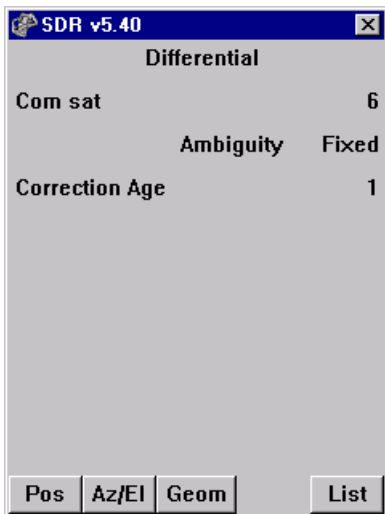
Azimuth Elevation

In addition, the Azimuth Elevation screen displays useful information about the strength of the GPS signal of both the L1 and L2. Attention should be given to the signal strength of the L2 signal. In general terms the signal strength should be above 30 on L2. As a satellite begins to set it will become weaker. Also displayed is the location in the sky of each Satellite being tracked.



Differential

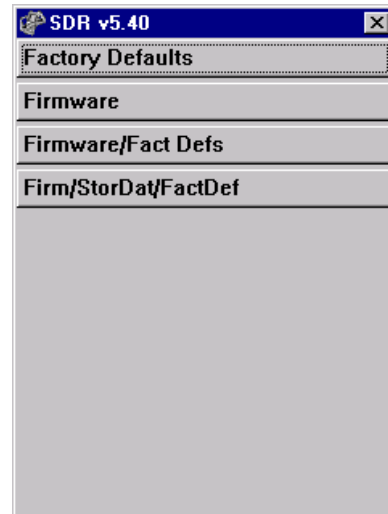
The Differential screen will display the number of satellites in the RTK filter and the state of the solution. Also displayed is the correction age of the solution. This age should depict the epoch interval the base is broadcasting. If the age begins to grow indicates that the rover receiver is not receiving all of the base corrections. When utilizing a modem as the data link it is not uncommon to have a correction age of 2 seconds. The routing of the information through the cellular network causes this delay.



DIFFERENTIAL

Receiver Information

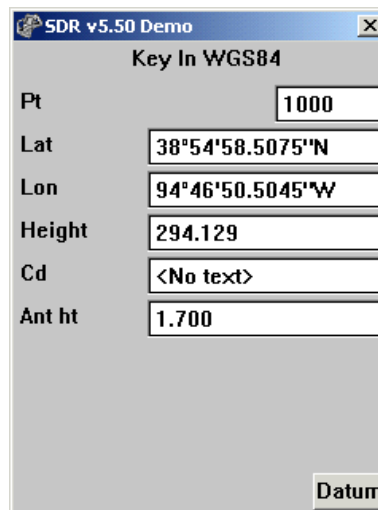
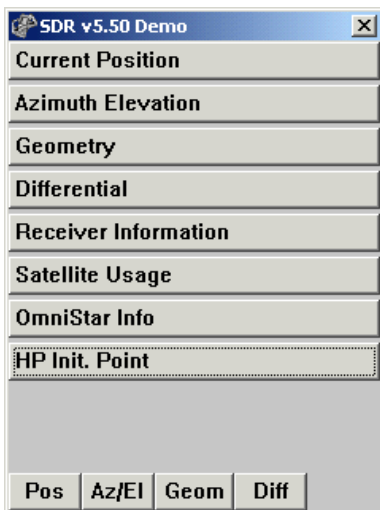
The receiver information screens displays all current firmware on the receiver, serial number and available memory. A softkey is given to allow the receiver to be reset if necessary from the SDR. There are 4 different levels of a reset, which may be used.



HP Initialization

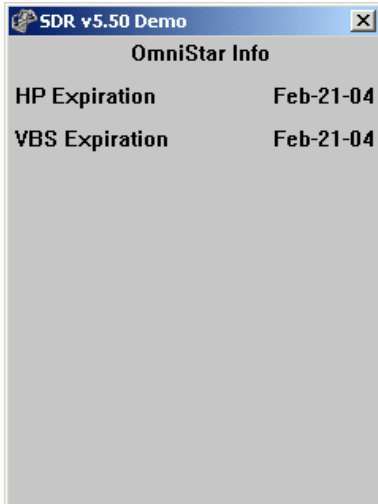
The GPS Status menu allows the User to speed up initializing the OmniStar HP receiver filter used by the GSR2650LB receiver. By supplying a known position of the GPS antenna will reduce the search performed by the receiver to resolve the HP position.

The position may be manually entered by the User or may be brought in from the current database. The User must enter the Antenna height so the SDR will be able to send to the receiver the exact height of the antenna. The coordinates supplied should have a maximum of 5 centimeters 3D standard deviation. If the coordinates exceed this threshold the search could take up to 20 minutes to produce a HP solution.



OmniStar Information

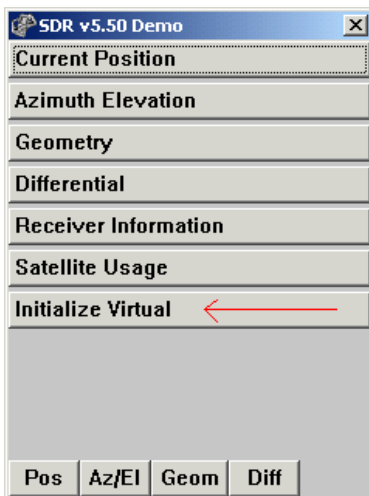
The OmniStar Information screen (GSR2650LB and Axis3 receivers ONLY), displays dates when your OmniStar subscription is to EXPIRE. Receivers that do not have a subscription will display the date 01/01/1980.



OMNISTAR INFO (GSR2650LB)

Initialize VRS

The Initialize Virtual option enables users to submit their current positions (as a NMEA-GGA message) to a VRS base system. By tapping on this option, it will send the current position of the Rover out COM2 and through the radio/modem link to the base location so corrections may be established. When you tap on the button, you will see a brief dialog box that says, "Working". This will serve as the only confirmation that the action has taken place. It may be utilized in either Position or GOBS positioning modes.



INITIALIZE VIRTUAL

Survey | Topography | Take Reading | RTK

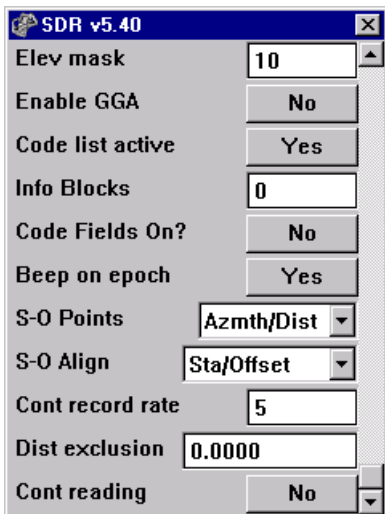
Create a New Job and select **No** to the XFM option. Verify that the Plane Curvature Correction is set Yes and the Job type is Numeric 4.

Select the appropriate GPS RTK Rover receiver by toggling to the receiver then off then on and arrow down.

Next Select the Antenna Softkey and select the appropriate Antenna and set the method to Vertical. Upon accepting the Rover Instrument verify the Base Antenna type and set Method as Slant. Now select Configure Reading and set the End observation criteria to Manual. At the GStn setup screen Enter GStn point 1 and coordinates of 0,0,0 and the correct an antenna height.

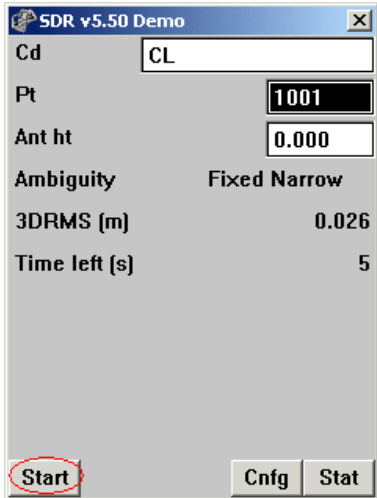
Now collect 4 points (1000 – 1003) that form a rectangle approximately 10 feet square. Upon completion of each reading select the Config softkey and change the end observation criteria.

Now utilize the Continuous reading functionality of the SDR. First, select the Config softkey and change the Auto point ID to 2000. Set the Continuous Reading option to yes, data rate to 1 second and the distance exclusion to 10 feet.

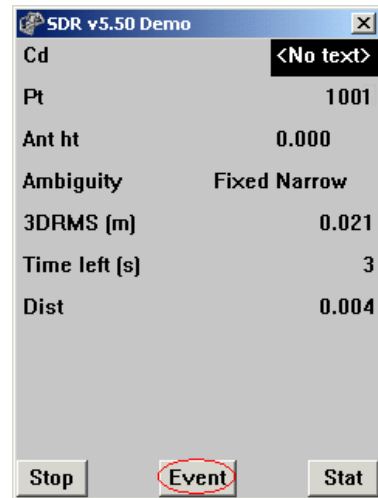


CONFIG READING – GPS/RTK

To begin continuous readings select the softkey Start. Starting at point 1000 move to point 1001 when you arrive at point 1001 note that a GOBS record will be stored.



CONTINUOUS READ – IDLE

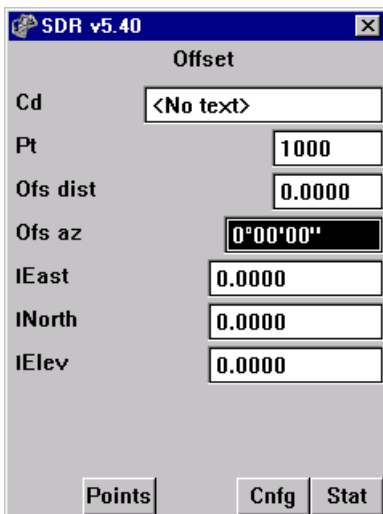


CONTINUOUS READ - EVENT

Now use the Event softkey momentarily to stop the continuous recording and collect a fine point. Note that the Take read idle screen is presented. After accepting the Reading, select the Resume softkey and now travel to the rest of the points in order and note when a GOBS record is stored.

Survey | Topography | Take Reading | Offset's | RTK

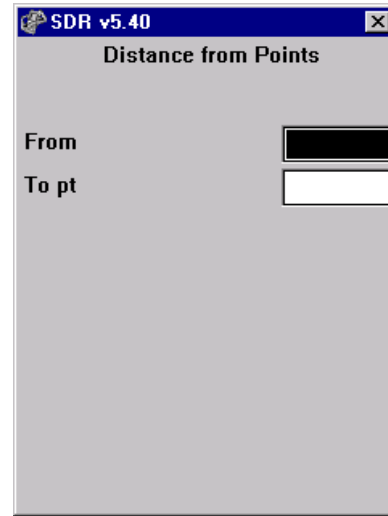
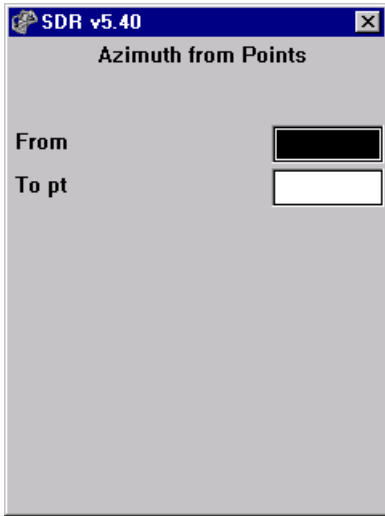
With the previous Job we will now perform an offset reading. An offset may be performed either before the recording has began or at the presentation of the GOBS prior to accepting the current reading. The actual GOBS of the pole location will be recorded to the database as a note record as well as the Offset values presented.



OFFSET – AZIMUTH/DISTANCE

Two methods of producing the offset values exist. 1. The User Keys in the offset values as Azimuth, Distance, and a Height difference. 2. The User Keys in the offset values as Delta North, Delta East, Height differences. 3. The Azimuth and Distance may be produced from Points that exist in the Database.

By selecting the Points softkey and highlighting an entry field the appropriate inverse function will be used to populate the value of the current field.



First use the Key in method. Enter an offset value in the delta East field of 10.00. The azimuth field should update to display 90 00' 00". Now occupy point 1000, collect a new reading and accept the reading. The new Point number should be 1004. View the database of the newly collected point and verify that the position is 10 meters East of point 1000 and the North coordinate is the same.

Now use the point option by setting the highlighted field as Azimuth and selecting the Point Softkey. Select point 1000 as the From Point and 1004 as the To Point. Upon accepting the screen the Azimuth field should now display 90 00' 00". Now move to the Distance field and select point 1000 as the From Point and 1004 as the To Point. Upon accepting the screen the Distance field should now display 10.00. Take a new Reading point 1005 and verify that the position is 10 meters East of point 1000 and the North coordinate is the same.

Now perform the offset functionality with XFM's by creating a New Job and select **Yes** to the XFM option. Select the appropriate RTK receiver. At the GStn setup screen Enter GStn coordinates of 0,0,0 and appropriate antenna height.

First take a reading using the appropriate antenna height without applying an offset. Now go to GPS Coordinate system and select Key parameters. Enter translation values that match the true projected coordinates of the projection record. This now calibrates the coordinate of the first shot.

From the Take reading idle screen select offset soft key. Now enter in an offset in the azimuth field of 90 00' 00" + the convergence angle and a distance of 10.00. View the database of the newly collected point and verify that the position is 10 meters East of the first collected coordinate and the North coordinate and the elevation is the same as the original point.

Survey | Topography | Take Reading | ETS

Survey | Topography | Take Reading | Offsets | ETS

OFS -Angular offset. The SDR will record a distance and a vertical angle to a point and then request a second observation to record the horizontal angle.

OFS-D - Offset with distance. The SDR will record a raw observation to the prism and then request information regarding the distance and direction to the real point.

OS-2D - Two distances offset. This offset would most likely be used in Mining. The SDR takes observations to two prisms; this then creates a vector to calculate the location of the point.

SDR v5.40

Code	<No text>
Pt	1002
Target ht	0.0000
V.obs	<Null>
S.Distance	<Null>

Cnfg

SDR v5.40

Code	<No text>
Pt	1002
Target ht	0.0000
Ofs dist	0.0000
Dirn to prism	<
H.obs	<Null>
V.obs	<Null>
S.Distance	<Null>

Cnfg

SDR v5.40

Take 2nd o/s read

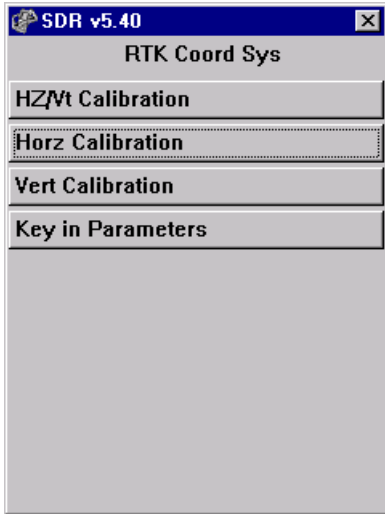
Stn	0001
Topo	

Cnfg

Survey | GPS Coordinate Systems

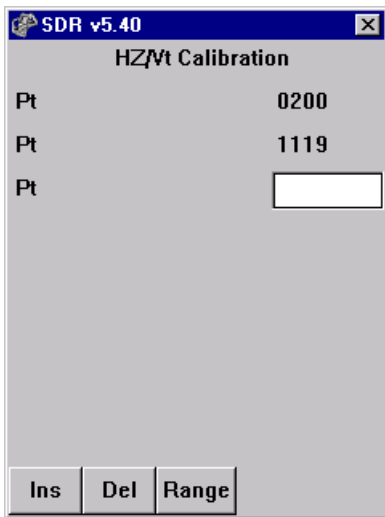
Calibrations in SDR Level 5 deal primarily with local assumed coordinate systems. However they also may be used in jobs that contain an [XFM](#) and are set for known or arbitrary start (unknown). Calibrations are used to move the GPS orientation and scale into coincidence with the local assumed coordinate system as well as to model the effects of [geoidal undulation](#).

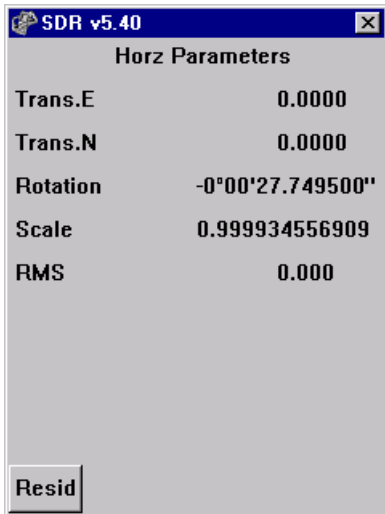
All calibrations are calculated utilizing Least Squares techniques, which is very similar to the [Helmert Transformations](#) also provided by SDR Level 5. The Calibration routine will produce residuals for all points included in the Calibration just calculated to aid the User in determining the validity of the calibration.



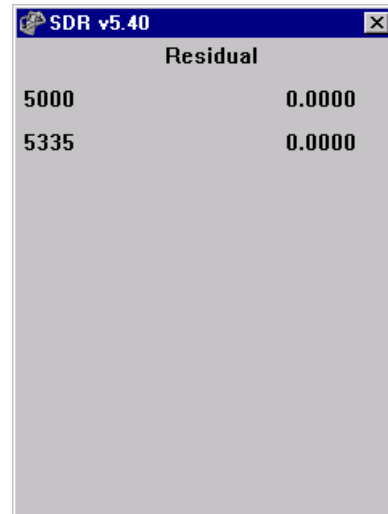
Horizontal or vertical calibrations are applied only to RTK vectors. There will be no calibration corrections applied to terrestrial collected data that is included. Therefore, to maintain a homogeneous coordinate system the terrestrial data should be set up to be collected in the destination system. Applicable settings, such as the Scale Factor, Curvature and Refraction settings if Plane Curvature Correction is to be applied to the RTK collected vectors, should be established when creating a job.

Only one requirement is made as to which points may be used in the calibration process. It is required that the SDR know the position of any point to be included in calibrations in both coordinate systems. This means that a GOBS/WGS84 or a GPOS, and a POS KI, or a RPOS must exist for any point to be utilized in a calibration. A maximum of 8 points may be utilized in any calibration.





HORIZONTAL PARAMS



RESIDUALS

If multiple calibrations are employed and have been saved in the attempt to obtain the desired calibration only the last calibration is used for reduction. All static records, such as SO records that were obtained between each calibration, are rendered obsolete due to the position that produced the record is no longer the same value. This is also true of any STN that occupied a GOBS point, as STN coordinates are static records.

SDR Level 5 allows keyboard input of calibrations. This means that if an area is to be surveyed often or included in multiple SDR job files (for example with two rovers), the user may keyboard in the values and are not required to observe all of the calibration points. Also this allows for a calibration to be zeroed out by entering a 0 for translations and rotation terms, and a scale of 1.000000000 —thus neutralizing any prior calibrations. If a calibration record exist in the Job database when the user enters into the Key in Parameters option the current calibration record is displayed for viewing or editing.

When performing a Roding Job with a RTK instrument a calibration must be performed prior to utilizing set out capabilities. The acquisition of the GOBS record for use in a calibration may be obtained via Road Topography option within the Roding module or from the Topography option in the Survey module prior to a calibration.

To verify the calibration routine a network of known points is required. The known points should be then shot via RTK methods and known values keyed in with Keyboard input. Select the points and perform the calibration. Verify the solved values equal that of the Combined factor, Convergence angle are that of the GSTN location and the translation values are that of its known location minus the arbitrary coordinates entered in the GSTN setup.

With a Job that contains a valid calibration record select GPS coordinate system. Select Key in Parameters. Verify that the current calibration is displayed. Now select the Null option and verify that a new calibration record was inserted into the database and that the values contained are zero for the translation elements 0 rotation and a scale factor of 1.

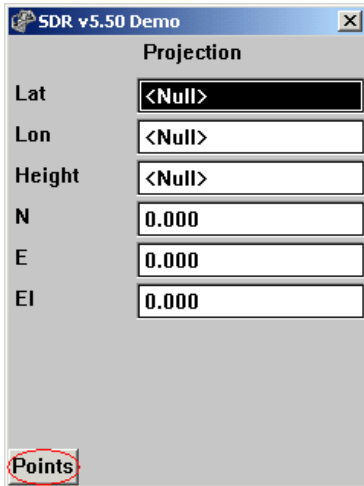
- **CALIBRATIONS W/ POSITION MODE******

Some special conditions do exist when using the RTK gear in ["Position"](#) mode. You will still follow the same procedures as outlined in this section, however the software will ask you to create a projection record upon entry into <GPS Coordinates System>. This is not as difficult as it may seem.

Since are raw data is a WGS coordinate expressed in Latitude and Longitude it must first be rotated onto a tangential plane. To do so we must first create a projection record to rotate about.

First, we must choose this point, which also may come from any arbitrary TOPO READ. This does NOT have to be a known monument we are just choosing a point to rotate about.

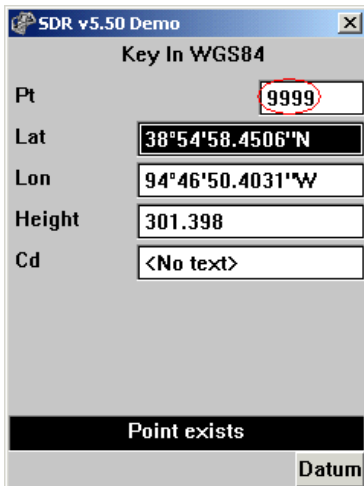
By Selecting <GPS Coordinates System> and selecting the Point Softkey select the point you wish to use as the origin. It will populate the fields with the WGS84 LLH of the point selected. Confirm this screen by the ALT+ENTER and save the projection record.



The screenshot shows the 'Projection' screen in the SDR v5.50 Demo application. The title bar reads 'SDR v5.50 Demo'. The screen contains several input fields for projection parameters:

Projection	
Lat	<Null>
Lon	<Null>
Height	<Null>
N	0.000
E	0.000
EI	0.000

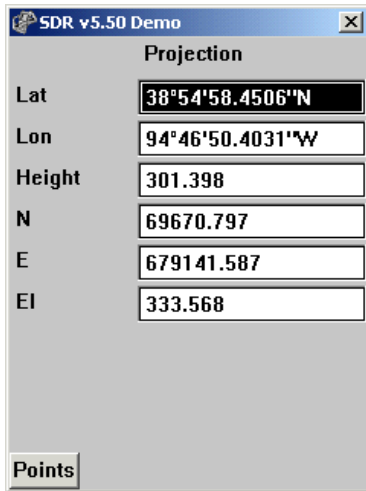
At the bottom left, there is a 'Points' softkey circled in red.



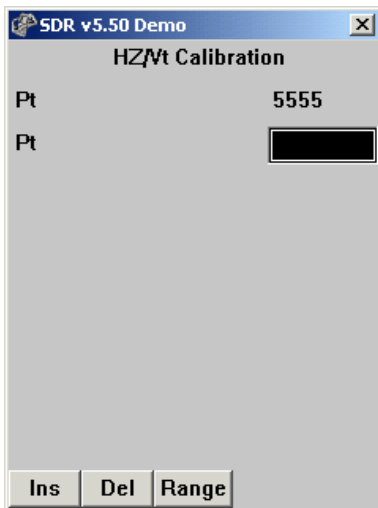
The screenshot shows the 'Key In WGS84' screen in the SDR v5.50 Demo application. The title bar reads 'SDR v5.50 Demo'. The screen contains several input fields for WGS84 coordinates:

Key In WGS84	
Pt	9999
Lat	38°54'58.4506"N
Lon	94°46'50.4031"W
Height	301.398
Cd	<No text>

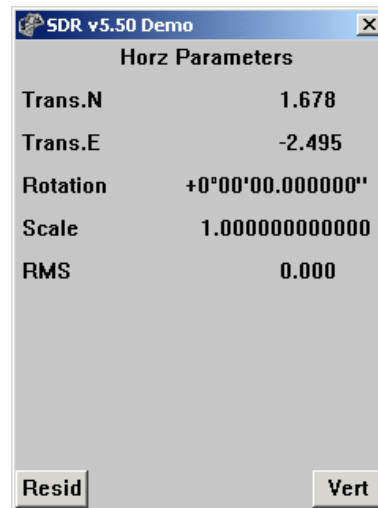
At the bottom, there is a 'Datum' softkey. A black bar at the bottom of the screen contains the text 'Point exists'.



The same calibration rules apply at this point as in GOBS positioning mode. You must take valid readings on the point(s) that you wish to calibrate to. In addition, there must be a KI POS record that exists with that same topography Point ID name (see page 39). So if you take a reading and call it 1001, then you need to have a KI POS record for 1001 as well. This will make the point show up now when you go into FUNC | GPS Coordinate System and choose a calibration method.



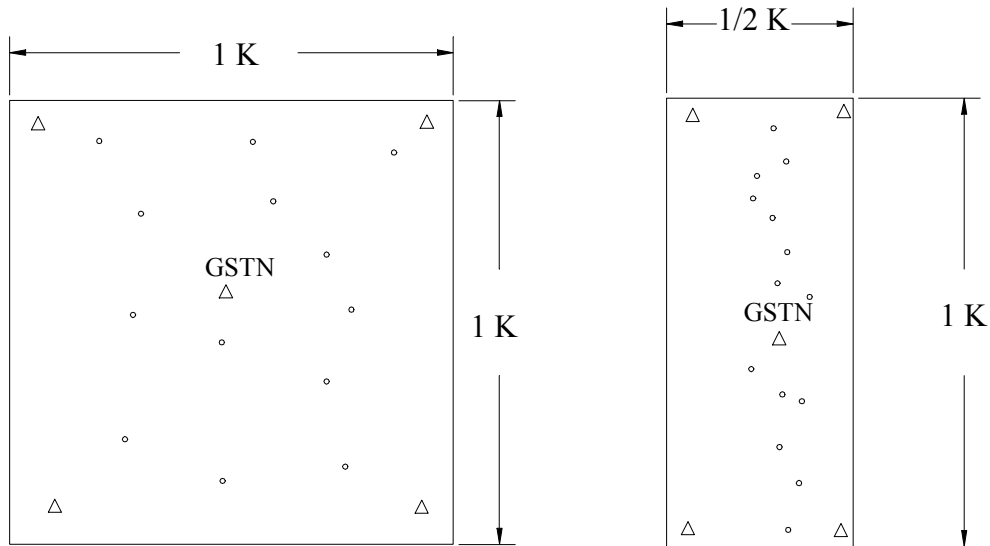
CALIBRATION – CHOOSE PT



CALIBRATION – HORIZ PARAM

Note that this was a XFM Unknown start, which is the reason that we used only a single point in the calibration. Had this not have been a XFM job; we would have had to have a minimum of 3 points for a HZ/VT calibration.

Typical Control layout
For linear and quadrangle
Project types



Survey | Keyboard Input

We will now use all methods of keyboard entry. This is accomplished by creating a RTK Job utilizing a XFM file and an appropriate Geoid file. A known coordinate with its orthometric height should be input utilizing the Key in coordinate option.

Now select the Key in LLH option. Type in the previous point id used in Key in coordinates. Select the view as Local LLH and verify the transformed LLH is correct and the Height is the same as keyed in previously. Now select the WGS view verify the transformed LLH and that the height is the difference of the N value.

Select the Elevation option and key in the previous point id. Verify that the orthometric height is now displayed for this point.

Select the Azimuth option now. Key in two points with existing coordinates. Key in azimuth and verify that a Red record is written to the database. Set the Instrument now as Total Station and select the two previous points as the station and backsight. Verify that the BKB record contains the azimuth from the Red record and not the inverse azimuth between the two coordinate values of the station and backsight points.

Select the Key in Azimuth and distance option. Verify that upon completion of entering an azimuth and distance that a coordinate may be produced from the keyboard values.

Select Key In Observation and key in a observation from the current Station from the last test. Verify that the same coordinates are produced as from the Key in azimuth and distance option.

Survey | Observation Corrections

We will now use Terrestrial observational corrections that may be applied to ETS data. First create a Numeric (4) Job with the following options selected: Atmos crn Yes, C and R crn Yes, Refract const 0.14,

Record Elev Yes, and Sea level crn Yes. Set the SCALE equal to 1.20000000. In Units Settings set the distance option to Meters, Pressure to Millibar, and Temperature to Celsius. Select a Manual Instrument, Mount Standard set the EDM o/s to 7.000, Refl o/s 0.030, and P.C. mm -33.000.

Go to Survey-> Topography and enter Station as:

0001 North 1.000 East 2.000 Elev 3.000 Theo ht 4.000
Pressure 777.00, and Temperature -4.00.

Backsight point 9999 and key in an Azimuth of 5-00'00".

Take the Backsight reading.

H.obs 0-00'00" with Target ht 2.000

View the database and verify the Obs MC View of the Face 1 record.

OBS MC 0001-9999 S.Dist <Null> V.ang <Null> Azimuth 5-00'00"
RED TP 0001-9999 Azimuth 5-00'00" H.dist <Null> V.Dist <Null>

Take a new reading using the following data:

Point 1000 >>> S.Dist 1.000 V.obs 5-00'00" H.obs 7-00'00"

View the database and verify the Obs MC, Red, and POS View of the Face 1 record.

OBS MC 0001-1000 S.Dist 9.690 V.ang 3-58'09" Azimuth 12-00'00"
RED TP 0001-1000 Azimuth 12-00'00" H.dist 0.805 V.Dist 9.667
POS TP 1000 North 1.787 East 2.167 Elev 12.667

Take a new reading using the following data:

Point 1001 >>> S.Dist 7.000 V.obs 7-00'00" H.obs 7-00'00"

View the database and verify the Obs MC, Red, and POS View of the Face 1 record.

OBS MC 0001-1001 S.Dist 15.820 V.ang 6-07'02" Azimuth 12-00'00"
RED TP 0001-1001 Azimuth 12-00'00" H.dist 2.023 V.Dist 15.730
POS TP 1001 North 2.979 East 2.421 Elev 18.730

Now change the instrument settings to reflect: Manual, Mount Not applicable, V.obs Zenith, EDM o/s <Null>, Refl o/s <Null>, and P.C. mm 3.000.

Go to Survey Topography and select Station as:

0001 North 1.000 East 2.000 Elev 3.000 Theo ht 4.000

Now Backsight 9999 and Take the Reading.

Point 9999 >>> S.Dist <Null> V.obs <Null> H.obs 0-00'00"

View the database and verify the Obs MC and Red Views of the Face 1 record.

Point 9999 S.Dist <Null> V.ang <Null> Azimuth 5-00'00"
RED TP 0001-9999 Azimuth 5-00'00" H.dist <Null> V.Dist <Null>

Take a new reading using the following data:

Point 1002 >>> S.Dist 8.000 V.obs 6-00'00" H.obs 55-00'00"

View the database and verify the Obs MC, Red, and POS View of the Face 1 record.

OBS MC 0001-1002 S.Dist 9.994 V.ang 4-48'05" Azimuth 60-00'00"
RED TP 0001-1002 Azimuth 60-00'00" H.dist 1.004 V.Dist 9.959
POS TP 1002 North 1.502 East 2.869 Elev 12.959

Take a new reading using the following data:

OBS F1 0001-1003 S.Dist <Null> V.obs 0-00'00" H.obs 0-00'00"
OBS MC 0001-1003 S.Dist <Null> V.ang 0-00'00" Azimuth 5-00'00"
RED TP 0001-1003 Azimuth 5-00'00" H.dist <Null> V.Dist <Null>

Take a new reading using the following data:

Point 1004>>> S.Dist 0.001 V.obs 0-00'00" H.obs 0-00'00"

View the database and verify the Obs MC, Red, and POS View of the Face 1 record.

OBS MC 0001-1004 S.Dist 2.004 V.ang 0-00'00" Azimuth 5-00'00"
RED TP 0001-1004 Azimuth 5-00'00" H.dist 0.000 V.Dist 2.004
POS TP 1004 North 1.000 East 2.000 Elev 5.004

Now apply only Sea level observational corrections to ETS data. First create a Numeric (4) Job with the following options selected: Atmos crn No, C and R crn No, Record Elev Yes, and Sea level crn Yes. Set the SCALE equal to 1.00000000. In Units Settings set the distance option to Meters.

Select a Manual Instrument, and P.C. mm 0.000. In Unit Settings set the precision to 3.

Select Topography and create station 0001 with the following coordinates:

0001 North 0.000 East 0.000 Elev 1000.000 Theo ht 0.000

Backsight point 9999 and key in azimuth of Azimuth 0-00'00". Then take reading.

9999>>> S.Dist <Null> V.obs <Null> H.obs 0-00'00"

View the database and verify the BKB record.

BKB TP 0001-9999 Azimuth 0-00'00" H.obs 0-00'00" Target ht 0.000

Take a new reading using the following data:

1000 S.Dist 100000.000 V.obs 90-00'00" H.obs 90-00'00"

View the database and verify the OBS MC, Red, and POS Views of the F1 record.

OBS MC 0001-1000 S.Dist 100000.000 V.ang 90-00'00" Azimuth 90-00'00"
RED TP 0001-1000 Azimuth 90-00'00" H.dist 99984.301 V.Dist 0.000
POS TP 1000 North 0.000 East 99984.301 Elev 1000.000

Create a new station 0002 with the following coordinates:

STN TP 0002 North 0.000 East 0.000 Elev 0.000 Theo ht 0.000

Backsight point 9998 and key in azimuth of Azimuth 0-00'00". Then take reading.

9998>>> S.Dist <Null> V.obs <Null> H.obs 0-00'00"

Take a new reading using the following data:

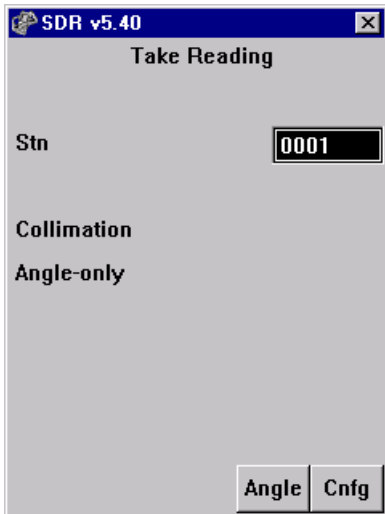
1001 S.Dist 100000.000 V.obs 90-00'00" H.obs 90-00'00"

OBS MC 0002-1001 S.Dist 100000.000 V.ang 90-00'00" Azimuth 90-00'00"

RED TP 0002-1001 Azimuth 90-00'00" H.dist 100000.000 V.Dist 0.000

POS TP 1001 North 0.000 East 100000.000 Elev 0.000

Survey | Collimation



To utilize the Collimation program generated corrections that are to be applied to ETS angle measurements first Create a Numeric (4) Job with the following options selected: Atmos crn Yes, C and R crn No, Record Elev Yes, and Sea level crn No. Set the SCALE equal to 1.00000000. Select a Manual Instrument, and P.C. mm 0.000. In Unit Settings set the precision to 3.

Select Collimation from the Survey menu and create a Station record.

0001 North 0.000 East 0.000 Elev 0.000 Theo ht 1.000

Take a reading on Face 1

1000>>> S.Dist <Null> V.obs 90-00'00" H.obs 10-00'00" Target ht 1.500

Take a reading on Face 1

1000>>> S.Dist <Null> V.obs 273-24'11" H.obs 182-31'21" Target ht 1.500

Verify the Tolerance errors generated from the two shots are as follows:

NOTE TL V.obs tol. Error: Pt: 1000 1-42'05"

Select to Continue.

NOTE TL H.obs tol. Error: Pt: 1000 3-44'20"

Select to Continue.

Take a reading on Face 1

1000>>> S.Dist <Null> V.obs 91-00'00" H.obs 12-00'00"

Take a reading on Face 2

1000>>> S.Dist <Null> V.obs 270-00'00" H.obs 180-00'00"

Verify the Tolerance errors generated from the two shots are as follows:

NOTE TL V.obs tol. Error: Pt: 1000 0-30'00"

Select to Continue.

NOTE TL H.obs tol. Error: Pt: 1000 6-00'00"

Select to Continue.

Escape out of the Take Reading Screen and verify the Collimation record is as follows:

COLLIMATION CL V.obs -1-06'03" H.obs -4-52'10"

Now got to Topography and select point 1 as the Station and point 9 as the Backsight point. Key in Azimuth as Azimuth 19-00'00.

Take the Backsight reading.

0009>>> S.Dist <Null> V.obs 90-00'00" H.obs 20-00'00"

View the database and verify the Obs MC view.

BKB TP 0001-0009 Azimuth 19-00'00" V.ang 88-53'57"

Survey | Set Collect

To perform Set Collection first create an Alpha (14) Job with the following options selected: Atmos crn No, C and R crn No, Refract const 0.14, Record Elev Yes, and Sea level crn No. Set the SCALE equal to 1.00000000. Select a Manual Instrument, and P.C. mm 0.000. In Unit Settings set the precision to 3.

Select the softkey Options and set face order as F1F2/F2 F1, Obs order 123..321, Pre-enter Points No.

Select the Set Collection option and enter Station SC STN as follows:

SC STN North 1000.000 East 2000.000 Elev 0.000 Theo ht 0.000

Backsight STN-A select azimuth and enter an Azimuth 0-00'00

Set # 1 Point count 6

Target ht 0.000

F1 STN-A	S.Dist 1500.006	V.obs 90-00'00"	H.obs 146-00'00"
F1 STN-B	S.Dist 1060.666	V.obs 90-00'00"	H.obs 191-00'03"
F1 STN-C	S.Dist 1667.054	V.obs 90-00'00"	H.obs 209-26'08"
F2 STN-C	S.Dist 1667.048	V.obs 270-00'00"	H.obs 29-26'05"
F2 STN-B	S.Dist 1060.659	V.obs 270-00'00"	H.obs 11-00'04"
F2 STN-A	S.Dist 1499.996	V.obs 270-00'00"	H.obs 325-59'58"

NOTE SC The following MCs are derived from set(s) 1.

OBS MC STN-A	S.Dist 1500.001	V.ang 90-00'00"	Azimuth 0-00'00"
OBS MC STN-B	S.Dist 1060.663	V.ang 90-00'00"	Azimuth 45-00'04"
OBS MC STN-C	S.Dist 1667.051	V.ang 90-00'00"	Azimuth 63-26'08"

BKB SC STN-A Azimuth 0-00'00" H.obs 145-59'59"

Set # 2 Point count 6

F1 STN-A	S.Dist 1500.002	V.obs 90-00'00"	H.obs 50-00'05"
OBS F1 STN-C	S.Dist 1667.051	V.obs 90-00'00"	H.obs 113-26'05"
OBS F1 STN-D	S.Dist 1500.030	V.obs 90-00'00"	H.obs 140-00'06"
OBS F2 STN-A	S.Dist 1499.997	V.obs 270-00'00"	H.obs 229-59'59"
OBS F2 STN-C	S.Dist 1667.046	V.obs 270-00'00"	H.obs 293-26'00"
OBS F2 STN-D	S.Dist 1500.001	V.obs 270-00'00"	H.obs 320-00'08"

NOTE SC The following MCs are derived from set(s) 1, 2.

POS TP A	North 2500.000	East 2000.000	Elev 0.000
POS TP B	North 1749.985	East 2750.018	Elev 0.000
POS TP C	North 1745.540	East 3491.048	Elev 0.000
POS TP D	North 999.964	East 3500.015	Elev 0.000

BKB SC STN-A Azimuth 0-00'00" H.obs 50-00'02"

NOTE SC The following MCs are derived from set(s) 1.

POS TP A	North 2500.001	East 2000.000	Elev 0.000
POS TP B	North 1749.985	East 2750.018	Elev 0.000
POS TP C	North 1745.516	East 3491.062	Elev 0.000

NOTE SC The following MCs are derived from set(s) 2.
 POS TP A North 2499.999 East 2000.000 Elev 0.000
 POS TP C North 1745.565 East 3491.034 Elev 0.000
 POS TP D North 999.964 East 3500.015 Elev 0.000

NOTE SC The following MCs are derived from set(s) 1, 2.
 POS TP A North 2500.000 East 2000.000 Elev 0.000
 POS TP B North 1749.985 East 2750.018 Elev 0.000
 POS TP C North 1745.540 East 3491.048 Elev 0.000
 POS TP D North 999.964 East 3500.015 Elev 0.000

Survey | Traverse

SDR Level 5 allows two methods to collect Traverse data. The Topography function allows for traverse data collection and. Set Collection, is used to collect a traverse data void of sideshots.

To perform a traverse first Create a Numeric 4 Job with the following settings Atmos crn No, C and R crn No, Refract constant 0.14, Record Elev Yes, Sea level crn No, Scale 1.00000000

Select a Manual Instrument with P.C. mm 0.000. In Config Reading select the Face 1 only option. Enter the Survey Topography Menu and create Station setup:

0001 North 7000.000 East 3000.000 Elev 100.000 Theo ht 1.500

Backsight point 0100

Select Azimuth and key in Azimuth 315-23'45"

Backsight point 0100.
 0100 S.Dist <Null> V.obs <Null> H.obs 315-23'45"

View the database and verify the BKB record matches that which was keyed in.

BKB TP 0001-0100 Azimuth 315-23'45" H.obs 315-23'45" TARGET ht 1.500

Take a reading now to point 1000.

1000 S.Dist 136.110 V.obs 90-00'00" H.obs 36-02'00"

Change instrument location to point 1000 and verify the coordinates of the Station record are the ones entered from Keyboard input.

1000 North 7110.069 East 3080.067 Elev 100.000 Theo ht 1.500

Backsight point 0001.
 0001 S.Dist <Null> V.obs <Null> H.obs 216-02'00"

Verify the BKB record in the database is as follows
 BKB TP 1000-0001 Azimuth 216-01'59" H.obs 216-02'00"

Take a reading now to point 1001
 1001 S.Dist 70.500 V.obs 90-00'00" H.obs 90-10'00"

Change instrument location to point 1001
 1001 North 7109.864 East 3150.567 Elev 100.000 Theo ht 1.500

Backsight point 1000

1000 S.Dist <Null> V.obs <Null> H.obs 270-10'00"

Verify the BKB record in the database is as follows

BKB TP 1001-1000 Azimuth 270-10'00" H.obs 270-10'00"

Take a reading now to point 1002

1002 S.Dist 75.000 V.obs 90-00'00" H.obs 223-22'00"

Change instrument location to point 1002

1002 North 7055.341 East 3099.067 Elev 100.000 Theo ht 1.500

Backsight point 1001

1001 S.Dist <Null> V.obs <Null> H.obs 43-22'00"

Verify the BKB record in the database is as follows

BKB TP 1002-1001 Azimuth 43-22'00" H.obs 43-22'00"

Take a reading now to point 1003

1003 S.Dist 326.500 V.obs 90-00'00" H.obs 61-24'00"

Change instrument location to point 1003

1003 North 7211.633 East 3385.729 Elev 100.000 Theo ht 1.500

Backsight point 1002

1002 S.Dist <Null> V.obs <Null> H.obs 241-24'00"

Verify the BKB record in the database is as follows

BKB TP 1003-1002 Azimuth 241-24'01" H.obs 241-24'00"

Take a reading now to point 1004

1004 S.Dist 24.000 V.obs 90-00'00" H.obs 181-00'00"

Change instrument location to point 1004

1004 North 7187.637 East 3385.310 Elev 100.000 Theo ht 1.500

Backsight point 1003

1003 S.Dist <Null> V.obs <Null> H.obs 1-00'00"

Verify the BKB record in the database is as follows

BKB TP 1004-1003 Azimuth 1-00'01" H.obs 1-00'00"

Take a reading now to point 0001

0001 S.Dist 429.880 V.obs 90-00'00" H.obs 243-52'00"

Note that the following tolerance errors on the previous observation are displayed.

Select duplicate point option to Store Note and verify the following Note record is displayed.

NOTE TL EDM tol. Error: Pt: 0001 1.311
NOTE TL H.obs tol. Error: Pt: 0001 0-10'05"
NOTE TP Action Check only Pt-Pt SDist 1.817

NOTE TL EDM tol. Error: Pt: 0001 1.311
NOTE TL H.obs tol. Error: Pt: 0001 0-10'05"
NOTE TP Action Check only Pt-Pt SDist 1.817

Take a reading now to point 0001

0001 S.Dist 429.880 V.obs 90-00'00" H.obs 243-52'00"

Change instrument location to point 0001

0001 North 7000.000 East 3000.000 Elev 100.000 Theo ht 1.500

Backsight point 1004

1004 S.Dist <Null> V.obs <Null> H.obs 63-52'00"

Verify the BKB record in the database is as follows

BKB TP 0001-1004 Azimuth 64-02'06" H.obs 63-52'00"

Take a reading now to point 0100

0100 S.Dist <Null> V.obs <Null> H.obs 315-25'00"

Note that the following tolerance errors on the previous observation are displayed.

NOTE TL H.obs tol. Error: Pt: 0100 0-11'21"

NOTE TP Action Check only Pt-Pt SDist <Null>

Survey | Traverse Adjustment

With the traverse just collected perform an adjustment by selecting the Traverse Adjustment menu. Start point 0001 to point 1000 the data collector should automatically pull the stations in the following order: 1001,1002,1003,1004. Close the traverse by keying in 0001 as the final point to adjust.

After accepting the start and close screen the Unadjusted Traverse precision is shown as follows:

Delta angle 0-01'15" Delta Dist 1.819 Precision 584
Delta North -1.708 Delta East -0.624 Delta Elev 0.000

Select the Adjust softkey to adjust the angular misclosure. Then select the Store softkey to store the following note records.

NOTE TV Start 0001 To pt 0001 Reoccupied? Yes
NOTE TV BS pt 0100 Azimuth 315-23'45"
NOTE TV FS pt 0100 Azimuth 315-23'45"
NOTE TV D.ang 0-00'00" D.Dist 1.889 Precn 562
NOTE TV D.North -1.801 D.East -0.570 D.Elev 0.000

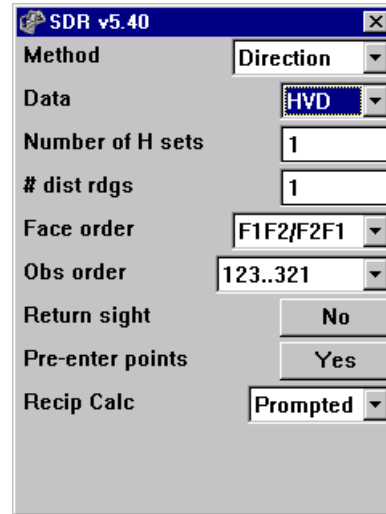
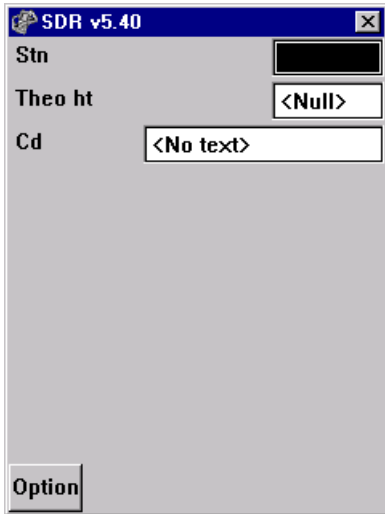
Now review the database and verify the following adjusted POS values.

POS TV 1000 North 7110.301 East 3080.139 Elev 100.000
POS TV 1001 North 7110.220 East 3150.676 Elev 100.000
POS TV 1002 North 7055.818 East 3099.224 Elev 100.000
POS TV 1003 North 7212.711 East 3386.035 Elev 100.000
POS TV 1004 North 7188.755 East 3385.635 Elev 100.000

Survey | Resections

SDR Level 5 provides the capability to perform Resections from both the Survey Module and the Cogo Module. Observations utilized in Resections may be partial or full observations to target points. Upon the successful Resection routine the SDR will provide a series of Notes records with corresponding Dvalues for

each point observed. The Dvalues are the deltas from the Calculated station value and the Observation to each sighted point.



To perform a resection calculation: First Create an Alpha (14) job with the following settings Atmos crn No, C and R crn No, Refract constant 0.14, Record Elev No, Sea level crn No, Scale 1.00000000.

In keyboard input key in the following points:

A North 600.000	East 1000.000	Elev <Null>
B North 0.000	East 1200.000	Elev <Null>
C North -200.000	East 500.000	Elev <Null>

In the INSTRUMENT select menus choose Manual instrument and set the P.C. to 0.000 (mm). From the Survey Resection menu select the Option softkey and set the Method to Direction, Data HVD, Number of sets 3, Face order as F1F2/F2F1, Obs order 123..321, and Pre-enter Points to Yes. Select station as RS and Theo ht = 0.00. Now collect the first set by Keying in the following Observations.

Set # 1 Point count 6

STN-A S.Dist <Null>	V.obs 90-00'00"	H.obs 24-00'00"
STN-B S.Dist 282.844	V.obs 90-00'00"	H.obs 159-00'01"
STN-C S.Dist 640.310	V.obs 90-00'00"	H.obs 255-20'26"
STN-C S.Dist 640.314	V.obs 270-00'00"	H.obs 75-20'26"
STN-B S.Dist 282.841	V.obs 270-00'00"	H.obs 338-59'58"
STN-A S.Dist <Null>	V.obs 270-00'00"	H.obs 203-59'57"

Verify the Database MC records

The following MCs are derived from set(s) 1.

OBS MC STN-A S.Dist <Null>	V.ang 90-00'00"	Azimuth 359-59'59"
OBS MC STN-B S.Dist 282.843	V.ang 90-00'00"	Azimuth 135-00'00"
OBS MC STN-C S.Dist 640.312	V.ang 90-00'00"	Azimuth 231-20'26"

NOTE RS A	DValues <Null>	<Null>	0-00'01"
NOTE RS B	DValues 0.003	<Null>	0-00'01"
NOTE RS C	DValues 0.001	<Null>	0-00'00"

STN RS STN North 199.997 East 1000.001 Elev <Null>

Now collect the second set. Verify the database BKB record is as follows:

BKB RS STN-C Azimuth 231-20'26" H.obs 255-20'26". Now collect the set with the following observations changing the Obs order 123..321 to 123..123:

Set # 2	Point count 6		
STN-A S.Dist <Null>	V.obs 90-00'00"		H.obs 216-36'24"
STN-B S.Dist 282.843	V.obs 90-00'00"		H.obs 351-36'24"
STN-C S.Dist 640.312	V.obs 90-00'00"		H.obs 87-56'49"
STN-A S.Dist <Null>	V.obs 270-00'00"		H.obs 36-36'24"
STN-B S.Dist 282.843	V.obs 270-00'00"		H.obs 171-36'24"
STN-C S.Dist 640.312	V.obs 270-00'00"		H.obs 267-56'49"

Now collect the third set. Verify the database BKB record is as follows:

BKB RS STN-C Azimuth 231-20'26" H.obs 255-20'26". Now collect the set with the following observations changing the Obs order to unprompted:

Set # 3	Point count 3		
STN-C S.Dist 640.100	V.obs 90-00'00"		H.obs 325-40'02"
STN-A S.Dist <Null>	V.obs 90-00'00"		H.obs 94-21'29"
STN-B S.Dist 283.144	V.obs 90-00'00"		H.obs 229-22'34"

The following MCs are derived from set(s) 1, 2, 3.

OBS MC STN-A S.Dist <Null>	V.ang 90-00'00"	Azimuth 0-00'06"
OBS MC STN-B S.Dist 282.903	V.ang 90-00'00"	Azimuth 135-00'20"
OBS MC STN-C S.Dist 640.270	V.ang 90-00'00"	Azimuth 231-20'10"

NOTE RS A DValues <Null> <Null> 0-00'00"

NOTE RS B DValues 0.017 <Null> 0-00'00"

NOTE RS C DValues 0.065 <Null> 0-00'00"

The following MCs are derived from set(s) 1, 2.

OBS MC STN-A S.Dist <Null>	V.ang 90-00'00"	Azimuth 108-18'11"
OBS MC STN-B S.Dist 282.843	V.ang 90-00'00"	Azimuth 243-18'12"
OBS MC STN-C S.Dist 640.312	V.ang 90-00'00"	Azimuth 339-38'37"

The following MCs are derived from set(s) 1, 2.

OBS MC STN-A S.Dist <Null>	V.ang 90-00'00"	Azimuth 359-59'59"
OBS MC STN-B S.Dist 282.843	V.ang 90-00'00"	Azimuth 135-00'00"
OBS MC STN-C S.Dist 640.312	V.ang 90-00'00"	Azimuth 231-20'25"

NOTE RS A DValues <Null> <Null> 0-00'00"

NOTE RS B DValues 0.002 <Null> 0-00'00"

NOTE RS C DValues 0.000 <Null> 0-00'00"

STN RS STN North 199.998 East 1000.001 Elev <Null> Theo ht <Null>

BKB RS STN-C Azimuth 231-20'25" H.obs 267-20'24"

NOTE SC The following MCs are derived from set(s) 2.

OBS MC STN-A S.Dist <Null>	V.ang 90-00'00"	Azimuth 192-36'24"
OBS MC STN-B S.Dist 282.843	V.ang 90-00'00"	Azimuth 327-36'24"
OBS MC STN-C S.Dist 640.312	V.ang 90-00'00"	Azimuth 63-56'49"

NOTE RS The following MCs are derived from set(s) 2.

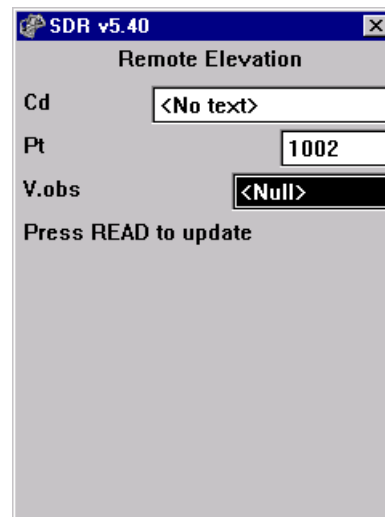
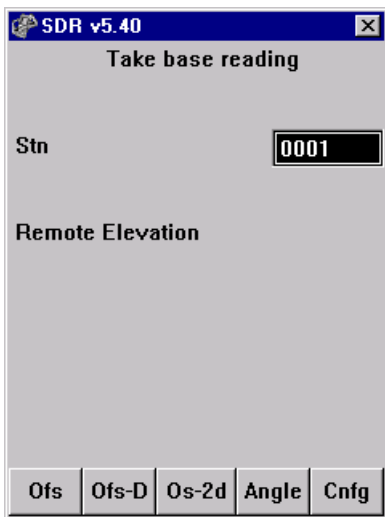
OBS MC STN-A	S.Distance <Null>	V.ang 90-00'00"	Azimuth 0-00'00"
OBS MC STN-B	S.Distance 282.843	V.ang 90-00'00"	Azimuth 135-00'00"
OBS MC STN-C	S.Distance 640.312	V.ang 90-00'00"	Azimuth 231-20'25"

NOTE RS A	DValues <Null>	<Null>	0-00'00"
NOTE RS B	DValues 0.001	<Null>	0-00'00"
NOTE RS C	DValues 0.000	<Null>	0-00'00"

STN RS STN North 199.999 East 1000.000 Elev <Null> Theo ht <Null>

BKB RS STN-C Azimuth 231-20'25" H.obs 87-56'49"

Survey | Remote Elevation



To perform Remote Elevation calculations: First Create an Numeric (4) job with the following settings
 Atmos crn No, C and R crn No, Refract constant 0.14, Record Elev Yes, Sea level crn No, Scale 1.00000000.

In the INSTRUMENT select menus choose Manual instrument and set the P.C. to 0.000 (mm).

STN RE 0001 North 0.000 East 0.000 Elev 0.000
 Theo ht 0.000 Code stn

RED KI 0001-0009 Azimuth 0-00'00" H.dist <Null> V.Distance <Null>
 Code bs

BKB TP 0001-0009 Azimuth 0-00'00" H.obs 0-00'00"

Target ht 0.000

OBS F1 0001-0009 S.Distance <Null> V.obs 90-00'00" H.obs 0-00'00"

POS TP 1000 North 15.000 East 4.000 Elev 3.000

NOTE RE Height: 0.000

POS RE 1001 North 10.000 East 0.000 Elev 0.000

NOTE RE Height: -0.875

POS RE 1002 North 10.000 East 0.000 Elev -0.875

NOTE RE Height: <Null>

POS RE 1003 North 10.000 East 0.000 Elev <Null>

NOTE RE Height: 0.000

POS RE 1004 North 10.000 East 0.000 Elev 0.000

NOTE RE Height: 1.763

POS RE 1005 North 10.000 East 0.000 Elev 1.763

NOTE RE Height: 2062648.062

POS RE 1006 North 10.000 East 0.000 Elev 2062648.062

NOTE RE Height: 2062648.063

POS RE 1007 North 10.000 East 0.000 Elev 2062648.063

NOTE RE Height: -27.475

POS RE 1008 North 10.000 East 0.000 Elev -27.475

NOTE RE Height: -27.475

POS RE 1009 North 10.000 East 0.000 Elev -27.475

STN RE 0001 North <Null> East 0.000 Elev 0.000
Theo ht 0.000 Code stn

BKB TP 0001-0009 Azimuth 0-00'00" H.obs 10-00'00"

OBS F1 0001-0009 S.Dist <Null> V.obs <Null> H.obs 10-00'00"

OBS F1 0001-1010 S.Dist <Null> V.obs 90-00'00" H.obs 0-00'00"

NOTE RE Height: <Null>

POS RE 1011 North <Null> East <Null> Elev <Null>

STN RE 0001 North 5.000 East 4.000 Elev 3.000
Theo ht 2.000 Code stn

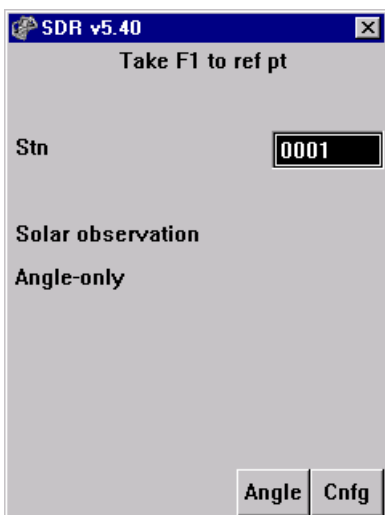
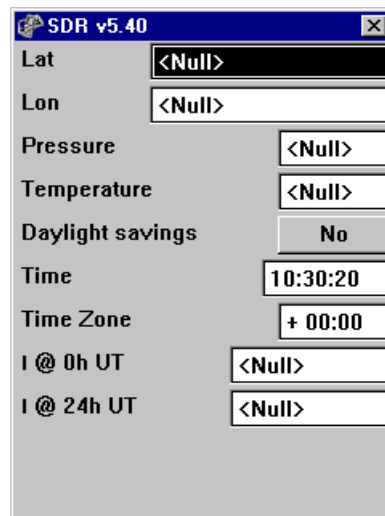
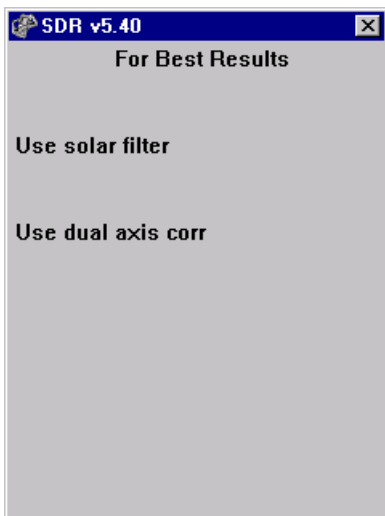
BKB TP 0001-0009 Azimuth 0-00'00" H.obs 10-00'00"

OBS F1 0001-0009 S.Dist <Null> V.obs 90-00'00" H.obs 10-00'00"

POS TP 1012 North -6.773 East 1.924 Elev 3.954
 NOTE RE Height: 0.000
 POS RE 1013 North -6.773 East 1.924 Elev 3.954
 NOTE RE Height: 1.046
 POS RE 1014 North -6.773 East 1.924 Elev 5.000

Survey | Remote Elevation

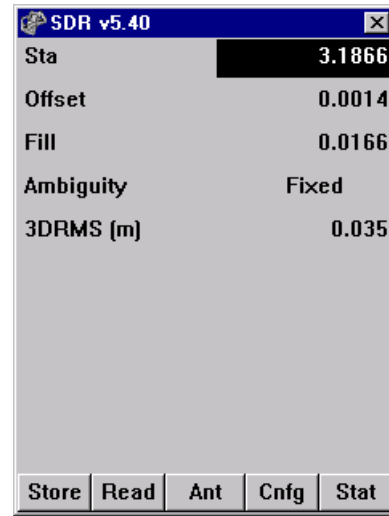
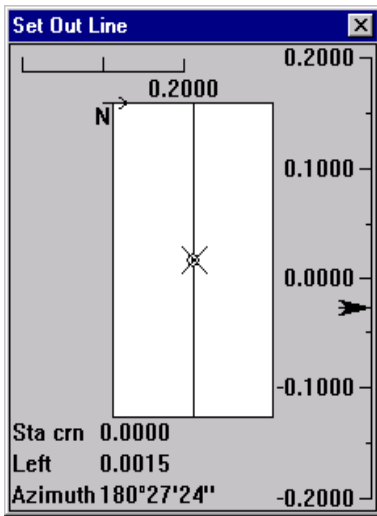
Survey | Solar Observations



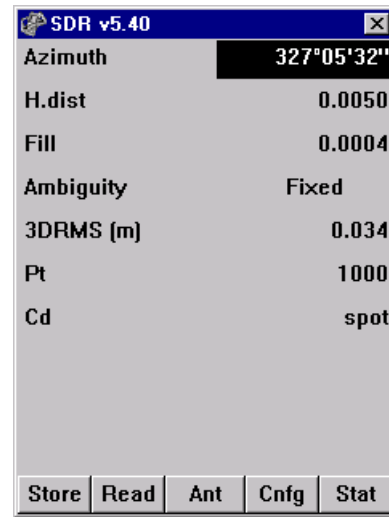
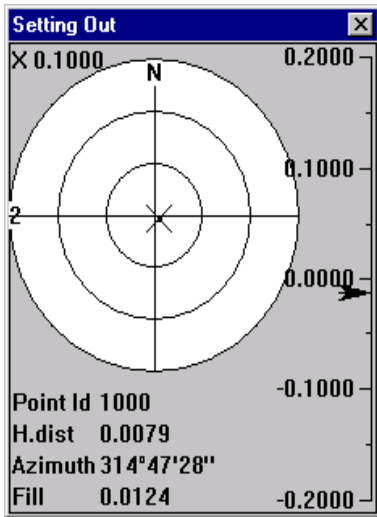
IV. COGO module

SDR Level 5 provides both Graphical and Text screens to aid in navigation to a desired location. The navigation graphical screen is invoked by pressing ALT <P>. To toggle back to the Text screen the User must press ESC. The Graphical display will increase or decrease as you move closer or farther away from the desired location. The scale and orientation will be displayed in the top right side of the display.

The graphical and text display for Line work is as follows:



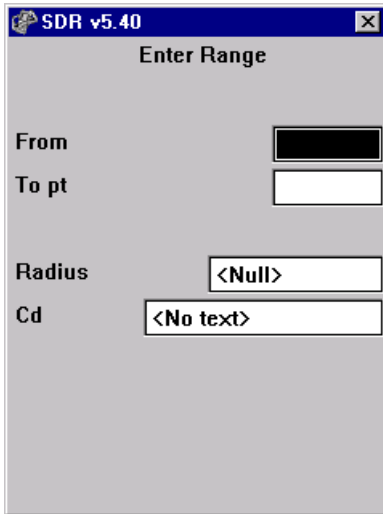
The graphical and text display for coordinate stake out is as follows:



Cogo | Set Out Coordinates

SDR Level 5 provides 3 methods of populating a list of points in which to set out.

1. The points may be manually entered one at a time.
2. A Range of points may be selected. When this method is selected the Range can be a chronological order defined by “from” and “to” points or by a Radius around the current Station point, or points containing a specific feature code.
3. All Positions contained in the current database. These Points may be sorted, for convenience of the user, by Azimuth.



SDR v5.40

Enter Range

From

To pt

Radius

Cd



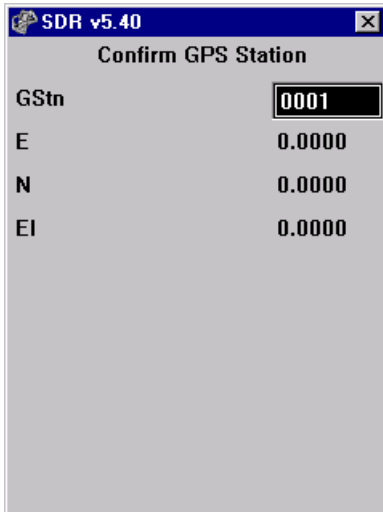
SDR v5.40

Add all POSs to list

Delete all from list

Sort by Azimuth

When entering any Cogo function the User will be required to confirm the GStn when Positioning mode is GOBS or Stn when doing terrestrial setout prior to proceeding further.



SDR v5.40

Confirm GPS Station

GStn	<input type="text" value="0001"/>
E	0.0000
N	0.0000
EI	0.0000

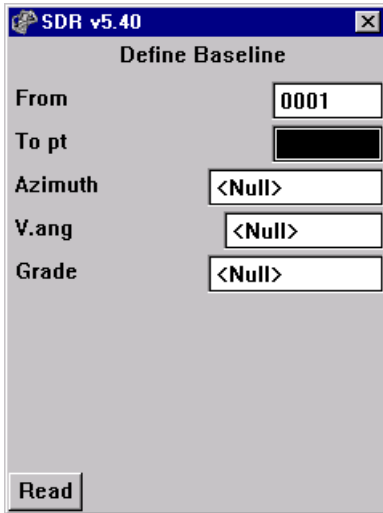
Select the Job previously created in Topography Take Reading exercise. View the database and place points 1000 to 1003 in POS view. Select the All option and Sort by Azimuth. Now navigate to each Point using the graphical screen. When the navigation can no longer be performed graphical toggle to the Text screen and finalize the Point location.

Cogo | Set Out Line

A Line definition may be produced in the following manners:

- From either a point contained in the database and keyed in Azimuth and grade.
- Points collected by utilizing the Read function.
- Two points from the database that will produce the direction and grade.

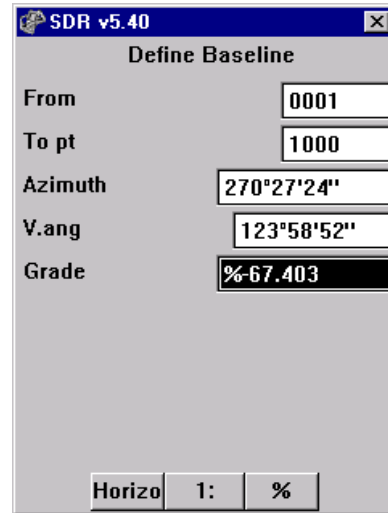
SDR allows the gradient of the line to be defined either by a ratio, or rise over run. The Line vertical grade must be set such to produce negative, positive or horizontal grades.



SDR v5.40 Define Baseline

From	0001
To pt	
Azimuth	<Null>
V.ang	<Null>
Grade	<Null>

Read



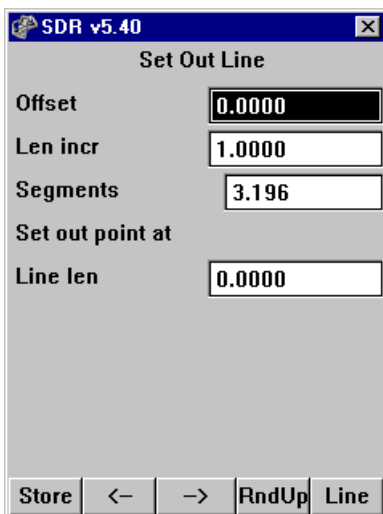
SDR v5.40 Define Baseline

From	0001
To pt	1000
Azimuth	270°27'24"
V.ang	123°58'52"
Grade	%-67.403

Horizo 1: %

There are two methods of Set Out Line:

1. "Points" specific locations on the line to be set out.
2. "Line" perpetual navigation displaying the location relative to the line at any given time.

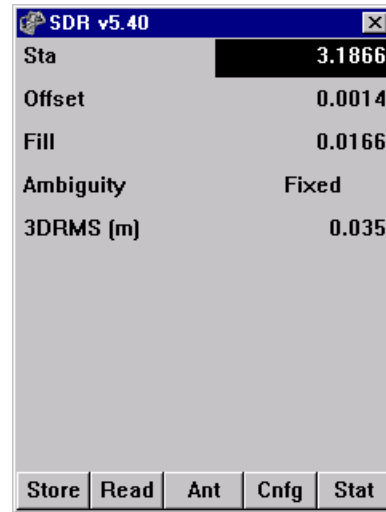
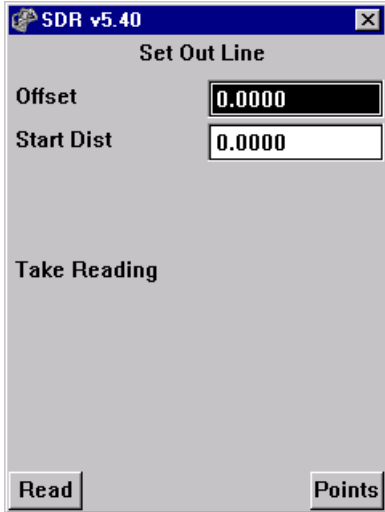


SDR v5.40 Set Out Line

Offset	0.0000
Len incr	1.0000
Segments	3.196
Set out point at	
Line len	0.0000

Store <- -> RndUp Line

Navigating utilizing the point option the SDR will calculate a desired location on the line or off set of the line and then provide navigation details in which to navigate to the design Point. Using the Point option the SDR provides for incremental stepping down the Line. The user may define the increment to produce the number of desired segments or define the number of segments and the SDR will calculate the required increment. Arrows are provided to move along the Line an increment at a time. A Store soft key is provided to allow storage to the database of the design position.

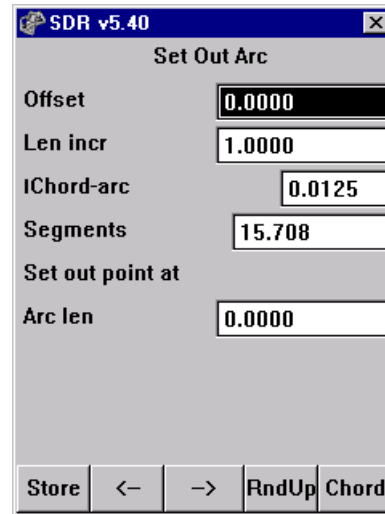
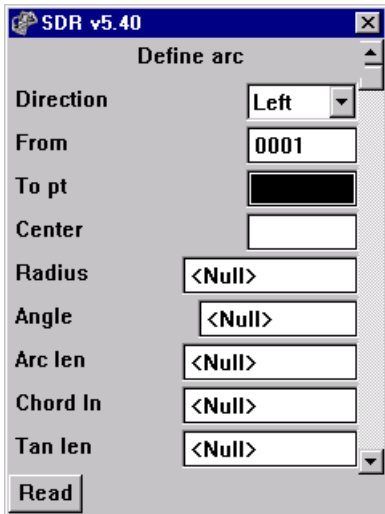


The Line option allows for perpetual line navigation. The user is not required to select a location on the line in which to navigate. The SDR displays the current location relative to the Line. The Line option allows the user to select a desired offset in which to apply to the line as well a start distance down the line to begin stationing the line. The navigation details will be presented as function of the Configure reading Alignment option. A Store softkey is provided to allow the User to Store the current navigation details as well as the GOBS that produced the present details. The feature code written in the GOBS will be that of the last read. If the need arises to change feature codes the user must take a reading.

Cogo | Set Out Arc

SDR Level 5 allows arc's to be setout utilizing either arc length or chord length. By selecting the Chord length softkey the method will toggle to Chord length. The RndUp softkey will round the number of segments to an even number.

Set out Arc should be verified in both the Left direction and Right direction. Verify the Arc definition solution with the following inputs:



Curve Right

From Point 1 N=0,E=0,EI=0
 To Point 2 N=10,E=10,EI=0
 Intersect 3 N=10,E=0,EI=0
 Center Point 4 N=0,E=10,EI=0

Radius = 10
 Delta = 90
 Arc Length = 15.708
 Chord = 14.142
 Tangent = 10
 Back Az = 0

Curve Left

From Point 1 N=0,E=0,EI=0
 To Point 2 N=10,E=-10,EI=0
 Intersect 3 N=10,E=0,EI=0
 Center Point 4 N=0,E=-10,EI=0

Radius = 10
 Delta = 90
 Arc Length = 15.708
 Chord = 14.142
 Tangent = 10
 Back Az = 0

- 1.From point, To Point, Radius
- 2.From Point, To Point, and Center Point
- 3.From Point, Intersection, and Radius

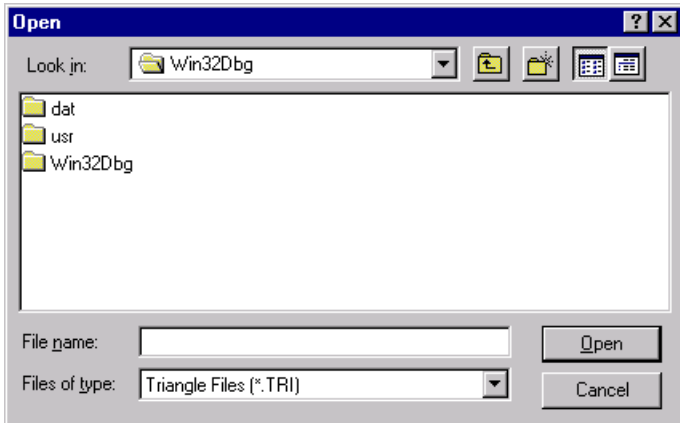
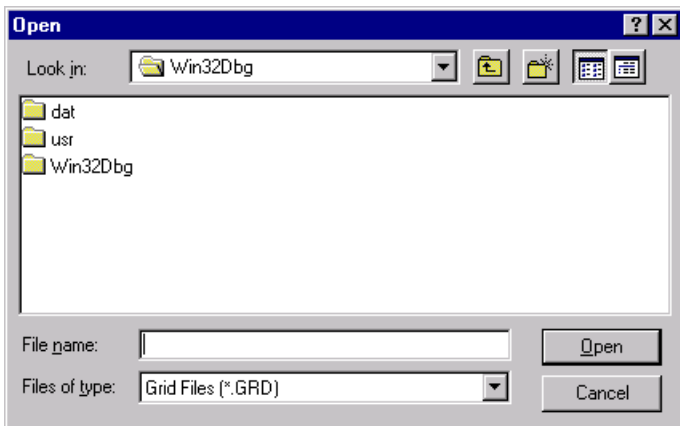
Navigation should be verified in both text and graphical modes.

Cogo | Set Out Surface

SDR has the ability to set out surface DTM defined by either a TIN or a GRID file.



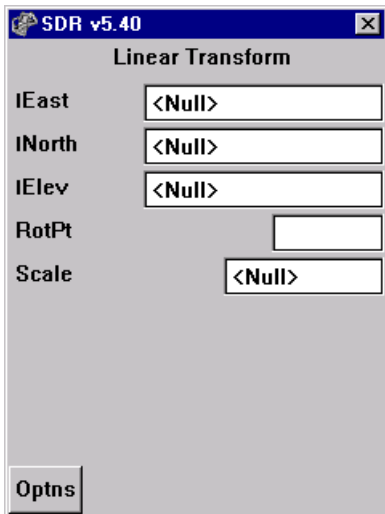
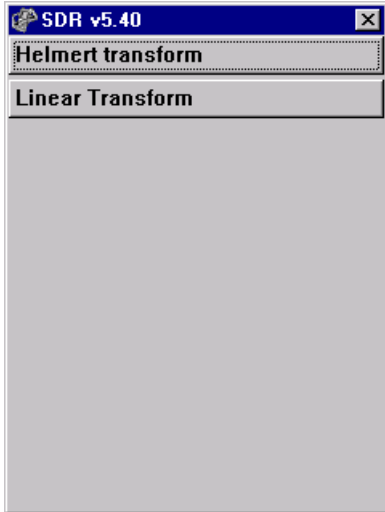
The Grid or TIN file may reside anywhere on the device. The only stipulation the Grid or TIN files must conform to the file format supported by the SDR and end with the extensions GRD for Grid files or pnt and tri for TINS. Users may request the SDR file formats.



Upon Selection of the desired method the SDR will perform RTK live Navigation providing location on the surface and the cut or fill. The user must hit store to save the record at any given location.

Cogo | Transformation

SDR Level 5 provides two methods in which to perform Transformations, Helmert and Linear. When using the Helmert option SDR will search the current job and the Job selected to transform from and find all common points in which to calculate the transformation parameters. The Linear option the User is required to enter the transformation parameters or points from which to calculate the parameters



SDR v5.40

Option: Translate

Pt:

Org.E: <Null>

Org.N: <Null>

Org.El: <Null>

Dest.E: <Null>

Dest.N: <Null>

Dest.El: <Null>

SDR v5.40

Option: Rotation

RotPt: 1000

Old Azim: <Null>

From:

To pt:

New Azim: <Null>

From:

To:

Cogo | Intersections

The SDR provides two methods in which to produce locations with which to perform an intersection with. First the point may be brought in from the database or the locations may be produced from a Read.

SDR v5.40

Intersections

Pt 1:

Azmth 1: <Null>

H.dist 1: <Null>

Pt 2:

Azmth 2: <Null>

H.dist 2: <Null>

Read

SDR v5.40

Intersections

Pt 1:

Azmth 1: <Null>

H.dist 1: <Null>

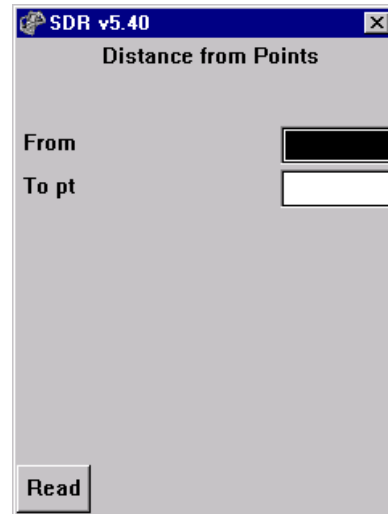
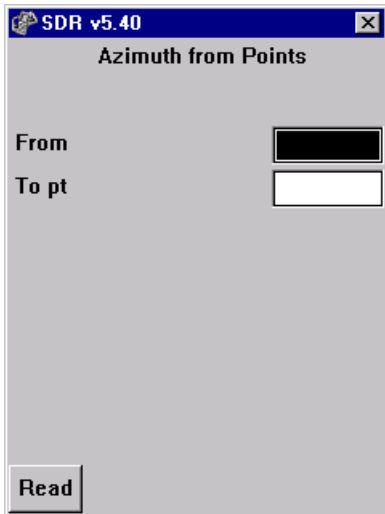
Pt 2:

Azmth 2: <Null>

H.dist 2: <Null>

Points

Directions and distances may be produced from points included in the SDR database.



The following example is to demonstrate intersection calculations. First Create an Alpha (14) job with the following settings Atmos crn No, C and R crn No, Refract constant 0.14, Record Elev No, Sea level crn No, Scale 1.00000000. In units settings select meters as distance unit.

In keyboard input key in the following points:

A North 9764.567	East 275.458	Elev <Null>
B North 10998.457	East 867.154	Elev <Null>
C North 587.456	East 1342.124	Elev <Null>
D North 195.457	East 2457.125	Elev <Null>
E North 129.665	East 104.467	Elev <Null>
F North 76.194	East 35.775	Elev <Null>
G North 8699.761	East 6487.197	Elev <Null>
H North 10257.157	East 6001.791	Elev <Null>
I North 9863.249	East 235.654	Elev <Null>
J North 11002.567	East 654.532	Elev <Null>
K North 563.358	East 1254.658	Elev <Null>
L North 124.559	East 2347.871	Elev <Null>
M North 125.523	East 98.564	Elev <Null>
N North 65.669	East 23.333	Elev <Null>
O North 8716.279	East 6531.149	Elev <Null>
P North 10231.558	East 5996.996	Elev <Null>

Go to the intersection menu and complete the following **Bearing-Bearing** intersections:

Point A 68° 30' 56.3185"

Point B 178° 42' 44.3995"

Point Q North 10006.234 East 889.457 Elev <Null>

POINT C 108° 12' 46.7902"

Point D 104° 59' 23.6610"

Point R North 85.664 East 2867.167 Elev <Null>

Point E 177° 38' 14.4170"

Point F 105° 26' 59.3961"

Point S North 56.373 East 107.491 Elev <Null>

Point G 22° 26' 07.0720"

Point H 51° 05' 18.4702"

Point T North 11623.454 East 7694.364 Elev <Null>

Go to the intersection menu and complete the following **Bearing-Distance** intersections:

Point A 68° 30' 56". 3185

Point B 992.473300

Point U North 10257.220 East 1527.132 Elev <Null>

Point C 108° 12' 46.7902"

Point D 424.486684

POINT V NORTH 85.664 EAST 2867.167 107.491

Point E 177° 38' 14".4170

Point F 74.404682

Point W North 56.373 East 107.491 Elev <Null>

Point G 22° 26' 07".0720

Point H 2175.217426

Point X North 11623.454 East 7694.364 Elev <Null>

Go to the intersection menu and complete the following **Distance-Distance** intersections:

Point I 658.591622

Point J 969.183899

Point Y North 10056.564 East 865.235 Elev <Null>

Point K 1547.867679

Point L 554.385100

Point Z North 447.879 East 2798.212 Elev <Null>

Point M 74.410215

Point N 77.403212

Point AA North 51.117 East 99.356 Elev <Null>

Point O 3250.063880

Point P 2353.595049

Point AB North 11688.879 East 7845.137 Elev <Null>

Cogo | Point Projections

This program projects a point on to a line or arc. It calculates the distance and offset of the point relative to the specified baseline (or arc). It also computes the coordinates of the intersection point, which can then be interpolated where possible.



SDR v5.40

Define Baseline

From

To pt

Azimuth

V.ang

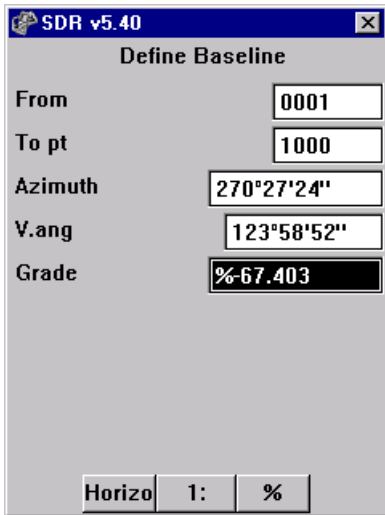
Grade

Read Arc

The following example is to verify Cogo Point Projection calculations. First Create a Numeric (4) job with the following settings Atmos crn No, C and R crn No, Refract constant 0.14, Record Elev Yes, Sea level crn No, Scale 1.00000000.

In the INSTRUMENT select menus choose Manual instrument and set the P.C. to 0.000 (mm).

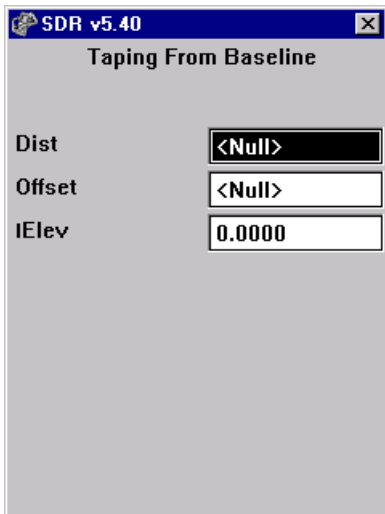
Cogo | Taping from Baseline



The screenshot shows the 'Define Baseline' dialog box in SDR v5.40. It contains the following fields and values:

Field	Value
From	0001
To pt	1000
Azimuth	270°27'24"
V.ang	123°58'52"
Grade	%-67.403

At the bottom, there are three buttons: 'Horizo', '1:', and '%'. The 'Horizo' button is currently selected.



The screenshot shows the 'Taping From Baseline' dialog box in SDR v5.40. It contains the following fields and values:

Field	Value
Dist	<Null>
Offset	<Null>
IElev	0.0000

SDR v5.40

Taping From Baseline

Dist	10.0000
Offset	10.0000
IElev	0.0000

Dsgn S-0

SDR v5.40

Store Design Point

Cd	p
Pt	1001
N	0.0000
E	0.0000
EI	10.0000

Yes No

The following example is to verify Cogo Taping from Baseline calculations. First Create a Numeric (4) job with the following settings Atmos crn No, C and R crn No, Refract constant 0.14, Record Elev Yes, Sea level crn No, Scale 1.00000000.

In the INSTRUMENT select menus choose Manual instrument and set the P.C. to 0.000 (mm).

Cogo | Inverse

The following example is to verify Cogo Inverse calculations. First Create a Numeric (4) job with the following settings Atmos crn No, C and R crn No, Refract constant 0.14, Record Elev Yes, Sea level crn No, Scale 1.00000000.

In the INSTRUMENT select menus choose Manual instrument and set the P.C. to 0.000 (mm).

From Keyboard input key-in points 1000 and 1001.

1000 North 700.000 East 300.000 Elev 100.000
 1001 North 750.000 East 300.000 Elev 100.000

Now select Topography and select point 1000 as the instrument point and 1001 as the Backsight point.
 1000 North 700.000 East 300.000 Elev 100.000 Theo ht 1.500

Take the Backsight reading to 1001.

1001 S.Distance <Null> V.obs <Null> H.obs 0-00'00" Target ht 1.500

Verify the BKB record in the database is as follows

BKB TP 1000-1001 Azimuth 0-00'00" H.obs 0-00'00"

Take a reading now to point 1002

1002 S.Distance 100.000 V.obs 78-27'47" H.obs 45-00'00"

Go To Inverse and select 1000 to 1002. Then verify the RED record in the database is as follows

RED IN 1000-1002 Azimuth 45-00'00" H.dist 97.980 V.Distance 20.000

Take a reading now to point 1003

OBS F1 1000-1003 S.Distance 100.000 V.obs 101-32'13" H.obs 135-00'00"

Go To Inverse and select 1000 to 1003. Then verify the RED record in the database is as follows

RED IN 1000-1003 Azimuth 135-00'00" H.dist 97.980 V.Distance -20.000

Take a reading now to point 1004

OBS F1 1000-1004 S.Distance 100.000 V.obs 78-27'47" H.obs 225-00'00"

Go To Inverse and select 1000 to 1004. Then verify the RED record in the database is as follows

RED IN 1000-1004 Azimuth 225-00'00" H.dist 97.980 V.Distance 20.000

Take a reading now to point 1005

OBS F1 1000-1005 S.Distance 100.000 V.obs 101-32'13" H.obs 315-00'00"

Go To Inverse and select 1002 to 1003. Then verify the RED record in the database is as follows

RED IN 1002-1003 Azimuth 180-00'00" H.dist 138.564 V.Distance -40.000

Go To Inverse and select 1003 to 1004. Then verify the RED record in the database is as follows

RED IN 1003-1004 Azimuth 270-00'00" H.dist 138.564 V.Distance 40.000

Go To Inverse and select 1004 to 1005. Then verify the RED record in the database is as follows
RED IN 1004-1005 Azimuth 0-00'00" H.dist 138.564 V.Dist -40.000

Go To Inverse and select 1005 to 1004. Then verify the RED record in the database is as follows
RED IN 1005-1004 Azimuth 180-00'00" H.dist 138.564 V.Dist 40.000

Cogo | Area's

Key in the following positions using Keyboard input

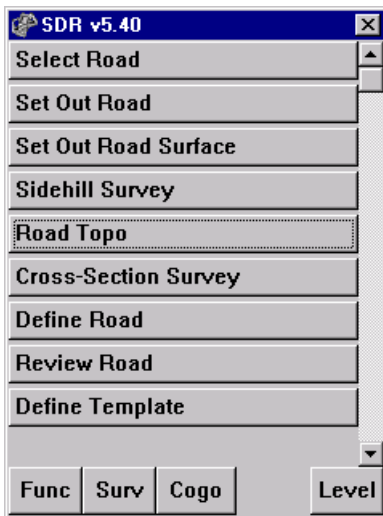
0001 North 0.000	East 0.000	Elev 0.000
0002 North 6.000	East -3.000	Elev 0.000
0003 North 9.000	East -3.000	Elev 0.000
0004 North 6.000	East -9.000	Elev 0.000
0005 North -6.000	East -9.000	Elev 2.000
0006 North -6.000	East -100.000	Elev 100.000
0007 North -1000.000	East -100.000	Elev -100.000
0008 North -1000.000	East 8000.000	Elev 0.000
0009 North 450.000	East 280.000	Elev 5.000
0010 North 9.000	East 3.000	Elev 0.000

The first example is a complex 10-point polygon shape. From the Area menu select the following points in order: 0001,0002,0003, 0004, 0005, 0006, 0007, 0008, 0009, and 0010. The Area should equal 6040093.000 (sqft). Change units to acres and verify that the area is now displayed as 138.661 (acres).

The second example is a 4-point polygon 0001, 0002, 0003, and 0004. The following 4-pt polygon shape Area should equal (sqft): 27.000.

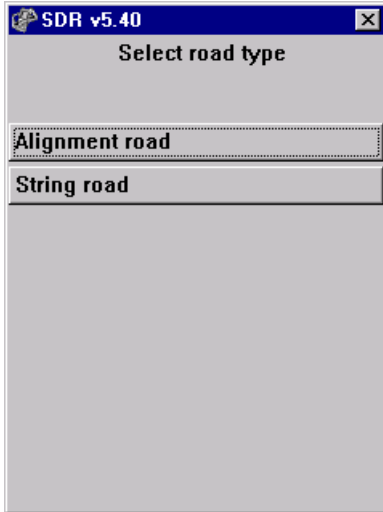
V. Roding module

The primary benefit of the Roding module over the Cogo module is a point may be selected for set out without having to key in its coordinates or know its database point id. In addition, the amount of memory required defining what could be thousands of points versus the ability to calculate and stake out locations on the fly from an alignment definition.

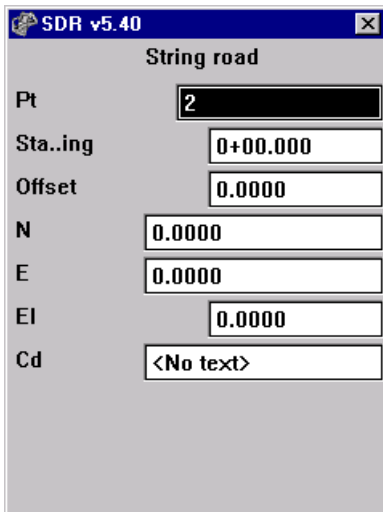


Road | Define Road

SDR Roding, designed primarily to work with routes, allows the User two methods in which to define the route or alignment. However any type of survey may make use of Roding features if it can be defined using a horizontal alignment, horizontal and vertical alignment, or horizontal and vertical alignment and x-sectional elements.



The first basic method of Road definition is called a String Road. A string road is comprised of solely RPOS coordinates. The RPOS record must contain its Station and Offset as well as a North East and Elevation.



Pt	2
Sta..ing	0+00.000
Offset	0.0000
N	0.0000
E	0.0000
El	0.0000
Cd	<No text>

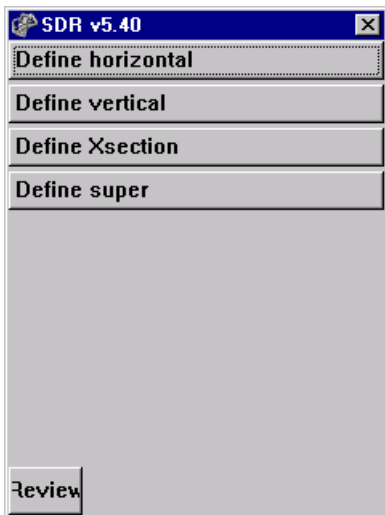
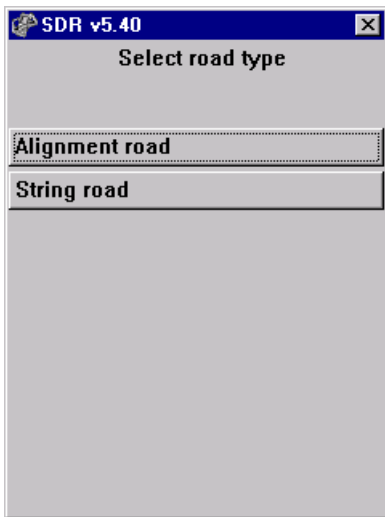
Utilizing a string road allows from the Set out Road option the ability to toggle through the alignment using the Station increment feature and toggle through offsets along the x-section as well.

String Road set out option does not perform any interpolations for stations or offsets. All locations desired for set out purposes must be entered as a RPOS record when defining the string road.

The second method of Road definition is called an Alignment Road. An Alignment Road is defined by a beginning Station and the associated geometric elements entered by metes and bounds or the end point coordinates of a tangent element.

There is two types of alignment routes coordinated and uncoordinated. If the User does not provide initial coordinates for the beginning of the route the SDR will assume the coordinates of the initial point and thereafter will not present coordinates for any position displayed or saved to the database. The Station and offset will serve as the point's coordinates rather than Northing and Easting.

All positions that fall within the radial alignment definition may be interpolated and selected for set out purposes.



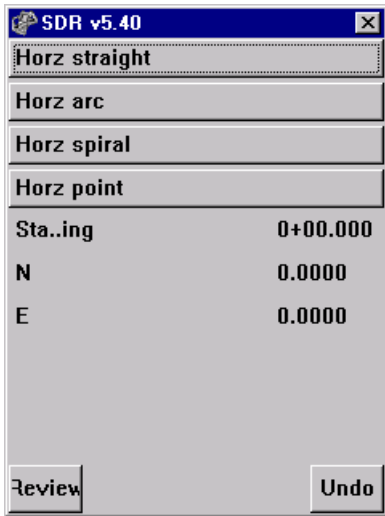
All Roading survey techniques regardless of road type, produce a Station and offset of set out coordinates and when appropriate the cut and fill information relative to any of the possible combination of elements of the defined centerline alignment. Some examples of other types of surveys that might take advantage of Roading techniques are pipelines, transmission lines, railroads etc.

There are five survey methods available in the Roading module. These are namely Road Topography, Road Setout, Set out Road Surface, X-section Survey and Sidehill Survey. All five methods utilize a horizontal alignment to calculate a position radial to the defined centerline.

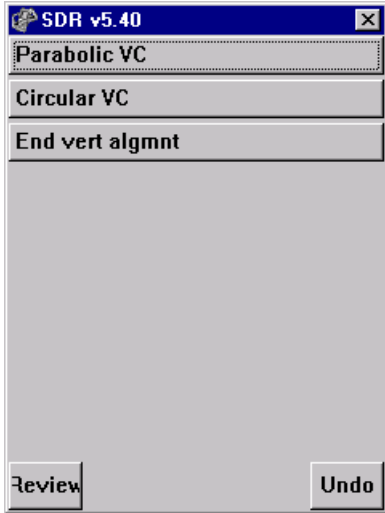
Horizontal alignments may contain any or all of the following geometric elements: tangents, arcs, and transition spirals. The SDR utilizes a clothoid spiral for all spiral calculations. One may need to check a specific alignment type to ensure that the clothoid spiral is the appropriate spiral type.

A restriction is placed on the use of arcs contained in horizontal alignments and that is they must be tangential to both the back and forward tangents to be a valid horizontal alignment element.

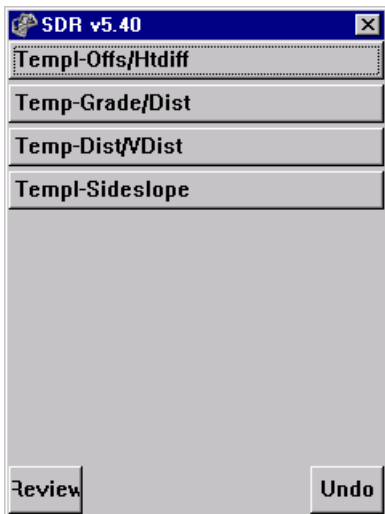
Horizontal alignments may completely be made up of tangent segments as in the case of a pipeline. A single vertical alignment may be attached to a horizontal alignment with or without cross sectional templates. Such would be the case in a pipeline where only a depth on centerline is desired. Or in the case of a road, cross sectional templates may be added to a vertical alignment when changes of grade are desired on the cross section.



Vertical alignments are made up of a series of gradients and lengths that are used to define vertical curves. The assumption is made that each gradient entered is part of a vertical curve definition. To have a series of straight grade changes entry of a zero length vertical curve is used to accomplish this task as in the example of a pipeline where the profile is a series of straight grade breaks.



Templates are utilized to define the vertical shape of the cross sectional view of a given alignment. Templates may be associated to a single side, or both sides of a horizontal alignment.



The cross section of any section is interpolated between templates on either side of the given station being staked. Care must be used in that the number of elements in both adjacent templates is the same. The element location within the cross section determines what template element will be interpolated. An example would be the ditch location of a road where the station being set out is between ditch PVI's. The same number of break points across the cross section must exist on both templates for the correct grade and offset to be interpolated for the current station ditch location.

Templates and alignments may associate with multiple SDR jobs. Alignments and templates are stored in separate files on the SDR. Once an alignment has been pulled into an SDR job a copy of the definition is copied into the current Job file.

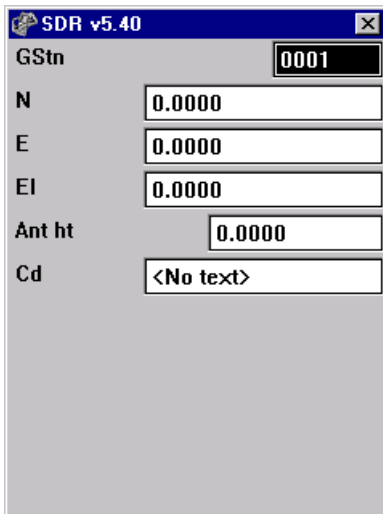
By storing the definitions of alignments and templates in separate files allows access to them from multiple SDR jobs separately without having to redefine all of the elements again.

Road | Set Out Road

When setting out a Road the same principles are used as in the Cogo Modules. Graphic Setout is also available except only the Set out Point graphic is utilized. When RTK Roding is being performed a Calibration must exist prior to being allowed to stake the Road. Depending on the Positioning mode the user will be prompted for a GStn conformation.



The screenshot shows a dialog box titled "Confirm GPS Station" from the SDR v5.40 software. It contains a "Set up on" label and a dropdown menu currently set to "Coords". Below this is a "GStn" label and a black rectangular input field.



The screenshot shows a dialog box from the SDR v5.40 software with the following fields:

GStn	0001
N	0.0000
E	0.0000
EI	0.0000
Ant ht	0.0000
Cd	<No text>

Upon confirming the GStn if in GOBS mode the User will be presented with the Selection screen. Here the User may select the desired location by its Chainage and offset.

Two methods are provided in the selection process. The User may toggle between only stopping on just available Control points by using the soft keys Next or Prev. or incrementing down the alignment by a desired even Chainage by using the soft keys Sta+ and Sta-.

Regardless of the method used the SDR will always prompt the User when a Control Point has been reached. A control point is defined as one end of any horizontal or vertical element contained in the alignment definition.

The user travels along the cross section by using the soft keys --> and <--.

SDR v5.40

Set Out Road

Sta..ing

Offset

Cd

EI

Horz o/s

Next Prev <- -> Incr

SDR v5.40

Set Out Road

Sta incr

Sta..ing

Offset

Cd

EI

Horz o/s

Sta+ Sta- <- -> CPt

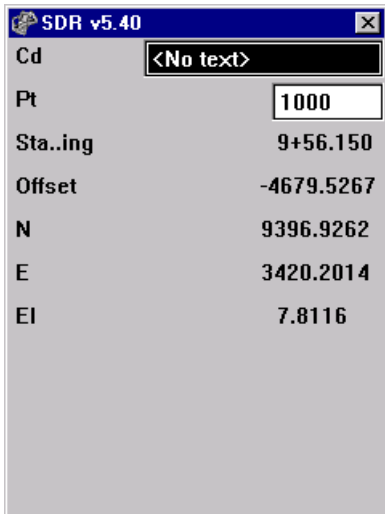
Upon accepting the desired location to stakeout either the Aim Screen or the live navigation screen will be displayed to allow the location to be set out.

Road | Set Out Road Surface

<To Be Added at a later date>

Road | Topo

The purpose of Road topography is to produce Station and offset of any shot point relative to a defined horizontal alignment. Both the raw observation and the Road position of each shot point will be saved to the database. The procedures are identical to the Main survey module Topography.



Road | Side-Hill Survey

The SDR Level 5 sidehill survey program allows you to pick up topographical and profile data. It calculates stationing and offset for the profile points based on a predefined centerline. Current implementation only supports the use of Total Stations.

There are two distinct parts to performing the survey: the first is to define the centerline; the second is to perform the survey. The centerline may be defined some time before the survey is to commence. It is also possible to use the same centerline definition over several sidehill surveys.

Centerline definition

The centerline definition is the 'Horizontal definition' of a road job. In order to define it, select the Roading module, and then select Define horizontal.

The only part of the road definition, which is used by the sidehill program, is the horizontal definition. If a vertical or cross-section definition is present then they will be ignored. The definition must be for a coordinated road that is the coordinates must be entered in the "Define horizontal" screen. The definition should not contain any spiral or circle elements. The sidehill program only uses the linear elements, which are defined either by Horizontal line or Horizontal point.

Choose "Sidehill survey" from the "Survey" menu. If there is not a current job open you will be required to select or create one. After you have selected the job the following screen will be displayed:

```

Sidehill survey
Road
  Sidehill road
Left    25.000
Cd      LEFTP

```

Right 25.000
Cd RIGHTP

The "Road" field specifies the name of the road from which the horizontal definition will be used.
The "Left" and "Right" fields define the offsets for the left and right offset points respectively.
The "Cd" fields are used for points generated as offset points.

Press <OK> to accept this screen.

The SDR will now copy the road definition from the road job into the survey job: this provides a record of the data that is to be used during the survey.

You will now be prompted to confirm an orientation before commencing the sidehill survey:

Take reading

Stn 1000
Bs Pt 1001

Sidehill survey

OFS OFS OF- ANG CFG

Take a reading to the point by pressing the <READ> key. A reading will be taken and the following screen displayed (observation screen):

Code

<No text>

Pt 1087
Target Ht 1.560
H.Obs 0-30'22"
V.Obs 87-47'16"
S.Dist 26.167
OFS OFS OF- ANG CFG

You now have the choice of storing the record as a topo point, as centerline/offset points or discarding it.
Press the <CLEAR> key to discard the reading.

Press the <READ> key to store the point as a topo observation. The next reading will then be commenced.

If you are measuring a centerline point, press the <OK> key and this screen will be displayed:

Pt 1087
Sta..ing 3+36.388
D.Offs 0.231
Cd Center
Left 0.241
Cd LEFTP
Right -0.216
Cd RIGHTP Fence

The "Pt" field is for information only; it shows the first of the three point ids, which will be used if this screen is accepted. (This comes from the observation screen above.)

The "Stationing" field is for information only and displays the stationing which has been applied to the defined centerline.

The "D.Offs" field is for information only and displays how far left or right of the defined centerline the point is. A negative value indicates a distance to the left.

The "Left" and "Right" fields should be filled in with differences in height of the left and right offset point respectively.

The "Cd" fields display the codes that will be used for the centerline point and the two offset points, and may be changed if required. Note: The centerline point Cd will default to "Center" unless a new Cd is entered on the observation screen, in which case the new Cd is used.

Press <OK> to accept this screen, the SDR33 will store the centerline observation as an OBS record, and the three road position (RPOS) records, and a note indicating how far off line the centerline point is. The SDR will then commence the next reading. Here is an example of the records stored:

OBS F1 1001-1087 S.Dist 26.167 V.obs 87-47'16" H.obs 0-30'22"

ROAD POS RO 1087 Sta...ing 3+36.388 Offset 0.000
North 10518.383 East 2204.534 Elev 35.430
Cd Center

ROAD POS RO 1088 Sta...ing 3+36.388 Offset -25.000
North 10528.455 East 2181.653 Elev 35.671
Cd LEFTP

ROAD POS RO 1089 Sta...ing 3+36.388 Offset 25.000
North 10508.311 East 2227.416 Elev 35.214
Cd RIGHT Fence

NOTE D.Offs 0.231

The survey will end when the <CLEAR> key is pressed to exit from the "Take reading" screen. Once the survey has been ended it can be continued; however another survey may be done using the same centerline definition.

Road | Cross Sections

VI. Leveling module

Level | Leveling

Level | Adjustment

Appendix A:

Terms and Definitions

Conformal Map Projection

A system by which meridians and parallels of the spheroid may be represented on a plane in which the angles between points on the sphere are preserved upon projecting to the plane.

Projection Record

The latitude, longitude and height, with corresponding Northing, Easting and elevation, which defines the origin of the coordinate system. The latitude, longitude and height will always be displayed in WGS84 coordinates, however the Northing, Easting, and Elevation will be in the destination coordinates.

Local Tangent Plane

A plane that is tangent to the earth at the initial GSTN or STN and whose origin is also the initial GSTN or STN.

Calibration

Least squared calculated corrections to be applied to transform between one coordinate system to another. Calibrations are applied when moving between GPOS to POS record views.

Ellipsoid

A three-dimensional mathematical figure formed by rotating an ellipse around its minor axis.

XFM

A file containing datum and projection definitions. These include the Semi-Major axis, flattening of the ellipsoid, and relationships to WGS84 described with shift rotate and scale terms. Defines the type of map projection to be utilized and corresponding definitions.

Semi-Major

The semi-diameter of the earth's equatorial axis.

Semi-Minor

The semi-diameter of the earth's polar axis.

Flattening

Value used in determining the relationship between WGS84 and a system contained in a XFM. Determined with the following equation: $(\text{Semi Major} - \text{Semi Minor}) / \text{Semi Major}$.

Latitude

An angle formed by the normal to the surface of the ellipsoid at a given point and the equatorial plane.

Longitude

The angle between two meridians: the first passing through Greenwich (Prime Meridian), the second through the point of interest, measured in the plane of the equator.

Ellipsoidal Height

The height as measured above the referenced ellipsoid.

Plane Curvature Correction

Correction applied to *only* GOBS to account for the curvature of the earth—enabling the calculation of vertical heights above a vertical datum.

Curvature and Refraction	Corrections applied to <i>only</i> OBS vectors to account for the curvature of the earth and the refraction of the EDM light beam—enabling the calculation of vertical heights.
Atmospheric Correction	Corrections applied to <i>only</i> OBS vectors to account for atmospheric conditions that affect the EDM light beam.
Job Scale Factor	The ratio of distance on the plane to the distance on the spheroid. A value that is applied only to terrestrial vectors.
Grid Azimuth	An angle as measured from the North Grid line.
Convergence Angle	A clockwise angle from the meridian as represented on the plane and the North derived grid axis
Geoid	Equipotential surface in the Earth’s gravity field approximated by Mean Sea Level.
GO	A derivation code used with a geoid file record.
SO	A derivation code that represents a set out point from the Cogo module.
XF	A derivation code that represents a coordinate produced by use of an XFM.
Horizontal Alignment	A series of horizontal geometric elements necessary to define a Centerline.
Vertical Alignment	A series of gradients and vertical curves defining the profile of a centerline.
Template	A series of gradients in cross section connected to a vertical alignment.

Record Types (Views)

GStn	A point that is occupied by a GPS base receiver.
GOBS	The plane vector displayed as a GPS derived North azimuth, vertical angle and slope distance.
GREd	A reduced horizontal plane distance, vertical distance and azimuth.
GPOS	The delta N, E, and up as projected on a plane with an origin at the original GStn.
POS	The reduced Coordinate of any SDR measurement type after applying appropriate corrections—such as plane curvature corrections and calibrations.
STN	A point that is occupied by a terrestrial total station.
OBS	The planar vector displayed as a horizontal angle, vertical angle, and slope distance.

MC	The reduced horizontal angle in the form of an azimuth, vertical angle corrected for instrument and rod heights and slope distance after applying collimation, curvature and refraction, atmospheric and scale corrections.
RED	The reduced azimuth, horizontal distance and vertical distance.
POS KI	A manually keyed in coordinate that is stored in POS view.
BKB	A back bearing record.
LLHSTN	A point occupied either by a GPS receiver or a terrestrial total station, whose coordinates are defined in terms of geodetic ellipsoidal coordinates.
WGS84	View of an observation converted to the WGS84 geodetic ellipsoidal coordinates.
Datum	View of an observation converted from WGS84 to local geodetic datum ellipsoidal horizontal coordinates and orthometric height if a geoid file is in use.
RSTN	A point that is occupied by a terrestrial total station of GPS RTK instrument while performing Roding functions.
RPOS	The reduced Road Position Coordinates of any SDR measurement type after applying appropriate corrections—such as plane curvature corrections and calibrations and its Road Station and Offset.