GPS - System 300

RT-SKI User Manual

Version 3.60

Leica Geosystems AG, Heerbrugg, (Switzerland)
Telephone +41 71 727 31 31, Fax +41 71 727 47 02

CONTENTS

1. Introduction

Welcome to the guide to RT-SKI, the Real Time Differential Phase GPS Survey System from Leica. RT-SKI is designed to give you coordinates with centimetric accuracies in real time, in the field.

This manual assumes that the user already has some experience of handling the GPS equipment in the field and is familiar with the basic operation of the GPS Sensors and Controllers.

Controller version 3.60, September 1998

The symbols used in this user manual have the following meanings:

DANGER:
Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury

WARNING:
Indicates a potentially-hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION:
Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or appreciable material, financial and environmental damage. The symbol is also used to alert against unsafe practices.

Important paragraphs which must be adhered to in practice as they enable the product to be used in a technically correct and efficient manner.

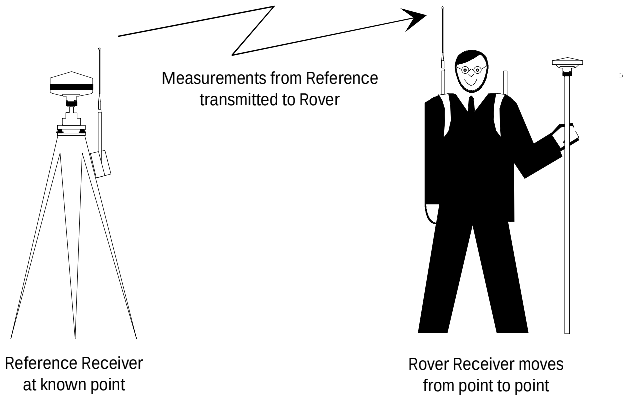
2. Basic Principles

As with all other types of differential GPS techniques, RT-SKI relies on simultaneous information from two GPS sensors, a reference and a rover.

The main difference with RT-SKI is that no post processing of the data is required, (although this can still be carried out if desired).

The reference Sensor has to be set up on a point whose coordinates are reasonably accurate. The reference station then transmits it's fixed coordinates and the raw data received to the roving station, where the computations are carried out. This implies, that the data transmitted from the reference station has to be transmitted through a radio modem. The data is then received at the roving station through a second radio modem.

The coordinates displayed and recorded at the rover will be based on the coordinates of the reference station. The baseline precision will be about 1cm +2ppm rms.



3. Setup scenarios

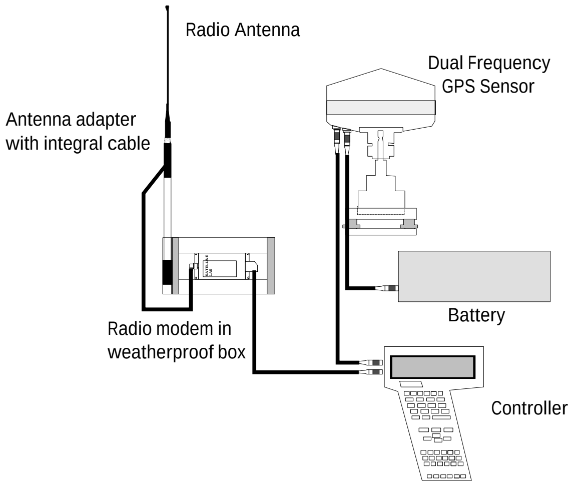
This chapter describes the envisaged setup scenarios at both the reference and rover stations with regard to equipment requirements. Note that the same Sensor model should be used at the reference and at the rover. i.e. an SR399(E) at the reference and rover, or an SR299(E) at the reference and rover. Do not mix Sensor models at the reference and rover. It is however, possible to mix the SR9500 and SR399/399E.

3.1 Setup at the reference station

At the reference station, it is envisaged that the following equipment will be required as a minimum.

Dual Frequency Leica GPS Sensor
GPS Controller with RT-SKI installed (CR244 or CR344)
Radio Modem
Radio antenna
GEB71, 7Ah Battery
Cable - 1.8m, Battery to Sensor/Controller
Cable - 2.8m, Sensor to Controller
Cable - 1.8m, Radio modem to Controller
Weather protection box
Antenna adapter for Radio modem antenna. (with integral cable for connection to Radio Modem)
GRT44 Carrier
GDF22 Tribrach
Height hook
Tripod

A suggested connection regime for the reference station is given overleaf. If required, an extra battery can be connected to the free port on the Controller.

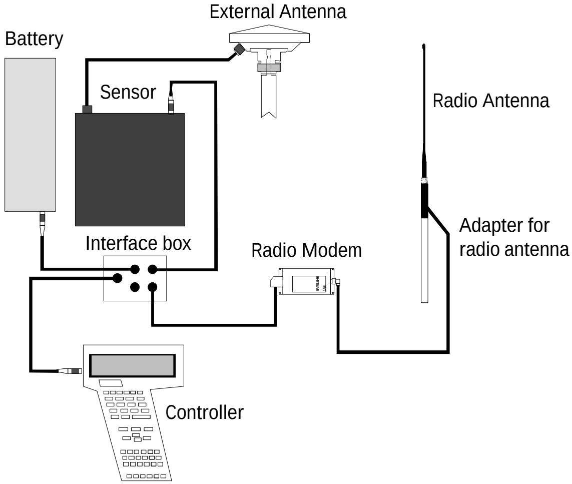


3.2 Setup at the rover station

The envisaged minimum equipment requirement at the rover should be as follows.

Dual Frequency GPS Sensor and External Antenna (SR299(E), SR399(E) or SR9500 and AT302)
GPS Controller with RT-SKI installed (CR244 or CR344)
Radio modem
Radio Antenna
GEB71, 7Ah Battery
GEV112 Interface Box
Cable - 0.5m Battery to interface box
Cable - 0.5m Sensor to interface box
Cable - 1.8m Radio modem to interface box
Cable - 1.8m Interface box to Controller
Cable - External Antenna to Sensor
Antenna adapter for radio modem antenna (with integral cable for connection to Radio modem)
Carrying Frame and Large Softbag
1.5m Stop and Go pole with 0.4m extension and holder for CR244/CR344
(Optional - Weatherproof box for radio modem.)

A suggested connection regime for the Rover is given below. Note that it is not essential that the interface box is used. The interface box merely makes for less cables running to the Controller. It is possible to use longer cables than those given in the list above and connect them all to the Controller.



The large softbag and carrying frame can be used to carry the equipment when measurements are being taken. In hot, dry conditions, open the top flap of the softbag and secure it in the open position.

4. Radio Modems

The radio modem is a vital part of the RT-SKI system, but is the only part of the system not manufactured by Leica. You may choose to find your own source for radio modems, or ask your local Leica representative.

Most countries have some form of broadcasting regulations regarding radio signals. You will normally have to select a radio modem that is licensed for use in your country or local area.

Another consideration is range. The range over which a radio can broadcast is partly related to it's power. Range will be considerably impaired in built up or mountainous areas. Bear these factors in mind when selecting a radio modem.

In addition to this, consider that you may also have to carry the radio modem. Powerful radios tend to be rather large and heavy and therefore not portable. Smaller, easily portable radios are very convenient but the effective ranges are lower.

Make sure that the radio modem baud rate at both stations is the same. As a minimum, 4800 baud should be used. Obviously, both radio modems should operate on the same frequency. Transmission is one way only. The reference station transmits and the rover receives. The data link should operate in transparent mode without handshake.

Note: As an alternative to radio modems you may also use GSM cellular phones that are supporting AT command language for data transmission. See Appendix 10.6: “Notes on Handshake for Communication Ports” for more information.

WARNING:
Electromagnetic radiation emitted by the Radio Data Modem can cause disturbances in other electronic equipment.
Equipment disturbed in this manner can cause serious consequential personal injury and material damage.

Precautions:
When using the Radio Data Modem, adhere to safety directions and instructions for use provided by the manufacturer.
Use only those Radio Data Modems approved for use in your country in accordance with national and international regulations

5. Controller operation - Main Menu

Upon activating the Controller, a title panel will appear giving information on the version of firmware installed in the Controller. Pressing any key will lead to the Main Menu [0000] as shown below.

```
[0000]   MAIN MENU

MISSIONS              AUXILIARY
CONFIGURATION         SELECT / ENTER
TRANSFER              CONTROLLER SERVICE

CONT
```

The various sub menus that can be accessed are displayed here.

The **MISSIONS** sub-menu: Different missions can be stored, each one of which controls the way in which the Sensor will operate and data will be stored.
The **CONFIGURATION** sub-menu allows the user to configure various operating parameters on the Controller.
The **TRANSFER** sub-menu controls transfer of data between the Controller and PC and vice versa.
The **AUXILIARY** sub-menu contains options for formatting data devices, a data dump facility and a function for copying transformation sets between various memory devices on the Controller.
The **SELECT / ENTER** sub-menu is where projects, jobs, points and lines are configured for the database.
The **CONTROLLER SERVICE** sub-menu contains programs for firmware management and viewing files contained on the Controller.

Explanations of the sub-menus that are important for the user at this stage follow.

5.1 Missions

A mission is the way in which the Controller will control the Sensor during data acquisition. A mission has many different possibilities for configuration but it is likely that any one user will only use three or four different mission configurations. Each mission can be stored after it has been created and configured correctly. The missions are stored in the **MISSIONS** sub-menu.

There are several different types of operation that can be performed by the Controller. These are Static, Stop and Go, Kinematic, Kinematic on the Fly, Real Time Rover and Navigation missions.

When you program your missions for RT-SKI applications, you will need to select a **Static mission for the Reference Station** and a **Real Time Rover mission for the Rover**. Default missions for both Real Time Reference and Real Time Rover are hard-wired into the Controller.

5.2 Configuration

Configuration is used to configure functions pertaining to the Controller . Upon entering **Configuration**, the following panel will be displayed.

```
[0200]   CONFIGURATION
Start-Up                 Units
Timer Missions           Data Logging
Date, Time, Zone         Transformation Set
Communication Port       Sensor and Antenna
Keyboard & Display       Coding System /GSI

CONT
```

For the RT-SKI user, the options which will be most useful at this stage are: **Communication Port**, **Data Logging**, **Transformation Set, Sensor and Antenna** and **Coding System.**

5.2.1 Configuring the Communication Ports

The radio link must connect to port 3 of the Controller, (either directly or through the Interface Box). Enter the **Communication Port** option. Move through the ports using the F3 or F4 keys until the settings for port 3 are as below.

```
[0240]   CONFIGURATION Comm. Port 3

Interface: RS-232  Baud rate: 4800
Data bits: 8       Stop bits: 1
Parity   : NONE    Handshake: SATELLINE


CONT          PORT-  PORT+         CHAN
```

Move through the parameters, adjusting them if necessary to suit your radio link settings. When you are satisfied with the settings, press **CONT** to return to the Main Menu. For real-time operations using a Satelline radio modem, set the handshake to SATELLINE.
Important Note: When using the Interface Box and single cable to port 3 of the Controller, (usually this will be the rover setup), port 3 will be set to RS232. Port 2 <u>must</u> be set to GLAN.

NMEA messages are normally output through port 2. Hence when outputting NMEA messages through this port, configure port 2 to RS232. Connect the radio link or interface box to port 3, the NMEA output cable to port 2 and the Sensor to Port 1. The battery can be connected to either the interface box (if used) or to the Sensor.

Note that the Handshake may be configured for different radio modems. A full description of each setting is given in the Appendix 10.6: “ Notes on Handshake for Communication Ports”.

5.2.2 Configuring the Data Logging device

If you have purchased the optional 1MB internal memory, you may choose where to log the data to. Enter the **Data Logging** component in **Configuration**. The following panel will be displayed.

```
[0270]   CONFIGURATION Data Logging

On Device :  INTERNAL MEMORY MODULE


CONT
```

You may switch to the **Memory Card** by pressing the cursor right key. Press **CONT** to return to the Main Menu.

5.2.3 Defining a Transformation Set

If you wish to work in local coordinates, you will need to define a transformation set. Enter **Transformation Set** in **Configuration**. The following panel will appear.

```
[0280]   CONFIG Transformation Set
                                             [0]

Name          :
Type          :STRICT

Use PgUp, PgDn, Home, End to scroll
                          NONE            ADD
```

A Transformation Set may be configured or defined and then attached to a **Project** in the SELECT/ENTER option. This Transformation Set may then be used to transform WGS coordinates to local grid coordinates. This function will prove especially useful when RTCM or RT-SKI is being used.

There are two methods for defining or determining a Transformation Set. A classical approach using a set local ellipsoid and Map projection (STRICT) or a one step approach that determines parameters and creates it's own projection depending on the number of points included in the transformation information.

A Strict Transformation Set requires three main parameters to be defined. These are the Local Ellipsoid parameters, the Datum transformation parameters, and the Map projection parameters.

You may determine Datum Transformation parameters for a strict transformation set on the Controller.

A One step Transformation set must be determined on the Controller by comparing the same points with WGS84 coordinates and local grid coordinates.

Firstly, press the **ADD** key and enter a name for the Transformation set.

Then you must decide which method to use for the transformation. The **STRICT** type will be used if you are aware of the local ellipsoid and map projection. If you do not know the parameters for either the local ellipsoid or local map projection use the **ONE STEP** method.

To switch between the two different methods, use the Cursor Left or Cursor Right key.

Use the **NONE** key to deselect a transformation set.

5.2.3.1 Defining a Strict Transformation

Press **NEXT** (F1). The following panel will appear.

```
[0281]   CONFIG Local Coordinates

Ellipsoid    : (none)
Datum transf.: (none)
Projection   : (none)


       STORE  ELLIP  TRANS  PROJ   PREV
```

Select your local ellipsoid from the list by pressing **ELLIP**. On the panel that appears use the **PG UP** or **PG DN** keys to cycle through the ellipsoid list until the correct one is displayed. If your local ellipsoid is not contained in the list, you may define it by pressing **ADD** and entering the relevant parameters. When you are satisfied with the selected ellipsoid, press **CONT** to return.

You will need to define a datum transformation for the area you are working in. The values for this may be derived from previous jobs undertaken in the Datum and Map option of SKI or values may be available from your national mapping agency additionally, you may determine transformations on the Controller. Press **TRANS**. A new panel will appear. Press **ADD**. Now you will be able to enter a name for the transformation. To Determine the transformation parameters, press **DETERM**. For details on determining the parameters and matching points, see the next section. Alternatively, press **NEXT** to access a panel with parameters that require definition. Press **NEXT** to access a panel with further parameters that require definition. When you are satisfied with the entries, press **STORE**. Your transformation parameters will now be stored. You must review the transformation before it is selected. Cycle through the two panels again. When you reach the last panel [0284] this time, press **CONT**. The transformation will be selected for use.

In addition to the transformation, a map projection for your local area needs to be defined. Parameters for national map projections should be available from national mapping agencies. From panel [0281] (shown above), press **PROJ**. You will now be able to enter a map projection in panel [0285] by pressing **ADD**, inputting a name for the projection and defining the type of projection. Use the **PG UP** or **PG DN** keys to select the projection type. Press **NEXT** and then enter the parameters for the map projection. When all the relevant parameters have been entered, press **STORE**. Then review the projection parameters before pressing **CONT** to confirm the selection.

Note that some customised map projections are hard-wired into the firmware and can be simply selected from the CONFIG Map Projection panel [0285] by pressing the **PG UP** or **PG DN** keys. Customised projections are those that are not possible to define in the Controller in the normal way. The currently supported projections are:

- Finnish KKJ
- Hungarian projection
- Malayan RSO Grid
- New Brunswick ATS77
- New Zealand Grid

- PE Island ATS77
- Soldner - Berlin
- Swiss 95 projection
- Swiss projection

Now from panel [0286], you may press **CONT**. Panel [0280] CONFIG Transformation Set will now be visible. Press **STORE**. The whole combination of ellipsoid, transformation parameters and map projection will be stored on the data device. Review the Transformation Set by pressing the **NEXT** and **CONT** keys.

5.2.3.2 Defining a One Step Transformation

The One Step option is selected from panel [0280] CONFIG Transformation Set. The parameters have to be determined either on the Controller itself or within SKI and downloaded to the Controller.

To determine the parameters, press the **DETERM** key.

For details on how to download a One Step transformation from SKI to the Controller refer to the SKI Help.

5.2.3.3 Determining Transformation Parameters

Transformation parameters may be determined on the Controller for Strict or One Step methods. This is initiated from both transformation types by pressing the **DETERM** key.

The following panel will appear.

```
[0293]   MATCH Common Points
------WGS 84----- ------GRID------ Match
213               213              YES
214               214              YES
306               306              YES
(None)            (None)           NO

NEXT     WGS84    GRID    MATCH            PREV
```

All points in WGS84 (measured points) and in local grid that have the same point Ids will be matched automatically.

To select further WGS84 points press the **WGS84** key and select from the list.

To select a local grid point press the **GRID** key and select from the list.

When defining a Strict type transformation, you may either match the points or deselect the points from being matched by pressing the **MATCH** key. When you have matched the required points, press **CONT** . You then have to specify which parameters you wish to calculate. You may select all 7 or as few as you wish. Press the **COMPUT** key to determine the transformation. A log file is produced from which you can see how accurate the transformation is.

When defining a One Step type transformation you may select whether the points are to be matched for position only (HOR), for height only (VER) for position and height (FULL) or not matched (NO) by pressing the **MATCH** key.

For determining a Strict type transformation you must match at least 3 points from each co-ordinate system.

When determining a One Step type transformation you may match as few as one or up to ten points. The Transformation will consist of a 2D Helmert transformation and a 1D Height approximation. (Depending on the local co-ordinate data input by the user).

The following may be determined:

With 1 WGS 84 co-ordinate and 1 matching Local co-ordinate: 2D Helmert transformation with shifts in X and Y.

With 2 WGS 84 coordinates and 2 matching Local coordinates: 2D Helmert transformation with shifts in X and Y, rotations and scale.

With more than 2 WGS 84 coordinates and more than 2 matching Local coordinates: averaged 2D Helmert transformation with shifts in X and Y, rotations and scale.

If no height information exists for the local grid points then no height transformation information will be determined.

If height information exists for 1 local grid points then height transformation information will be determined and given as a constant for the whole transformation area.

If height information exists for 2 local points then height transformation information will be determined and given as an average between the two for the whole transformation area.

If height information exists for 3 local points then height transformation information will be determined and given as a plane for the whole transformation area.

If height information exists for more than 3 local points then height transformation information will be determined and given as an average plane for the whole transformation area.

When you have matched the points as required, press **COMPUT**. A logfile will be produced where you may see how accurate the transformation is. Study the residuals and scales in order to determine the quality of the transformation. If you import your project in SKI V2.2 you can output the logfile as an optional part of the RTSKI fieldbook.

5.2.4 Selecting the Sensor type

You must select the type of Sensor being used. For RT-SKI applications this must be the 299, 399, 299E with external Antenna, 399E with external antenna or 9500 with external antenna. Users of RT-SKI-L1 will need to select the 9400 with external antenna. To switch between Sensor and Antenna types enter the **Sensor and Antenna** option in **Configuration**. The following panel will appear.

```
[0290]   CONFIG Sensor and Antenna

Sensor Type          : SR9500
Antenna Type         : AT202-302
Using Groundplane    :  NO

CONT                             USER
```

Switch between Sensor types by using the right or left cursor keys. Using the same method you can switch between Antenna types. When the desired selection is displayed, press **CONT**.

Note also that you may specify an Antenna from a third party. To do this you will require the phase centre eccentricities with respect to a Leica SR299 or 399 with internal antenna. To enter these values press USER (F5). You may then enter the Antenna name and the corresponding eccentricity values. Up to 3 third party antennas may be entered, (USER 1 ... USER3) Details of how to calculate the phase centre eccentricities are given in the appendix.

5.2.5 Selecting the Coding System

The Controller supports three different coding systems. In theory, all of these coding systems could be used simultaneously. This is not recommended as it could make for confusion and error in the field and afterwards during data evaluation.

The coding systems that are supported are:

- GEODB codes
- Point Annotations
- GSI type codes

GEODB codes are those currently definable using the Codelist Manager software from Workbench. This type of coding system is described in section 6.

Point Annotations allow you to input up to 4 notes (each maximum 31 characters long) whilst in the field. They are a type of free form attribute. This information will be taken into SKI during data download and will typically be used for saving field notes or special information relevant to the measurements taken in the field.

GSI type codes are codes that may be input in the field that follow the GSI format used by existing WILD/Leica total stations, by Leica LISCAD software and many other locally produced surveying software packages. The GSI-8 and GSI-16 format is supported. GSI is a very general format that allows the user to totally customise his/her surveying system to their own requirements. This type of coding system will most likely be used by customers who already possess and use instruments and software supporting GSI coding. Full descriptions of the GSI format as used by Leica GPS is contained in the Technical Reference Help.

5.3 Auxiliary

Transformation sets may be copied between the memory card, memory module or System RAM.
Upon entering **Auxiliary** select **Copy Transformation Sets**. The following panel will appear.

```
[0550]   COPY Transformation Sets

Source:              Destination:

Memory Card   ---> System RAM


CONT     COPY     SOURCE   DEST
```

To select the source where the transformation set(s) is/are to be copied from press **SOURCE**. To select the destination where the transformation set(s) is/are to be copied to press **DEST**.

This function is useful to store all transformation sets and map projections a user requires and then transfer them onto memory cards after each time a new one is used or formatted.

5.4 Controller Service

The Controller Service menu contains functions relating to maintenance and testing of the Controller. Upon entering **Controller Service**, the following panel will appear.

```
[0700]   CONTROLLER SERVICE

Factory Settings      Registration Code
Self-test             Software Options
Software Update       Directories


CONT
```

The function of interest to the user at this moment will be the **Registration Code** function. In order to run the RT-SKI mission, you must enter your own personal registration code.

5.4.1 Entering the Registration Code

Select the Registration Code function. The following panel will appear.

```
[0735]    CONTROLLER Registration Code

Code      : SK-123456789

CONT
```

When you purchase the RT-SKI option, you will be supplied with a code number for each Controller. Type in this code number beginning with SK- and press **CONT**.

In addition to the RT-SKI option the following programs can be purchased and be used within Real Time Rover missions:

Raodline Application
DTM Stakeout Application
Quickslope Application

For information about these programs please refer to the Technical Reference Help System or the appropriate manuals.

6. Data Management

Before you can perform any operations with RT-SKI, you must enter at least one Project and Job on the Controller. The CR344 is part of the Leica Open Survey World and therefore information recorded by it can be exchanged with any Leica TPS which is also OSW compatible. The CR244 Controller is not OSW compatible due to the type of memory card used but information about Projects, Jobs etc. is entered in exactly the same way as with the CR344.

The information is arranged thus:

Each time you measure, the data will be stored in a **Job**. This **Job** has to be defined by you before measurements can commence. The **Job** must also contain a link to a **Project**, (see below). Other information such as the **Job** name, the operator, field party, time zone and time when the **Job** was created are optional and can be defined if desired.

Each **Job** in the Controller is linked to a **Project**. A **Project** can contain any number of **Jobs**. Each **Project** must have a name defined. All other information pertaining to the **Project** is then optional. You may define a Code List, a Transformation set and a Geoidal Field File to use and also other information associated with the project such as the Manager of the project, the client, the street where the survey is being conducted and it's map reference.

Points are also stored in the database. **Points** may be user entered points or measured points. This point information consists of a point id, a code (optional), and a set of coordinates (grid or WGS84). The points can then be called during measurements and used as waypoints, reference points, points to be set out etc.

Lists of points may be organised into different jobs. All the points from all the jobs may be displayed or may be filtered as required. This is so that the following operation may be performed:

A user has several points for which coordinates already exist. The points have to be staked out. Additionally, the user has to actually measure the points that are being staked out as a check. A job is defined in the Controller and the stakeout coordinates are downloaded via workbench in the office. Out in the field, a different job is defined and the points staked out and also recorded. using the filter key (see below) the user may filter the points from one particular job only.

All points can be listed from various places within the Controller program.

This is usually achieved by accessing the SELECT/ENTER menu and then selecting Point. The **SEARCH Point** panel will appear and present a list of all points currently stored in the database.

```
[0635]   SEARCH Point <              >    [12]
----Point Id----  --Code--  System    Class
1                           GRID      MEAS
10                          GRID      AVG
11                          WGS84     FIX
15                          GRID      FIX

CONT    POINT   COINFO  NOTES   FILTER  ADD
```

The Point Id and Code (if any) are shown.
The **SYSTEM** refers to the co-ordinate system used for the point. This may be either a local grid (Easting, Northing, Height) displayed as **GRID** or **WGS 84** coordinates.
CLASS refers to the classification of the point and may be one of the following:
FIX - Manually entered point.
MEAS - Point measured once only.
AVG - Point measured more than once, Average automatically computed. Note that points with classification **FIX** will not be used for averaging purposes.

Select a point and press **POINT** the following menu will show the actual coordinates of the point

```
[0630]   SELECT/ENTER Point      [WGS84]
[935 KB]                            [19]
Point Id: 10               Code:
Lat     :  47 24  0.00000 N  Class: FIX
Lon     :   9 37  0.00000 E
EHgt    :       400.000 m    CQ: ----m

CONT     EDIT     COINFO              DELETE  ADD
```

Press **PG-UP** or **PG-DN** to access the previous or next point in the list.

Lines may be defined between any two **Points** or from a **Point** with a bearing and distance. **Lines** may be called during measurements and used for staking out. Offsets to a line may also be set out during measurement.

Summing up, the <u>minimum</u> information that is required to be entered in the **Select/Enter** option before measuring can commence is a Project name, a Job name and a link between the Job and Project.

Note that all information regarding Jobs, Projects, Points, Transformation Sets etc. is stored on the PCMCIA card or old style memory card and not in the Controller itself (except of course when a Controller with Internal memory is used). Removing the card will remove the data from that particular Controller. This card can then be transferred to another Controller or, (in the case of PCMCIA cards), be also used in a Leica TPS. It is possible to store one codelist and one transformation set in the system RAM in order that they may be kept on one Controller.

Important - Formatting the Memory/PCMCIA Card or Internal Memory will erase all Projects, Jobs, Points. Lines and raw data stored upon the data device concerned. Similarly, deleting a Project will also delete any Transformation sets, points etc. stored within that Project.
Note that this is not valid for Geoidal Field Files since they are stored in the system ram.

6.1 Entering a Project

To enter a new Project onto the memory card/internal memory, enter the **Select/Enter** menu and select **Project**. The following panel will appear.

```
[0610]  SELECT/ENTER Project           [878 KB]
Project Name:Default Project                [1]
Code list   :(none)
Transf. set :(none)
Created     : 15-Jun-97 10:24  Points  : 12
Use Geoid   : NO               File   : OSU91A

NEXT    DELETE  SEARCH  TRFSET  CODLST  ADD
```

Press the **ADD** button to add a new Project. You must enter a name for the Project. You may also define a Code List and Transformation Set for use with this Project. Press **CODLST** or **TRFSET** to access the Code Lists or Transformation sets available on the PCMCIA card.

If you have previously downloaded a Geoidal Field File to the controller's system ram press the right cursor key to toggle Use Geoid to YES. If you are using more than one Geoidal Field File press cursor down and toggle between the files using cursor left or right. Note: Geoidal Field Files may only be deleted within a mission. Refer to chapter 7.1 The Reference Station Mission (SELECT Project / Job) for more information.

When you are satisfied with the entered information, press **STORE**.

6.1.1 The Codelist

The key CODLST always applies to GEODB code lists only. Only GEODB code lists may be attached to Projects in this way. The type of coding system to use is selected in Configuration before mission start-up. Refer to section 5.2.5 for further details.

When the CODLST key is pressed, the following panel appears:

```
[0615]  SELECT Code List

Codelist  : xxx
Project   : (Global Codelist)
Manager   :
Created   : 15-Jun-97 11:30

CONT    ATTACH  SEARCH  SAVE    LOAD
```

ATTACH attaches the currently selected codelist to the currently selected project.
SEARCH searches the data device and presents a list of the codelists on the current data device.
SAVE copies the currently selected codelist to the system RAM.
LOAD enables a codelist in the system RAM to be copied to the data device.

Note: Codelists are prepared within Codelist Manager in the Workbench software and downloaded to the Controller. Transformation sets are prepared within the Datum/Map Component of SKI or within the Controller itself - see section 5.2.3.

6.2 Entering a Job

To enter a Job, choose the **Select/Enter** menu and then select **Job**. The following panel will appear.

```
[0620]   SELECT/ENTER Job                   [1]
Project   : Default Project
Job name  : Default Job
Operator  :
Fieldparty:
Created   : 15-Jun-97            Zone: 2:00

CONT    DELETE  SEARCH  PROJCT          ADD
```

You may enter a new Job by pressing **ADD**. The Project to which this job will be linked is displayed. This is the last project selected or entered. To select a different project use the **PROJCT** key. Enter a name for the Job. The other parameters can be defined if desired. Note that the Time Zone is taken from that which is defined in Configuration / Date, Time, Zone. When you are satis-fied with the input, press **STORE**.

6.3 Point Management

6.3.1. Entering a new point

If you should wish to enter a point for future use (e.g. as reference point, waypoint etc.), select **Select/Enter** and then **Point**. The following panel will appear.

```
[0635]  SEARCH Pt  <                   >    [12]
----Point Id---- --Code--  System   Class
1                          GRID     MEAS
10                         GRID     AVG
11                         WGS84    FIX
15                         GRID     FIX

CONT     POINT    COINFO   NOTES    FILTER   ADD
```

Press the **ADD** button to enter a new point. Input the Id and the coordinates. To toggle between Cartesian coordinates (WGS84 X, WGS84 Y, WGS84 Z) and Geodetic coordinates (Lat, Lon, EHgt) press **ALT C**. To change between WGS84 and Grid system, press **ALT G**. If a Geoidal Field File is in use an undulation value will be interpolated and stored for each new point. **ALT O** enables you to switch between ellipsoidal (EHgt) and orthometric (OHgt) height.

When you are satisfied with the selection, press **STORE**.

Note that it is also possible to prepare points within Workbench and download them to the Controller internal memory or memory/PCMCIA card.

6.3.2. Viewing and managing points

All points can be listed from various places within the Controller program.

This is usually achieved by accessing the SELECT/ENTER menu and then selecting Point. The SEARCH Pt panel appears. Position the cursor on the desired point by using $\downarrow$ or $\uparrow$ key and press **POINT**. The following panel will appear.

```
[0630]  SELECT/ENTER Point              [WGS84]
[935KB]                                    [12]
Point Id: 10                    Code:
Lat     :  47  24  0.00000 N    Class: FIX
Lon     :   9  37  0.00000 E
EHgt  G :        400.000 m      CQ: ---- m

CONT     EDIT     COINFO  NOTES   DELETE  ADD
```

CONT returns to panel [0635] SEARCH Pt

EDIT enables editing of the currently selected point.

COINFO accesses a panel showing all the point entries for the point selected. See next section.

DELETE deletes the currently selected point after asking for confirmation.

ADD enables you to enter a new point (see previous section).

Note: The G after EHgt indicates that an undulation value is available for that point and you may switch between displaying ellipsoidal and orthometric height by pressing ALT O.

6.3.2.1. The SEARCH function

From various places within the Controller program whenever a point has to be selected or by using Point from the SELECT/ENTER menu the SEARCH Pt panel appears and a list of currently available points is displayed.

```
[0635]  SEARCH Pt  <                  >    [12]
----Point Id---- --Code--  System   Class
1                          GRID     MEAS
10                         GRID     AVG
11                         WGS84    FIX
15                         GRID     FIX

CONT     POINT    COINFO  NOTES   FILTER  ADD
```

The **Point Id** and **Code** (if any) are shown.
The **SYSTEM** refers to the co-ordinate system used for the point. This may be either a local grid (Easting, Northing, Height) displayed as **GRID** or **WGS84** coordinates.

CLASS refers to the classification of the point and may be one of the following.
FIX - Manually entered point
MEAS - Point measured once only
AVG - Point measured more than once. Average automatically computed. Note that points with classification **FIX** will not be used for averaging purposes.

Use **PG-UP** or **PG-DN** to access the next or previous pages of points. Alternatively, there is a text entry cursor on the title line of the display. Typing in the first few characters of the point Id will bring you straight to the point. The search method is case sensitive.

The **COINFO** key accesses a panel showing all the point entries for the point selected.

```
[0640]  Pt-Id: P1
---Date/Time--- Class -Src-  -CQ- Use LE
30-Jun-95  6:58  MEAS RTGPS  0.02 YES
30-Jun-95  6:59  MEAS RTGPS  0.02  NO *



CONT     COORDS  DIFFS    YES/NO  DELETE
```

The date and time when the point was measured together with it’s class is shown.
Src shows the source how the point was entered. **RTGPS** means the point was measured, **USER** means the point was entered manually or via Workbench.
CQ gives the co-ordinate quality of the point.
Use shows whether the point entry is being used in the average position or not. **LE** shows whether or not the averaging limit has been exceeded.

COORDS shows the actual coordinates of the point entry.
DELETE deletes the point entry.
YES/NO toggles the point entry to be included in the averaging process or not.
DIFFS brings up the Coordinate Differences panel giving information as to how much the coordinates differ from each other for the chosen point.

Referring back to panel [0635] SEARCH Point.

DIFFS displays the differences that exist between observations to a particular point. This panel is where the coordinate differences are taken into account to produce an average coordinate for a point (as long as the sets of coordinates fall within specific tolerances). Refer to section 8.5 for further details.

FILTER allows points to be filtered by coordinate system or by job and sort points by point id or by time. Pressing the **FILTER** key leads to the following panel:

```
[0650]  SET Point Filter

Active project: Default-project
Selected Job  : ALL JOBS
Coord. system : GRID AND WGS84
Sort points   : BY POINT ID


CONT          JOB
```

You may select to make coordinates available by **GRID AND WGS84, GRID ONLY** or **WGS84 ONLY.** Additionally or alternatively, you may select points from a particular job to be available by pressing the **JOB** key and selecting the jobs from which you wish to make points available.
Point lists can by sorted in order of the point ids by selecting **BY POINT ID** or in order of the time the points were recorded by selecting **BY TIME.**

Referring back to panel [0635] SEARCH Point, the **ADD** key allows you to add a new point to the list.

6.4 Entering a Line

Lines may be defined using two methods, either a straight line between two points or a straight line with a start point and a bearing.

From **Select/Enter** in the **Main Menu** [0000] select the **Line** option. The **Select/Enter Line** [1144] panel will appear. To add a new line press **ADD**. The following panel will appear.

```
[1150]  SELECT Line Type


   Straight Line (2 points)
   Straight Line (Point, Direction)


CONT
```

Select the method you wish to use to define the Line and press **CONT**.

6.4.1 Entering a Straight Line - two known points

When you select to enter a straight line between two known points, the following panel appears.

```
[1151]  ADD Straight Line
Line Id:                    Code:

Start Point Id:
End Point Id  :


         STORE   CODE    START   END
```

Enter an Id for the Line and select to attach a code if required by pressing the **CODE** key.

Select the start point of the line by pressing the **START** key. The **SEARCH Pt** [0635] panel will appear from which you may select the point.

Select the end point of the line by pressing the **END** key. The **SEARCH Pt** [0635] panel will appear once more from which you may select the point.

When you are satisfied with the selection, press **STORE**.

6.4.2 Entering a Straight Line - Start Point and Direction.

When you select to enter a straight line with a start point and direction, the following panel appears.

```
[1152]  ADD Straight Line
Line Id:                 Code:
Start Point Id:
End Point Id  :
Direction     :   0° 0' 0"
Distance:     0.000 m   dH:     0.000m

TOGGLE  STORE  CODE  START  NONE  LAST
```

Enter an Id for the Line and select to attach a code if required by pressing the **CODE** key.

Select the start point of the line by pressing the **START** key. The **SEARCH Pt** [0635] panel will appear from which you may select the point.

Enter an Id for the end point of the line. This point will be automatically created once you have entered a direction and distance for the line and stored the parameters.

Enter a direction and distance for the line as well as a height difference (or slope). Use **TOGGLE** to switch between height difference (dH) and slope. The slope may be entered as percentage (%), vertical to horizontal ratio (V/H) or horizontal to vertical ratio (H/V). Enter a negative value if the slope is descending.

When you are satisfied with the selection, press **STORE**.

7. Running the missions and resolving ambiguities

When you use RT-SKI in the field, you will have, as explained previously, a minimum of two GPS Sensors running simultaneously, - a reference and a rover. The reference Sensor requires a different mission setup to the rover. Mission setups at both reference and rover are explained in these chapters.

There are also two types of RT-SKI messages that may be used. You may use the RT-SKI phase message which will give results in the centimetre range but requires initialisation, or you may use the RT-SKI code message which gives results in the 0.3-1.5m range but requires no initialisation. Sections 7.1, 7.2 and 7.3 cover cases when the RT-SKI phase message is used, section 7.4 covers cases when the RT-SKI code message is used.

7.1 The Reference Station Mission

You may set up your own reference station mission by using the **COPY** and **EDIT** functions in the **MISSIONS** menu. These functions are described fully in the Technical Reference Manual and will not be entered into here. Alternatively, you may set up the mission parameters each time you run the mission. The following description of how to set up a reference station mission also applies to users who wish to configure their own mission since each panel is described. In addition, a default Reference mission is included on all Controllers with RT-SKI installed.

After switching the Controller on move to the **MISSIONS** menu and press **CONT**. The Default Real Time Reference mission will be displayed. Select this mission and press **RUN**.

The **CURRENT MISSION** panel [1000] will be displayed. To proceed to the next panel, press **CONT**.

The **SELECT Project/Job** panel [1002] will be displayed as below

```
[1002]  SELECT Project / Job
Project     : Default Project
Active Job  : Default Job
Codelist    : (none)
Transf.set  : (none)
Use Geoid   : NO        File     : OSU91A

CONT     PROJCT  JOB              GEOID
```

A Default Project and Job will be listed if no other projects or Jobs exist. Otherwise the last Project and Job that were entered or selected will be displayed. If you want to select a different Project/Job or enter a new one, press the **PROJCT** or **JOB** buttons. You will then enter the **SELECT/ENTER** menu and be able to choose a different Project or Job or enter a new Project or Job.

If you want to use a Geoidal Field File press the right cursor key to toggle Use Geoid to YES. Pressing the **GEOID** button allows you to manage your Geoidal Field Files. To toggle between files press left or right cursor key. To display further information about Geoidal Field Files press the **INFO** button or press the **DELETE** button to remove individual files from the system ram.
Note: Geoidal Field Files may only be deleted within a mission.

When you are satisfied with your changes, press **CONT**.
The **SET Operation** panel [1021] will then appear. For the Real Time reference station, select a **STATIC** type mission. When this has been done, press **CONT**.

The **SET Datalink Parameters** panel [1013] will then appear. The following parameters should be set.

```
[1013]  SET Datalink Parameters

Datalink Messages    : ON
Message input/output: RTIME CODE/PHASE OUT
Comm. Port number    : 3
Byte format rule     : --

CONT
```

The **Datalink Messages** should be set to **ON**, **Message input/output** set to **RTIME CODE/PHASE OUT** and the **Comm. Port number** set to port **3**. When you have done this, press **CONT**. Alternatively, you may select the **RTCM CODE/PHASE OUT** option. This will allow you to resolve ambiguities and survey in real time to centimetre level. The only difference is the format of the transmitted data.

Panel [1015] **SET Reference Position** will then appear. Enter the position for the reference station. Remember, this position should be as accurate as possible as your coordinates calculated at the rover will be based on it. This means better than 10m. Alternatively, you can press the **LOAD** button and select a point (previously entered in **SELECT/ENTER**) from the database.

If you do not have an accurate reference position, you may instruct the Controller to begin computing a single point position as soon as it is tracking enough satellites. The Controller will calculate a single point position after the time that you specify and will not broadcast any measurement data until the single point position is calculated.

To set the Controller to calculate a single point position, press the **SPP** key. Switch the **SPP** Calculation field to **ON** and then specify a minimum calculation time. The minimum calculation time possible is 3 minutes but in reality 20 minutes should be set to obtain a position better than 25m rms. Note that there is no guarantee of achieving this level of accuracy in this time and that minimum calculation time is specified in hours and minutes. When you are satisfied with the input values press **CONT** to return to the **SET Reference Position** [1015] panel. Some initial coordinates are still required for the Single Point Position. These should be correct to about 1° in Latitude and Longitude. Ensure that your height reading and antenna offset are correct.

If your selected project has a transformation set attached, you will be able to input the reference position in local coordinates. Otherwise, WGS 84 coordinates will have to be used. Press ALT-G to toggle between co-ordinate systems.

When you are satisfied with the values, press **CONT**.

The **SET NMEA Parameters** panel [1017] will then appear. This should normally not be required at the reference station and therefore can be left switched off.

Press the **CONT** button to view the **SET Satellite Tracking Control** panel [1006]. Accept the default settings and press **CONT**.

The **SET Data Collection Parameters** panel [1101] then appears. This panel sets the rate at which the Sensor takes data from the satellites.

```
[1101]  SET Data Collection Parameters


Compacted or Sampled: COMPACTED
Obs.-rate static    : 1 secs


CONT                        EVENT   TMARK
```

The **COMPACTED** option should be selected as this takes an average of the measurement to each satellite for each epoch. The **Obs.-rate static** option should be set. For moving or kinematic operations, set it at 1 or 2 seconds. For static operations set it at 4 or 5 seconds.

The EVENT key will only appear if an SR9400 or an SR9500 Sensor is configured for use. It enables you to configure the event input options. This will not normally concern real-time users. Further details are available in the Technical Reference Help.

The **TMARK** key allows you to access the SET Time-Mark Parameters panel [1012]. This function only applies if the optional time-mark output is fitted to the Sensor and will not normally be needed in a Real-Time Reference mission. Therefore it may be ignored in this instance.

The following panel will then appear. The equipment will begin to search for and track satellites.

```
[1110]  SURVEY:STS                    M[STSDEF]
                                   [RTIME OUT:/]
Point Id: 000001                   Code:
Ht.Readg:   0.000            Ant.offset: 0.000 m
Epochs  : 0
Status  : 6/6 of 6           GDOP 2.2     504 KB

 MEAS    EXIT-M  CODE              STATUS  MENU
```

When the Sensor has acquired the visible satellites and computed a GDOP, the raw data will be broadcast. This is shown by a bar turning in a clockwise direction in the **RTIME OUT** field.

If a Single Point Position has been selected to be computed this will be carried out over the time specified prior to any measurement data being broadcast. In the meantime, data containing battery status, tracking status etc. will be broadcast.

If you wish to record the data for subsequent post-processing, press **MEAS**. Otherwise just leave the reference station transmitting data.

7.2 The Rover mission

The rover mission setup parameters differ slightly from those of the reference station.

You may set up your own rover mission by using the **COPY** and **EDIT** functions in the **MISSIONS** menu. These functions are described fully in the Technical Reference Manual and will not be entered into here. Alternatively, you may set up the mission parameters each time you run the mission. The following description of how to set up a rover also applies to users who wish to configure their own mission since each panel is described. In addition, a default rover mission is included on all Controllers with RT-SKI installed.
After switching the Controller on move to the **MISSIONS** menu and press **CONT**. The Default Realtime Rover mission will be displayed. Select this mission and press **RUN**.

The **CURRENT MISSION** panel [1000] will be displayed. To proceed to the next panel, press **CONT**.

The **SELECT Project/Job** panel [1002] will be displayed. Enter the project and job parameters as described in section 7.1. Note that an **Active Job** may be selected. This is for the purpose described in section 6 in the Points explanation.

The **SET Operation** panel [1021] will then appear. For the rover station, select a **REAL-TIME ROVER** type mission by pressing the cursor left or right keys to toggle between operation types. When this has been done, press **CONT**.

The CONFIG Reference Sensor/Antenna panel [0275] will then appear. You have to set the type of Sensor and Antenna being used at the reference station.

```
[0275]  CONFIG Reference Sensor/Antenna

Sensor Type         : 9500
Antenna Type        : 202-302
Using Groundplane   : NO


CONT                                USER
```

If you are using a third party Sensor at the Reference you should select Sensor type UNKNOWN and then the Antenna type USER. To define the User Antenna type press USER (F5) and enter the height offsets. Details on how to calculate the height offsets are given in the Appendix. Press **CONT** to continue.

The **SET Datalink Parameters** panel [1013] will then appear. The following parameters should be set.

```
[1013]  SET Datalink Parameters

Datalink Messages    : ON
Message input/output: RTIME PHASE IN
Comm. Port number    : 3


CONT
```

The **Datalink Messages** will be set to **ON**, **Message input/output** set to **RTIME PHASE IN** and the **Comm. Port number** set to port 3. When you have done this, press **CONT**. Alternatively, you may select the **RTCM PHASE IN** option. This will allow you to resolve ambiguities and survey in real time to centimetre level. The only difference is the format of the transmitted data.

Panel [1017] **SET NMEA Parameters** then appears. Leave the NMEA parameters switched off unless you wish to output this type of message. The message formats supported are ZDA, VTG, LLK, GGA, GGK, LLQ, GLL, GGQ, and CAT. Refer to the Appendices for a more detailed description. Remember that if the radio link is connected to port 3 NMEA messages will have to be output through port 2. When you have made your choice press **CONT**.

The **SET Initial Position** panel [1005] then appears. Check that this is correct. It should be set to **LAST FIX** and your approximate position displayed. If the last fix position is incorrect by a large margin, (200 km or more), toggle to **USER INPUT** and enter your approximate position. Press **CONT** to proceed to the next panel.

Press the **CONT** button to view the **SET Satellite Tracking Control** panel [1006]. Accept the default settings and press **CONT**.

The **SET Data Collection Parameters** panel [1101] then appears. This panel sets how satellite data is received and the rate at which the Controller receives and records the data from the Sensor. Note that raw observation data is only recorded when **Record Observations** is set to **YES** in the next panel.

```
[1101]  SET Data Collection Parameters

Compacted or Sampled: COMPACTED
Obs.-rate static    : 4 secs
Obs.-rate moving    : 1 secs
Time Tagged Points  : NEXT EPOCH

CONT                    EVENT   TMARK
```

The **COMPACTED** option should be selected as this smoothes the measurements to each satellite for each epoch. The **Obs.-rate static** option should be set to 4 or 5 seconds. For moving or kinematic operations, set the **Obs-rate moving** option at 1 or 2 seconds.
The **Time Tagged Points** option sets the type of Time Tagged points that you wish to record during moving operations. Time Tagged Points are definite points along a kinematic trajectory. They will be recorded at the start of the epoch directly following the instant the **REC-TM** key was pressed. With this release version, only **NEXT EPOCH** time tags may be recorded when running a Real Time mission.

The EVENT Key allows to set parameters relevant to the event input ports which may be fitted as an option to SR9400 and

SR9500 Sensors. Most Realtime users will not use this option. Complete descriptions are given in the Technical Reference Help.

The **TMARK** key allows you to access the SET Time-Mark Parameters panel [1012]. This function only applies if the optional time-mark output is fitted to the Sensor and will not normally be needed in a Real-Time Rover mission. Therefore it may be ignored in this instance.

Pressing **CONT** takes you to the **SET Data Recording Parameters** panel [1102].

```
[1102]  SET Data Recording Parameters
Record Observations    : NO
Required coord. quality: 0.05m
Store coordinates as   : GRID
Auto. coord. recording :  NO
Support seismic        :  NO

CONT                   AUTREC
```

You should now decide whether you wish to record the raw data for subsequent post processing. Data will be recorded at the rate set in the previous panel [1101]. Data recording is not necessary for RT-SKI but is required if you wish to post-process afterwards. Additionally, the required co-ordinate quality of the real time coordinates and in which system to store them should also be set.

Note that if you set the co-ordinate quality to a very high accuracy level (e.g. .01m) you will be required to wait for a rather long period of time before this quality is reached. RT-SKI is intended for accuracies around the .02m mark. A good compromise is to set the co-ordinate quality at .03m.

The coordinate system in which coordinates have to be stored in can be specified as long as a transformation set is being used. WGS will record coordinates in the WGS84 system. GRID will record coordinates in the local grid system as defined by the transformation set.

The Auto. coord. recording allows real time coordinates to be recorded according to a time or distance interval. It is activated and configured by pressing **AUTREC.** The following panel will appear.

```
[1105]  SET Auto. Coordinate Recording
Auto coord. recording  : BY DISTANCE
Coord. rec. rate factor:  6
Obs. Rate moving       :  1 secs
Coord. rec. rate       :  6 secs
Spacing along traject. :  10.0 m

CONT
```

Set the method by which you wish to automatically record coordinates from the **Auto.coord. recording field. BY TIME** records using the Coord. rec. rate set (Coord. rec. rate factor x Obs.-rate moving). **BY DISTANCE** records a point every time a distance of the amount input has been covered.
Press **CONT** to return to the SET Data Recording Parameters panel [1102].

The **Support seismic** option allows you to write a record that may be used by seismic software after download of the data. The record is written as the fourth point annotation and is attached to each point that you record. this Seismic record will be written as the fourth point annotation even if you have not selected the Point Annotation coding system for use in CONFIGURATION.

Press **CONT** to continue.

The final panel then appears. This is the **SET Point Id Parameters** panel [1104]. If you intend to record many points consecutively, you may wish to configure this panel.

```
[1104]  SET Point Id Parameters
Point Id Template:  NNNNNN**********
Point number start/end pos.:  1 /  6
Point number increment     :       1
Use autom. incrementation  :     YES
First cursor position      :       5

CONT     SET              STAKE
```

The **Point Id Template** shows how the point Id parameters are currently set. NNNNNN represents the positions for numbers. i.e.

in this case, the first 6 positions will be numbers that will automatically increment at each new point. ********** represents the alphanumeric character positions that will not automatically increment at each new point. Whatever is typed in at these positions will remain for each subsequent point unless manually edited.

Point number start/end pos. specifies where the point number (the Ns) starts and ends in the point Id string.

Point number increment specifies the amount by which the point number (the Ns) will advance at each subsequent point.

Use autom. incrementation specifies whether the automatic incrementation feature will be used or not.

First cursor position sets the position along the point Id string where the text entry cursor will appear at each measured point.

E.g. A user wishes to record many points starting with the first point id *POINT 01*, then *POINT 02* etc.

He should set the Point Id parameters thus:

```
[1104]  SET Point Id Parameters
Point Id Template:  ******NN********
Point number start/end pos.:  7 /  8
Point number increment     :       1
Use autom. incrementation  :     YES
First cursor position      :       9

CONT     SET               STAKE
```

The first 6 positions will be taken by the word *POINT* and a space. This text has to be entered when in the Survey panel [1120] or in the Position panel [1130], when occupying the first point. The next 2 positions are taken by numbers, starting with *01* and incrementing automatically by 1 at each subsequent point. The cursor will automatically appear at position 9 which is the first position after the end of the number and will allow the user to type in any additional information for the point as required.

The point id template can be formatted for normal survey mode and for line-stakeout mode. To change to the line-stakeout template press the **STAKE** button. The template will look per default as follows: LLLLLLLLNNNN****, whereby the part LLLLLLLL represents the placeholder for the line id.

Pressing **CONT** will now start up the mission.
Once you have set up the Real-Time Rover mission, the following panel will appear.

```
[1120]  SURVEY: New Chain               M[ROVDEF]
                                     [RTIME IN:/]
Point Id: POINT 01              Code:
Ht.Readg:   0.000         Ant.offset:  0.000 m
Epochs  : 0               Amb: 6/6     CQ: 0.03
Status  : 6/6 of 6        GDOP 2          504KB

MEAS    EXIT-M  CODE    STAKE   STATUS  MENU
```

This is the main survey panel. The Controller will acquire the signal from the reference station and begin to track the satellites. When it has acquired the signal from the reference station a bar will appear in the **RTIME IN** box and rotate in a clockwise direction. The height reading should be entered along with the antenna offset.
When all available satellites are being tracked (indicated in the **STATUS** field) and a signal is being received from the reference station, press **MEAS**.

Note: When a SR399/399E or SR9500 is being used, the Controller will automatically try to resolve ambiguities On the Fly unless **MEAS** is pressed. When ambiguities are resolved, the **MEAS** key will automatically change to **STOP** and the **REC-TM** key will become available.

7.3 Resolving the ambiguities at the Rover

You are required to observe at least 5 common satellites (at the reference and rover) before the system will try to resolve ambiguities. A position will be displayed as soon as 4 common satellites are observed. This position will only be accurate to a metre or so. Once ambiguities are resolved, the position will be accurate to 1-3 cm and the system will be able to function with a minimum of 4 common satellites. On pressing **MEAS** the following message will appear at the bottom of the screen:

Moving, Static, Known-Pt Initialisation?

This is in effect, asking you to define the method for resolving the ambiguities.

Note: With the SR299 system, the following message will be displayed:

Static, Known-Pt Initialisation?

You now have to give instructions as to whether you are going to resolve ambiguities in rapid static mode, on the fly or by initialising on a known point.

To resolve ambiguities on the fly, press **MOVING** (SR399 only).
To resolve ambiguities in rapid static mode, press **STATIC**.
To resolve by initialising on a known point, press **KNOWN**.

If you have pressed **KNOWN**, the last entered point in the point list will be displayed. You may either select this point (press **CONT**), select another point from the list (press **SEARCH**) or enter a new point (press **ADD**).
Whichever method is used to select the point, the point selected will be used as the known initialisation point. Thus to resolve the ambiguities correctly, you MUST select the point that you are on and the coordinates for this point have to be accurate to 2 or 3 cm.

SR399/399E and SR9500 users have the option to initialise on the fly by pressing **MOVING**. As soon as this is pressed, you may begin moving.

7.3.1 Resolving ambiguities by Rapid Static

Pressing **STATIC** will initiate rapid static mode. The ambiguity search will begin. As the ambiguities are resolved to the satellites, information showing this will be displayed in the **Amb** field. The first number is the number of satellites to which the ambiguities are currently resolved, the second is the number of visible satellites. E.g. 5/6 in the display means that ambiguities are resolved to 5 out of 6 satellites.

Next to the **Amb** field is the **CQ** field. This shows the co-ordinate quality and is a conservative indication, in metres, of how accurate the current position is. This will vary with the number of resolved ambiguities.

Press **STAKE** to display the Target panel. For further details on Targets refer to section 9. Press **POS**, the following panel will be displayed.

```
[1130]    POSITION: New Chain          [WGS 84]
Time loc:  6-Dec-94  9:52:45       [RTIME IN:/]
Point Id: POINT01                 Code:
Lat     :  47 25  6.78901 N       Amb: 5/5
Lon     :   9 35 35.98765 E       CQ : 0.02
Height  :       481.678 m

MEAS     EXIT-M  CODE     SURVEY  STATUS  MENU
```

Your real time position is given. The co-ordinate type is dependent on what you have configured and is displayed in the top right hand corner of the screen. The accuracy is predicted in the **CQ** field as on the previous panel.

Press **SURVEY** to move back to the SURVEY panel [1120]

To enter a code for the point, press the **CODE** key.

When the ambiguities are resolved, the Controller will beep and the message “Ambs fixed” will appear on the bottom line.

When the required accuracy level is reached (displayed in the CQ field) and you have entered all relevant features for the point, press **STOP** and then **REC-PT** to record the real-time coordinate and the point details.

When the ambiguities have been resolved, the ambiguities will be held with a minimum of four common satellites. If the equipment is trying to resolve ambiguities and only four satellites are available, it will give a code solution until 5 common satellites are available upon which an attempt to resolve ambiguities will be made. This is shown by the word FLOAT next to the CQ value.

Refer to section 8 for details on how to proceed.

7.3.2 Resolving ambiguities - initialising on a known point

If you have pressed **KNOWN**, the last entered point in the point list will be displayed. You may either select this point (press **CONT**), select another point from the list or enter a new point (press **ADD**).

Whichever method is used to select the point, the point selected will be used as the known initialisation point. Thus to resolve the ambiguities correctly, you MUST select the point that you are on and the coordinates for this point have to be accurate to 2 or 3 cm.

When you have selected the initialisation point, the message "**Ready for init. on known point? (Y/N)**" appears. If you are ready, press Y. The ambiguity search will begin. Hold the pole very steady.

As the rover is on a known point, the ambiguities will be resolved very quickly, usually in a few epochs. When the ambiguities are resolved, the Controller will beep and the message “Ambs fixed” will appear on the bottom line.

When the ambiguities have been resolved, the ambiguities will be held with a minimum of four common satellites. If the equipment is trying to resolve ambiguities and only four satellites are available, it will give a code solution until 5 common satellites are available upon which an attempt to resolve ambiguities will be made. This is shown by the word FLOAT next to the CQ value.

Refer to the previous section for details on ambiguity resolution. When the required accuracy level is displayed, press **STOP** and then **REC PT**.

Refer to section 8 for details on how to proceed.

7.3.3 Resolving ambiguities on the fly whilst moving

This ambiguity resolution method will be automatically invoked when a SR399/SR399E or SR9500 is being used. Alternatively, these users have the option to initialise on the fly by pressing **MOVING**. As soon as this is pressed, you may begin moving. Note that when a SR399/399E/SR9500 is connected, the system will automatically try to resolve ambiguities on the fly as soon as the conditions are good enough for it to do so. MEAS will change to STOP automatically and the process will begin. When the ambiguities are resolved, the Controller will beep and the message “Ambs fixed” will appear on the bottom line. Then, you will be ready to record points using **REC-TM** and **REC-PT**.

When the ambiguities have been resolved, the ambiguities will be held with a minimum of four common satellites. If the equipment is trying to resolve ambiguities and only four satellites are available, it will give a code solution until 5 common satellites are available upon which an attempt to resolve ambiguities will be made. This is shown by the word FLOAT next to the CQ value.

Refer to section 8 for details on how to proceed.

7.4. Using RT-SKI Code

As mentioned previously, using the RT-SKI code-only mode will enable the user to measure points with a coordinate quality of around 1-2m. No initialisation period is required as with the RT-SKI phase message. The reference and rover missions may be set up as if the RT-SKI phase message was being used with the following exceptions.

In SET datalink messages [1013] the Message input/output field should be set to **RTIME CODE/PHASE OUT** for the reference mission and **RTIME CODE IN** for the rover mission. Alternatively you may use the RTCM standard for transmitting and receiving the code data. You may either opt to transmit/receive the raw code measurement, (set reference to **RTCM CODE/PHASE OUT** and rover to **RTCM CODE IN**), or the code correction (set reference to **RTCM CODE CORR OUT** and rover to **RTCM CODE CORR IN**).

The **Required coord. quality** field in the SET Data Recording Parameters [1102] panel will need to be set at a realistic value when setting up the Rover mission. A realistic value would be between 2 and 3m.

When the mission is started at the rover and data is received from the reference it will take approximately 30 seconds until the CQ value is at its optimum level. This will normally be 1-2m. Note that this is the 3D position and includes height. When the CQ displays such a value, the position accuracy will be around the 0.3-0.5m mark. When code only is selected, the message CODE will appear before the CQ.

Refer to section 8 for details on how to proceed.

8. Surveying in real-time

This chapter describes how to use RT-SKI after you have initialised (using initialisation on a known point or rapid static initialisation), when using ambiguity resolution on the fly (SR399 and SR9500 users only), or when using the RT-SKI code message.

8.1 Running in Kinematic mode

Kinematic mode is invoked by either:

1. Initialising on a known point.
2. Initialising using a rapid static fix.
3. Using resolution on the fly (SR399 and SR9500 users only).

After pressing **STOP** and **REC PT** at the end of the rapid static initialisation (section 7.3.1) or after performing initialisation on a known point (section 7.3.2), you should press **MEAS**. The following message will appear at the bottom of the screen.

Moving, Stop-Go Chain?

To begin measuring in kinematic mode, press **MOVING**. You should move to the first point you wish to measure or begin to move along your desired route. A coordinate will be recorded at the coordinate recording rate that you have specified during mission start-up (panel [1102] Coord. rec.-rate moving). You may also record distinct points along the trajectory by using the time tagged points function.
Most users will prefer to use the kinematic mode with time tagged points instead of stop and go mode.

To record a time tagged point, press the **REC TM** button. The message will appear:

Wait for position. don't move !

You must now keep the pole as steady as possible until the next epoch is reached. Then, the following message will appear:

Position available - accuracy reached

You may now press the **REC-PT** button to record the point information. If you decide that you do not want to record the point, press **ESC**.

8.2 Running in stop and go mode.

You may run in stop and go mode after initialising on a known point or after a rapid static initialisation.

After pressing **STOP** and **REC-PT** at the end of the rapid static initialisation (section 7.3.1) or after initialising on a known point (section 7.3.2), you should move to the first point for which you wish to determine coordinates. Press **MEAS**. A message will appear at the bottom of the screen.

Moving, Stop-Go Chain?

To begin measuring in stop and go (static) mode, press **STOPGO**. The pole has to be held steady or placed in the quickstand. After a couple of epochs or so, record the point details by pressing **STOP** and **REC-PT**. Continue to other points. At each point press **MEAS** then **STOP** and **REC PT**.

8.3 Kinematic on the fly

SR399/9500 users have the advantage of being able to resolve ambiguities on the fly. This means that no rapid static initialisation or initialisation on a known point is required. The ambiguities will be resolved while moving. When running in resolution on the fly mode, time tagged points etc. are taken in exactly the same way as in normal kinematic mode.

8.4. Using the Code only measurements

When the code only measurements are used, no initialisation is required and therefore as soon as the CQ has reached an acceptable level (1-2m) coordinates may be recorded. The word CODE will appear before the CQ. It is only possible to work in a Kinematic mode recording points via Time Tagged points. The Kinematic measuring mode will be invoked automatically when the mission has been started.

8.5 Automatic Averaging of coordinates of the same point

When a real time point is recorded in the data base a check is carried out as to whether the point already exists or not. If it does, the coordinates are compared and if the differences are within the user defined thresholds the message "n measurement on point - difference ok" is displayed and an average is calculated and stored. If the thresholds are exceeded, the system allows the user to use the old or new value.

Coordinates of points whose class is FIX are not altered by averaging.

If you try to record a point that is already contained in the database and the averaging routine detects that the new coordinates exceed the threshold, a panel will appear showing the coordinate differences as below.

```
[0642]   Coordinate Differences      [2]
---Date/Time--- -dHori- dHeight  Use  LE
30-June-95 6:58  0.000   0.000   YES
30-June-95 7:35  0.001   1.900   NO   *


Coord. differences--> check your input
CONT     COORDS  COINFO  YES/NO  DELETE  LIMIT
```

The new point suggests **NO**, not to use this new point. If you wish to change this and force the system to use the new point press **YES/NO**.

To delete one of the points, highlight the point and press **DELETE**.

To move directly to **SET Limit for Averaging**, press **LIMIT**. You may reset the limit for averaging whilst measurement is taking place from the **SET** menu. Enter this menu and select **Limit for Averaging**. The following panel will be displayed.

```
[0643]   SET Limit for Averaging


Maximum horizontal difference: 0.050 m
Maximum height difference    : 0.150 m


CONT
```

You may reset the values displayed. Press CONT to return to the Main Survey panel [1120]. The limit may also be reset from the Main Survey panel through MENU and then SET. See section 8.7.4.

If the difference occurred due to a erroneous point id or antenna height/offset, press **ESC**, enter the correct values and press **REC-PT** again.

8.6 Assigning a code

Up to 3 coding systems may be defined on the Controller. These are described in section 5.2.5. Access to the coding system(s) is always through the F3 key.

GeoDB codelists are accessed via the **CODE** key.
Point annotations are accessed via the **NOTE** key.
GSI codes are accessed via the **GSICOD** key.

The hot key that appears on F3 when selecting a code (i.e. the coding system that is available), will depend on which coding system has been configured for use. GEODB codelists get first priority, so if this system has been selected it will always appear first. Point annotations get the next priority and may be accessed through the codelist panel. GSI codes are accessed in turn through the Point Annotations panel.

8.6.1 Assigning a GeoDB Code

To assign a GeoDB code from a codelist, press **CODE** and the following panel will appear:

```
[1441]  SELECT Code   <_        >     CQ: 0.03
--Code--  -Codename-  <POINT 01       >
BM     *  Bench Mark
CHEK      Check Point
CUL       Box Culvert
DEFAULT   Default

CONT     REC-TM  ATTRIB  GSICOD  NONE     >>>>>
```

All codes in the codelist are available. To quickly access a code that you know the name of, type in the first few characters of the code. This will appear in the top display line. The code that matches your input the closest will be automatically displayed.

Next to the code and codename, the currently assigned point id is displayed.

To access further codes, use the **PG-UP** or **PG-DN** keys. Select the code you require and press **CONT**.

A * indicates that the code has attributes available.

To define attributes for a code press **ATTRIB**. The following panel will appear:

```
[1442]  Attributes for <BM>

Mark T.    : ALUMINIUM MARKER           M
Setting    : DRIVEN INTO GROUND
Diameter   : 0.200 m
Remarks    : Marker Damaged

CONT     REC-TM  ADDVAL  LAST    DEFLT   NONE
```

You may select the attribute value for each attribute as required. Use **PG-UP** or **PG-DN** to set attributes as required. The attribute values were defined in Codelist Manager. An **M** at the end of an attribute value indicates that the attribute is mandatory and must have a value assigned. It may not be empty. To add a new attribute value, press **ADDVAL**. Add the new attribute value and press **STORE**. This new value will be available once only. That is, it will not be permanently added to the Code List.

LAST selects the last values set.
DEFLT selects the default settings for the code.
NONE selects no values for the attributes.

Once you have made your selection, press **CONT**.

The >>>>> key will reveal extra keys .

The **LAYERS** key leads to panel [1444] SET Active Layers where you may deactivate Layers that do not contain codes pertinent to your current work. To activate or deactivate a Layer, move to the Layer with the ↑ or ↓ keys or use the **PG-UP, PG-DN** keys and press the **YES/NO** key.

You may add a code to the list by pressing the **ADD** key. You are then prompted to enter the code information including which Layer the code is on. In the event of no Layer being available or even that no codelist is available, one will be created automatically and you will be prompted to fill in the details. The new code can also have up to 5 attributes attached called Remark1 to Remark5 by default. You may define your own attribute names by using the **ATTRNA** key.

8.6.2 Assigning Point Annotations

Point annotations are assigned through the **NOTES** key. This key will appear in different panels depending upon which coding systems have been selected for use.

If the GeoDB codelist system has NOT been configured for use the key will appear in the main surveying panel [1120] under F3.

If the GeoDB codelist system has been configured for use, It will appear in the SELECT Code panel [1441] under F4. This means you have first to press **CODE** in the main surveying panel and then **NOTES** in the SELECT Code panel. This will only have to be done once in any particular mission. After this operation has been performed, the NOTES key will always appear in the Main Surveying panel [1120] under F3 until a different code is used.

When Point Annotations have been selected, the following panel will appear:

```
[1480]  ADD Point Annotations
Point Id: POINT 01
Note 1  :
Note 2  :
Note 3  :
Note 4  :

CONT    REC-TM          GSICOD  NONE    LAST
```

The point Id to which these point annotations will be attached is displayed. You may enter each point annotation as required. Note that if the user has chosen to record Seismic information only 3 Annotations will be available as Seismic uses the fourth annotation.

The F4 key will either show **GSICOD**, **CODE** or be blank depending on which coding systems have been configured. **GSICOD** takes you into the Add GSI Code Block panel [1490]. **CODE** takes you into the SELECT Feature Code panel [1441].

NONE sets all the annotations back to blank.

LAST sets all the annotations to those set on the last recorded point.

CONT accepts the entered values and returns to the Main Survey panel [1120].

8.6.3 Assigning a GSI Code Block

GSI code blocks can be recorded when the **GSICOD** key appears. This key will appear in different panels depending upon which coding systems have been selected for use. GSI coding is only possible if the coordinate system is set to GRID via mission programming in SET Data Recording Parameter.

If GSI is the only coding system that has been selected for use the **GSICOD** key will be on F3 in the Main Survey panel [1120].

Otherwise, the **GSICOD** key will be available either through the SELECT Feature Code panel [1141] or through the ADD Point Attributes panel [1480]. Once a GSI code block has been selected, the GSICOD key will become available from the Main Surveying panel [1120] instead of the **CODE** key and will remain so until a different coding system is used.

Note also that it is possible to convert the code part of a GEODB code into a GSI code block through the Data Manager program in Workbench.

When the GSICOD key is pressed the following panel will appear:

```
[1490]  ADD GSI Code Block              CQ: 0.03
Code No: 123        Id:POINT 01
Info 1 :            Info 2 :
Info 3 :            Info 4 :
Info 5 :            Info 6 :
Info 7 :            Info 8 :

STORE   REC-TM          CODE    NONE    LAST
```

You may now enter the code block information as required.
The GSI data format may be set to GSI-16 in the configuration menu. In this case only Info 1-4 will be displayed in the first instant. Use PG-DN to toggle to Info 5-8

Further information about the GSI coding system as used by RT-SKI is given in the appendices.

8.7 Information panels at the Rover

In addition to all the normal information panels that can be viewed via **MENU** in **STATUS**, **DISPLAY**, **SELECT/ENTER** and **SET** in static, kinematic and stop & go missions, several additional panels are available when running the Real Time Rover mission.

8.7.1 Information panels in the STATUS Menu

From one of the main survey panels (panels [1120], [1130] or [1140]), press **MENU**. This enters the surveying menu. From this menu, select **STATUS**.

The following panel will appear.

```
[1314]   STATUS

Satellites            Sensor Settings
Tracking              Computation
Data Logging          Ambiguity Search
Battery/Voltage

CONT
```

You will see that there are two additional options, **Computation** and **Ambiguity Search**. These panels are only available if the RT-SKI phase message is being used.

The Tracking status, battery status and data logging status of the Reference receiver can be viewed on the rover Controller by entering the relevant **STATUS** menu option and pressing the **REFROV** key.

8.7.1.1 STATUS Computation Panel

This panel gives information about what data is being used in the real time computation.

```
[1471]    STATUS Computation L1

Sat : --  --  --  --  --  --  --  --  --
Obs : --  --  --  --  --  --  --  --  --
Miss: --  --  --  --  --  --  --  --  --
Cont: --  --  --  --  --  --  --  --  --

CONT              L1/L2             AMBIG
```

The **Sat**ellite row displays the id number of each satellite being tracked.
The **Obs**ervation row shows how many observations to each satellite have been taken into account for the computation.
The **Miss**ing row shows how many observations to each satellite have not been taken due to loss of lock.
The **Cont**inuous row shows the total number of observations taken since the last loss of lock.

Pressing **CONT** will return to the survey panel ([1120], [1130] or [1140]).
Pressing the **L1/L2** key will show another similar panel giving the same information about what is happening on the L2 frequency.
Pressing **AMBIG** leads to the STATUS Ambiguity panel (see next section).

8.7.1.2 STATUS Ambiguity search panel

The Ambiguity search panel gives information on what is happening in the ambiguity search.

```
[1472]   STATUS Ambiguity Search

Search time      :      sec
Sat: --  --  --  --  --  --  --  --  --
L1 : --  --  --  --  --  --  --  --  --
L2 : --  --  --  --  --  --  --  --  --

CONT                             COMP
```

The Search time is a period of time over which the equipment will try to resolve the ambiguities to the satellites. Ambiguities to each satellite are shown as resolved or not in the two rows below.

When an ambiguity is resolved, **FIX** will be displayed in the L1 or L2 row for each satellite being tracked. When searching for ambiguities, **SHR**, standing for searching will be displayed.

If the search time is exceeded without enough ambiguities being resolved for a real time position to be computed, the process will automatically restart.

8.7.2 Additional Information in the DISPLAY menu

From one of the main survey panels (panels [1120], [1130, [1140]) press the **MENU** key. This enters the surveying menu. From this menu select **DISPLAY**.

The following panel will appear:

```
[1313]   DISPLAY

Computed Baseline    Course
Rover Position       Date, Time, Zone
Reference Position   Satellite Health
Navigated Position

CONT
```

Additional information is contained in the **Computed Baseline**, **Rover Position** and **Reference Position** options.

8.7.2.1 Computed Baseline

This panel gives you information concerning the baseline currently computed between the reference station and the current position of the rover.

```
[1217]   Computed Baseline
                                      [RTIME IN /]
dLat    :   1234.987m
dLon    :    657.912m
dHeight :      3.573m
Distance:   1399.305m

CONT
```

The differences in metres for latitude, longitude and height are given along with the baseline slope distance.

8.7.2.2 Rover Position

The position of the rover is displayed as below:

```
[1214]   Rover Position                 [WGS 84]
                                      [RTIME IN /]
Time loc: 21-Feb-95 14:08:30               0:00
Lat     : 47 24 33.09941 N
Lon     :  9 37  3.11316 E               GDOP: 3
EHgt    :        484.027 m            [DIFF PHASE]

CONT
```

The current position is given along with the local time and time zone. To toggle between Cartesian coordinates (WGS84 X, WGS84 Y, WGS84 Z) and Geodetic coordinates (Lat, Lon, EHgt) press **ALT C**. To change between WGS84 and Grid system, press **ALT G**. If a transformation set has been attached to the project, local Grid coordinates (Y East, X North, EHgt) will be displayed. The coordinate system that is being used is shown in the top right-hand corner. The source of information being used to calculate the position is shown in the bottom right hand corner.

8.7.2.3 Reference Position

The position of the reference station can be displayed.

```
[1215]   Reference Position     [WGS 84]
Point Id: Point 01         Code:
Lat     : 47 23 18.13590 N
Lon     :  9 33 57.64599 E
EHgt    :        481.756 m   [FIXED POS]
Ht readg: 1.234 m    Ant.offset: 0.441m

CONT
```

To toggle between Cartesian coordinates (WGS84 X, WGS84 Y, WGS84 Z) and Geodetic coordinates (Lat, Lon, EHgt) press **ALT C**. To change between WGS84 and Grid system, press **ALT G** (providing that a transformation set has been attached to the project). The height reading and antenna offset entered at the reference station are also displayed.

8.7.3 Additional information in the SELECT/ENTER menu

When accessed through the MENU key, the SELECT/ENTER menu contains one additional (important) parameter, - the **Stakeout Filter**.

8.7.3.1 Stakeout Filter

The Stakeout Filter is set to filter out unwanted point information. This makes point searches quicker.

```
[0650]   SET Filter for Stakeout
Active project    : Default-project
Selected Job      : ALL JOBS
Coord. system     : WGS84 ONLY
Sort points       : BY POINT ID
Show lines/roads  : YES

CONT          JOB
```

Selected Job allows you to filter out points according to which Job they were saved in. Use the **JOB** key to select the Jobs from which you require points to be available.

Coord. System allows you to filter points according to the coordinates system in which they are recorded. WGS84 ONLY filters all points except those recorded in WGS84. GRID only filters all points except those recorded in grid format.

Sort points by allows to sort point lists in order of the point id by selecting BY POINT ID or in order of the time the point was recorded by selecting BY TIME.

Show lines/roads allows you to choose not only points but also lines, slopes and road design data as target. If the Show lines/roads option is set to YES you will be asked to choose between Point, Line, Slope or Road whenever you choose a target.

8.7.4 Additional information in the SET menu

The **SET** menu also contains information available only to users of a Real Time Rover mission. This is in **SET Limit for Averaging**.

8.7.4.1 SET Limit for Averaging

The SET Limit for averaging function is used to adjust the threshold above which, coordinates measured on the same point will not be questioned. RT-SKI contains an averaging function whereby any coordinates with the same Point Id are checked and averaged. If the coordinates do not fall within the threshold specified here, the user will be notified and the coordinate not included in the average value.

```
[0643]   SET Limit for Averaging


Maximum horizontal difference: 0.050 m
Maximum height difference    : 0.150 m


CONT
```

The limit for averaging is split into horizontal and height components. If required you may reset them here.

9. Using RT-SKI for staking out

RT-SKI includes functionality developed principally for stakeout or setting out operations. Any point or line held in the database that has not been filtered may be accessed and used for staking out or setting out. Such points or lines are known as targets.

9.1 Selecting a Target

A Target may be selected whenever the **TARGET** key appears in the softkey display line.

From the **Main Survey panel** [1120] press the **STAKE** key. The following panel will appear.

```
[1140]   TARGET: New Chain              S[WGS84]
                                   [RTIME IN /]
Target   : 213              Code:
dLat     :       32.543 m     Amb:  6/6
dLon     :       76.981 m     CQ :  0.03
dHeight  :        0.750 m

STOP              TARGET  POS     GRAPH   MENU
```

The last point or line that was selected will be displayed as the target point. To change the target press the **TARGET** key. The **SELECT Target** panel [1143] will appear where you must select what type of target you wish to select a Point, a Line, a Slope or Road design data. The Targets available depend on what is set in **FILTER** in the SEARCH point [0635] panel. If no Lines are contained in the project and the RoadLine program has not been purchased, the Search Point panel [0635] will be displayed automatically. The other reason for no lines being available is that they have been filtered out in the Stakeout Filter. See section 8.7.3.

If you select a **Point** you will enter the point list from which you may select a point. The panel will appear as above and you may use the dLat, dLon and dHeight values to navigate to the point.

Alternatively, a graphical display may be accessed. This is described in section 9.4.

If you select **Line** or **Slope**, the last line that was selected will be displayed as below.

```
[1144]   SELECT/ENTER Line
[916 KB]                                   [1]
Line Id: Line 1          Code:





CONT     EDIT     SEARCH   LNINFO   DELETE   ADD
```

PG-UP or **PG-DN** will toggle to the previous/next line in the list. Use **EDIT** to edit the line parameters. Use **SEARCH** to search for a different line. **LNINFO** displays the Start and End points of the selected line.

Line stakeout allows you to stakeout points on a line with predefined offsets and intervals while the cut or fill value is the vertical difference to the first point of the line. See next section

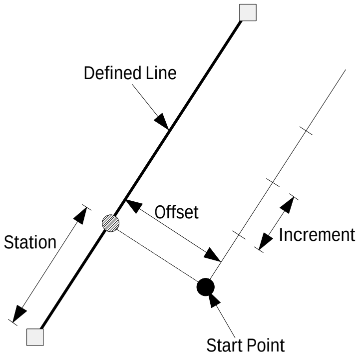
Slope stakeout allows you to stakeout points on a line while the cut or fill value is the vertical difference of the current position and the projected point on the line. The slope stakeout does NOT allow to stakeout points with predefined offsets and intervals. Note: Slope stakeout is available only if a transformation set has been attached to the project.

9.2 Using a defined line for stakeout

If you select a **Line** from the line list and press **CONT**, the following panel appears.

```
[1145]   SET Stakeout Parameter         [LINE]
Length (Line 1               ):     308.830 m
Startpoint      Station  :         35.000m
                Offset   :         10.000m
                dHeight  :          0.000m
Increment                :          1.000m

CONT     CENLIN            ACTSTA
```

This panel allows you to input additional line/grid parameters. The various components are described in the diagram below.



Negative values may also be used for the Startpoint, Offset and dHeight values as well as for the increment, thereby allowing you to define a line for stakeout anywhere in space. Looking in the direction of the selected line, positive values for Station, offset and dheight will define a startpoint forward, right and above the first point of the selected line. Negative values will define a Startpoint behind, left and below the first point of the selected line.

When you have defined the line, press CONT. The following panel will appear.

```
[1140]   TARGET New Chain
Line    : kkk                       [RTIME IN/]
Target  : +35.000  +10.000    Code:
dLat    :        35.872 m        Amb:  5/5
dLon    :       165.054 m        CQ : 0.03
dHeight :         2.610 m

STOP     REC-TM   TARGET   POS      GRAPH    MENU
```

The dLat, dLon and dHeight is displayed to the startpoint. To display the next point increment along the line, press PG DN. To display the previous point along the line, press PG UP.

9.2.2 The CENLIN key

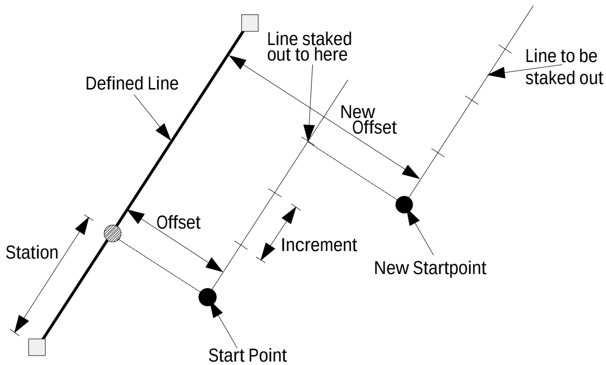
The **CENLIN** key is used if you are in the middle of staking out a line or offset line and wish to return to the first point of the reference line. Press **TARGET**, then **PARAM** for **Line** and then **CENLIN**. The first point of the reference line will then be automatically chosen as the target point.

9.2.3 The ACTSTA Key

The **ACTSTA** key is used to define a different offset and startpoint from that already chosen.

In the example shown, the user has set out an offset line parallel to the reference line but now wishes to carry on at a different offset value. It may be the case that he has moved off the last increment point recorded.

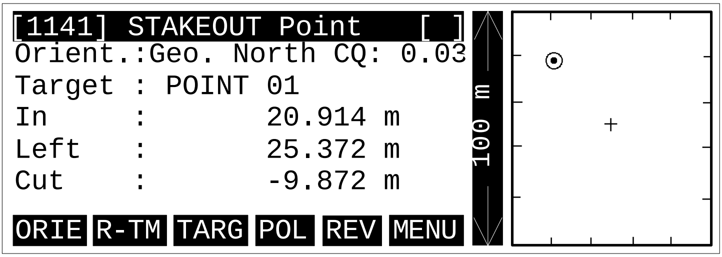
Press **TARGET**, then **PARAM** for Line. Enter the new offset value and then press **ACTSTA**. When you press **CONT** you will have a new target point. This is a new startpoint for a new offset line based on the last increment point recorded.



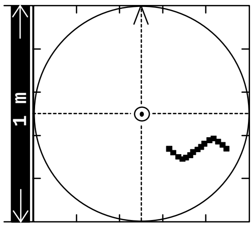
9.3 Accessing the graphics screen

From the SURVEY panel [1120], the graphics screen is accessed by proceeding through the TARGET panel [1140].

To do this, from the SURVEY panel press **STAKE**. This leads to the TARGET panel. Press **GRAPH** to access the STAKEOUT panel. The following will be displayed:



On the right hand side is the graphics screen which shows the target point, (the circle), in relation to your position, (the cross in the centre of the screen). The scale running vertically up the left side of the graphics screen varies with your distance from the target. The largest value for this is 500m, then 100m, 20m, 5m and finally 1m. At the 1m scale, the graphics screen appears as follows.



At this 1m level, your position is shown as well as your previous positions displayed as a track behind you. The target is the small circle at the centre of the screen. The moving cross is your current position.

9.3.1 Orienting yourself

The direction in which you are oriented can be selected by pressing the **ORIENT** key. Upon pressing this key, the following panel will appear:

```
[1142]   SELECT Orientation

         Geo./Grid North
         Point
         Last Point
         Line

CONT
```

Use the ↑ or ↓ cursor keys to toggle to your required choice.

North orientates the graphics screen to the north. All bearings, offsets etc. will be calculated using north as zero.

Point orients the graphics screen to a point selected from the points list.

Last Point orients the graphics screen to the last point recorded by the operator.

Line allows you to orient yourself parallel to any line contained in the database. The idea behind this is to facilitate the stakeout of parallel lines or a string of points parallel to the line. The left/right values will always display the offset from the line as long as the line is also chosen as the Target.

9.3.2 Recording a point in the STAKEOUT panel

It is possible to record a time tagged point from the STAKEOUT Point/Line panel by pressing the **R-TM** key. A panel then appears prompting you to enter the point Id. The target point will be prompted by default. You may accept it or press **PT-ID** to change the point id template. Depending on the target selected the following alternatives for the point Id are possible: Distance and offset, Point Id (Survey) or Point Id (Line-Stakeout). Refer to chapter 7.2 on how to set the Point Id Parameters.

Additionally select a code if required.

Once this is done, press the **REC-PT** key to save the coordinate and associated point information.

9.3.3 Selecting a different Target

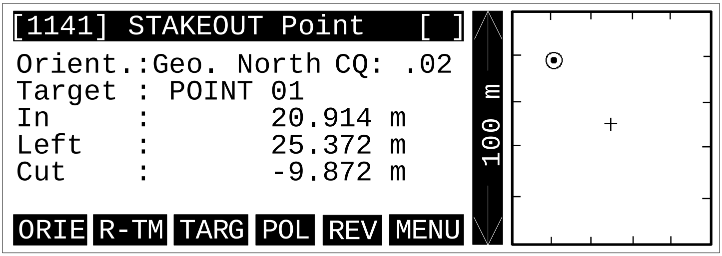
A different target may be selected by pressing the **TARG** key. Follow the process given in section 9.1. When using the STAKEOUT panel for finding/Staking out points, the target point can also be changed by using the **PG-UP** or **PG-DN** keys.

9.3.4 Selecting a stakeout or navigation system

There are two methods by which you may navigate to a target point when in the Stakeout panel. You can use either a distance with offset system (ORT) or an azimuth and distance system (POL).

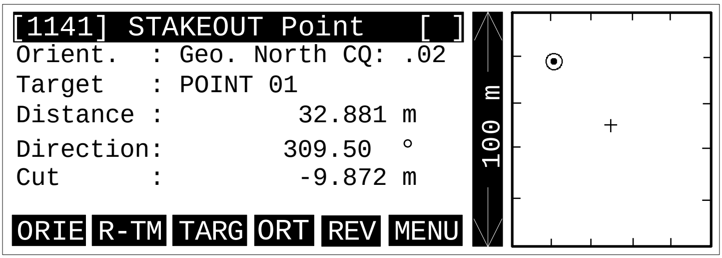
Use the F4 key to toggle between **ORT** and **POL** systems.

When **ORT** is selected, the STAKEOUT panel appears as below:



The distance (In or Out) with an offset (Left or Right) from your present position to the target position is shown relative to the orientation direction. In this example shown above, the user would have to walk 20.914m North, and then 25.372m left to reach his target point. The cut or fill (height difference) to the target point is also displayed.

When **POL** is selected, the STAKEOUT panel appears as below:



The distance to the target point accompanied by an associated bearing is displayed together with the cut/fill (height difference). In this example, the user would have to walk 32.881m on a bearing of 309.50° to reach the target point.

9.3.5 The REVerse key

A useful function incorporated in the STAKEOUT panel is the **REV**erse key. This enables a user to always face towards the point he is navigating to and have the orientation arrow point in the correct direction. In addition, the distance/direction is displayed correctly on the screen. It is used if the user would have to walk backwards to reach a target point.

For example, if a user is trying to navigate to a point using the ORT system and the display shows that the point is 20m to the rear of the current position, pressing REV will simply change the orientation displayed on the graphics screen by 180°. The user can now turn through 180° and move towards the point. The orientation arrow will point in the correct direction (rearwards) and the polar angle will be corrected by 180°. In the case of the ortho function being used, the In/Out and Left/Right displays are adjusted accordingly.

Note that this function is not available when the distance to the point is 0.5m or less (i.e. the 1m graphic display is shown).

9.3.6 The CLR key

This function is available when the user is within 0.5m of the selected target point and the 1m graphic display is shown.

When the 1m graphic display is shown, your trajectory or path travelled is displayed on the graphic screen. If you remain in a similar position for some time, the screen may become rather cluttered with dots. If this happens, pressing the CLR key will clear the trajectory displayed.

9.3.7. The MENU key

The **MENU** key gives you direct access to the SURVEYING MENU panel [1310].

10 Appendices

This section contains additional information which may be of use to some users.

10.1 NMEA Formats

The CR244/344 can output as many as eight standard formats and one none standard NMEA message via ports 2 or 3. The following is a description of the content and format of each of the three messages. This information might be useful for developers who want to interface the CR244/344 with some external device where they wish to utilise the NMEA message (i.e., echo sounders etc.).

Sentence Delimiters and Checksums:
In all examples a start of sentence delimiter is indicated with a `$`. An end of sentence delimiter is indicated with a `*`. A checksum (2 alphanumeric hex characters) appears after the end of sentence delimiter.

Dissemination of Component Elements:
Distinct elements of the messages are delimited using a comma in order to aid dissemination of the messages.

TALKER Identification:
All of the CR244/344 NMEA messages are generated with a TALKER identification of GP. This indicates that the information provided in the message was generated using a GPS receiver.

Latitude:
Latitude is always represented as `llll.ll` (2 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fractions of minutes. Leading zeros are always included for degrees and minutes in order to maintain fixed length).

Longitude:
Longitude is always represented as `yyyyy.yy` (3 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fractions of minutes. Leading zeros are always included for degrees and minutes in order to maintain fixed length).

UTC of Position Fix:
Time is always represented as hhmmss.ss (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal seconds. Leading zeros are always included for hours, minutes, and seconds in order to maintain fixed length).

10.1.1 The ZDA Message

The ZDA Message consists of UTC of position, Day, month, year, Local Zone description.

$$\overbrace{\texttt{\$--ZDA}}^{1},\overbrace{\texttt{hhmmss.ss}}^{2},\overbrace{\texttt{xx,xx,xxxx}}^{3},\overbrace{\texttt{xx,xx}}^{4}\overbrace{\texttt{*hh}}^{5}$$

	Sentence Content	Description
1	`$--ZDA`	$ Start of sentence delimiter -- TALKER identification (GP for GPS) ZDA Sentence Formatter
2	`hhmmss.ss`	*UTC of Position Fix* (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds and a variable number of digits for decimal fraction of seconds.. Leading zeroes always included for hours, minutes and seconds to maintain fixed length.)
3	`xx,xx,xxxx`	*Day*[01...31], *Month* [01...12], *Year* (2 fixed digits of days, 2 fixed digits of month, 2 fixed digits of year)
4	`xx,xx`	*Local Zone Description* [±hh, ±mm] (2 fixed digits of hours, 2 fixed digits of minutes)
5	`*hh`	Checksum
	`<CR><LF>`	Sentence termination delimiter

The ZDA message carries the highest priority when several messages are selected. At the start of transmission of this message, the time given in the time stamp is accurate to ± 10 milliseconds.

Therefore, this message is quite useful for synchronising (e.g.) the GGK message output (which may be delayed by 2-3 seconds) with echo sounder readings within a hydrographic software package.

10.1.2 The GGA Message

The GGA message consists of UTC of position, Latitude, Longitude, GPS Quality indicator, No. of satellites in use, HDOP, altitude of antenna above MSL (geoid), Units of antenna altitude, Geoidal separation, Units of geoidal separation, Age of GPS data, Reference station ID.

```
   1         2           3          4       5  6   7   8  9  10 11  12   13   14
$--GGA,hhmmss.ss,1111.11,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx,*hh
```

	Sentence Content	Description
1	$--GGA,	$ Start of sentence delimiter -- TALKER Identification (GP for GPS) GGA Sentence Formatter
2	hhmmss.ss,	*UTC of Position Fix* (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length)
3	1111.11,a,	*Latitude* [ddmm.mm], N/S (2 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
4	yyyyy.yy,a,	*Longitude* [dddmm.mm], E/W (3 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
5	x,	*GPS Quality Indicator* 0 = fix not available or invalid 1 = GPS fix 2 = differential GPS fix
6	xx,	*Number of Satellites in Use* (00 to 12, may be different from the number in view)
7	x.x,	*HDOP*
8	x.x,	*Altitude of Antenna Above MSL (geoid)*
9	M,	*Units of Antenna Altitude, metres*
10	x.x,	*Geoidal separation*
11	M,	*Units of Geoidal separation, metres*
12	x.x,	*Age of Differential GPS Data*
13	xxxx	*Differential Reference Station ID*
14	*hh	Checksum
	<CR><LF>	Sentence termination delimiter

10.1.3 The GLL message

The GLL message - Latitude, Longitude, UTC of position.

$$\overbrace{\$--\mathtt{GLL}}^{1},\overbrace{\mathtt{1111.11,a}}^{2},\overbrace{\mathtt{yyyyy.yy,a}}^{3},\overbrace{\mathtt{hhmmss.ss}}^{4},\overbrace{\mathtt{A}}^{5},\overbrace{\mathtt{*hh}}^{6}$$

	Sentence Content	Description
1	`$--GLL,`	$ Start of sentence delimiter -- TALKER Identification (GP for GPS) GLL Sentence Formatter
2	`1111.11,a,`	*Latitude* [ddmm.mm], N/S (2 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
3	`yyyyy.yy,a,`	*Longitude* [dddmm.mm], E/W (3 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
4	`hhmmss.ss,`	*UTC of Position Fix* (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length)
5	`A`	*Status:* A = Yes, data valid, warning flag clear V = No, data invalid, warning flag set
6	`*hh`	Checksum
	`<CR><LF>`	Sentence termination delimiter

10.1.4 The VTG message

The VTG message consists of Track in true degrees, Track in magnetic degrees, Speed in knots, Speed in Km/h.

$$\overbrace{\$--\mathrm{VTG},}^{1}\ \overbrace{\mathrm{x.x,T},}^{2}\ \overbrace{\mathrm{x.x,M},}^{3}\ \overbrace{\mathrm{x.x,N},}^{4}\ \overbrace{\mathrm{x.x,K},}^{5}\ \overbrace{*\mathrm{hh}}^{6}$$

	Sentence Content	Description
1	$--VTG,	$ Start of sentence delimiter -- TALKER Identification (GP for GPS) VTG Sentence Formatter
2	x.x,T	*Track in True Degrees*
3	x.x,M	*Track in Magnetic Degrees*
4	x.x,N	*Speed in knots*
5	x.x,K	*Speed in Km/h*
6	*hh	Checksum
	<CR><LF>	Sentence termination delimiter

10.1.5 The GGK message

The GGK message - UTC of Position, UTC Datum, Latitude, Longitude, GPS quality indicator, No. of common satellites, GDOP, Ellipsoidal Antenna Height.

```
    1        2         3           4                 5            6  7   8      9      10
$RTGGK, hhmmss.s, mmddyy, dddmm.mmmmmm, n, dddmm.mmmmmm, w, q, uu, dd.d, eht.xxx.m*hh
```

	Sentence Content	Description
1	$--GGK,	$ Start of sentence delimiter -- TALKER Identification (RT for RTDGPS) GGK Sentence Formatter
2	hhmmss.s,	*UTC of Position Fix* (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length)
3	mmddyy	*Month* [01...12] *Day* [01...31] *Year*
4	ddmm.mmmmmm, n	*Latitude* [ddmm.mm], N/S (2 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
5	dddmm.mmmmmm ,w,	*Longitude* [dddmm.mm], E/W (3 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
6	q,	*GPS Quality Indicator* 0 = fix not available or invalid 1 = No Realtime position, navigation fix 2 = Realtime position, ambiguities not fixed 3 = Realtime position, ambiguities fixed
7	uu,	*Number of Satellites in Use* (Common satellites between ref and rover, Values between 00 to 12, may be different from the number in view)
8	dd.d,	*GDOP* Calculated in GPSDesk
9	eht.xxx,m	*Ellipsoidal Antenna Height (ground)*
10	*hh	Checksum

10.1.6 The GGQ message

The GGQ message - UTC of Position, UTC Datum, Latitude, Longitude, GPS quality indicator, No. of common satellites, Coordinate Quality of position, Ellipsoidal Antenna Height.

$$\overbrace{\texttt{\$RTGGQ}}^{1},\overbrace{\texttt{hhmmss.s}}^{2},\overbrace{\texttt{mmddyy}}^{3},\overbrace{\texttt{ddmm.mmmmmm,n}}^{4},\overbrace{\texttt{dddmm.mmmmmm,}}^{5}\overbrace{\texttt{q}}^{6},\overbrace{\texttt{uu}}^{7},\overbrace{\texttt{dd.dd}}^{8},\overbrace{\texttt{eht.xxx.m}}^{9},\overbrace{\texttt{*hh}}^{10}$$

	Sentence Content	Description
1	`$--GGQ,`	$ Start of sentence delimiter -- TALKER Identification (RT for RTDGPS) GGQ Sentence Formatter
2	`hhmmss.s,`	*UTC of Position Fix* (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length)
3	`mmddyy`	*Month* [01...12] *Day* [01...31] *Year*
4	`ddmm.mmmmmm, n`	*Latitude* [ddmm.mm], N/S (2 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
5	`dddmm.mmmmmm ,w,`	*Longitude* [dddmm.mm], E/W (3 fixed digits of degrees, 2 fixed digits of minutes, and a variable number of digits for decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length)
6	`q,`	*GPS Quality Indicator* 0 = fix not available or invalid 1 = No Realtime position, navigation fix 2 = Realtime position, ambiguities not fixed 3 = Real time position, ambiguities fixed
7	`uu,`	*Number of Satellites in Use* (Common satellites between ref and rover, Values between 00 to 12, may be different from the number in view)
8	`ddd.dd,`	*CQ* Co-ordinate quality of this position in metres
9	`eht.xxx,m`	*Ellipsoidal antenna height*
10	`*hh`	Checksum

10.1.7 The LLK Message

The LLK message - UTC of Position, UTC Datum, Easting, Northing, GPS quality indicator, No. of common satellites, GDOP, Ellipsoidal Antenna Height.

$$\overbrace{\texttt{\$RTLLK}}^{1},\overbrace{\texttt{hhmmss.s}}^{2},\overbrace{\texttt{mmddyy}}^{3},\overbrace{\texttt{eeeeee.eee,m}}^{4},\overbrace{\texttt{nnnnnn.nnn,m}}^{5},\overbrace{\texttt{q}}^{6},\overbrace{\texttt{uu}}^{7},\overbrace{\texttt{dd.d}}^{8},\overbrace{\texttt{eht.xxx,m}}^{9},\overbrace{\texttt{*hh}}^{10}$$

	Sentence Content	Description
1	`$--LLK,`	$ Start of sentence delimiter -- TALKER Identification (RT for RTDGPS) LLK Sentence Formatter
2	`hhmmss.s,`	*UTC of Position Fix* (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length)
3	`mmddyy`	*Month* [01...12] *Day* [01...31] *Year*
4	`eeeeee.eee,m`	*Eastings,metres* (Default 6 leading integers followed by 3 decimal fractions. When more than 6 integers are required these will automatically be included. Leading zeros always included for eastings to maintain fixed length)
5	`nnnnnn.nnn,m`	*Northings, metres* (Default 6 leading integers followed by 3 decimal fractions. When more than 6 integers are required these will automatically be included. Leading zeros always included for northings to maintain fixed length)
6	`q,`	*GPS Quality Indicator* 0 = fix not available or invalid 1 = No Realtime position, navigation fix 2 = Realtime position, ambiguities not fixed 3 = Realtime position, ambiguities fixed
7	`uu,`	*Number of Satellites in Use* (Common satellites between ref and rover, Values between 00 to 12, may be different from the number in view)
8	`dd.d,`	*GDOP* Calculated in GPSDesk
9	`eht.xxx,m`	*Altitude of Antenna*
10	`*hh`	Checksum

10.1.8 The LLQ message

The LLQ message - UTC of Position, UTC Datum, Easting, Northing, GPS quality indicator, No. of common satellites, Coordinate Quality of position, Ellipsoidal Antenna Height.

$$\overbrace{\texttt{\$RTLLQ}}^{1},\ \overbrace{\texttt{hhmmss.s}}^{2},\ \overbrace{\texttt{mmddyy}}^{3},\ \overbrace{\texttt{eeeeee.eee, m}}^{4},\ \overbrace{\texttt{nnnnnn.nnn, m}}^{5},\ \overbrace{\texttt{q}}^{6},\ \overbrace{\texttt{uu}}^{7},\ \overbrace{\texttt{dd.dd}}^{8},\ \overbrace{\texttt{eht.xxx, m}}^{9},\ \overbrace{\texttt{*hh}}^{10}$$

	Sentence Content	Description
1	`$--LLK,`	$ Start of sentence delimiter -- TALKER Identification (RT for RTDGPS) LLK Sentence Formatter
2	`hhmmss.s,`	*UTC of Position Fix* (2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds, and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length)
3	`mmddyy`	*Month* [01...12] *Day* [01...31] *Year*
4	`eeeeee.eee,m`	*Eastings,metres* (Default 6 leading integers followed by 3 decimal fractions. When more than 6 integers are required these will automatically be included. Leading zeros always included for eastings to maintain fixed length)
5	`nnnnnn.nnn,m`	*Northings, metres* (Default 6 leading integers followed by 3 decimal fractions. When more than 6 integers are required these will automatically be included. Leading zeros always included for northings to maintain fixed length)
6	`q,`	*GPS Quality Indicator* 0 = fix not available or invalid 1 = No Realtime position, navigation fix 2 = Realtime position, ambiguities not fixed 3 = Realtime position, ambiguities fixed
7	`uu,`	*Number of Satellites in Use* (Common satellites between ref and rover, Values between 00 to 12, may be different from the number in view)
8	`ddd.dd,`	*CQ* Co-ordinate quality of this position in metres
9	`eht.xxx,m`	*Altitude of Antenna*
10	`*hh`	Checksum

10.2 Seismic Record

When the **Support Seismic** option in panel [1102] SET Data Recording parameters is set to **YES**, a seismic record will be recorded along with any other point and coordinate information.

A typical seismic record will take the following format:

```
1  2    3  4  5      6      7      8      9         10  11   12  13   14
@, GSE, V, M, gg. g, pp. p, hh. h, vv. v, aaa. aaa, ss, eee, ii, REC, RSN
```

	Record Content	Description
1	@	Record Flag. @ = Automatically stored (not user entered).
2	GSE	Record Type. GSE = **G**PS **SE**ismic.
3	Version	Version number of this record.
4	M	Position type. Range 0,1,2,3,4. Default if none available - 0 0 - position not available 1 - navigated position 2 - differential code position 3 - differential phase, float solution 4 - differential phase, fixed solution
5	gg.g	GDOP value. Range 0.0 to 99.9. Default if not available - 0.0.
6	pp.p	PDOP value. Range 0.0 to 99.9. Default if not available - 0.0.
7	hh.h	HDOP value. Range 0.0 to 99.9. Default if not available - 0.0.
8	vv.v	VDOP value. Range 0.0 to 99.9. Default if not available - 0.0.
9	aaa.aaa	Antenna Height - sum of instrument height and antenna offset. Range -99.9 to 999.99. Default if not available - 0.0.
10	ss	Number of satellites used for solution. Range 0 to 12. Default if not available - 0.
11	eee	Number of epochs spent on point. Range 0 to 999. Default if not available - 0. Default if not available - 0.
12	ii	Length of interval between epochs (seconds). Range 0, 2, 3, 4, 5, 6, 10, 12, 15, 30, 60. Default if not available - 0.
13	REC	Receiver type. Range SR299, SR399, SR299E, SR399E, SR9400, SR9500
14	RSN	Receiver serial number. Range 0 - 999999. Value if unavailable - 0.

The Seismic record will be recorded as the fourth point annotation. For this reason, if the user has selected to use Point Annotations, only three such annotations will be available if the Support seismic option has been activated. A typical seismic record will take the format of the following:

```
@GSE12 4.0 0.0 0.0 0.0 1.220 5 1 2SR9500 001899
```

10.3 COGO Application Functions

Within the APPLICATIONS menu, there are, at present access to three application programs: COGO (Coordinate Geometry), DTM Stakeout and QuickSlope Slope Staking.

DTM Stakeout and QuickSlope Slope Staking applications are optional packages which can only be accessed if the necessary Registration code has been entered. For information about these programs please refer to the appropriate manuals.

Surveying with Coordinate Geometry (COGO) for GPS will help you to take advantage of Leica's RT-SKI solutions in the field. This section will give you a basic understanding of COGO, how it works, and how to perform basic operation in the field with the COGO functions. This section is only an introduction to Leica's COGO functions and not a description of COGO in general. For more information concerning how surveying coordinate geometry is used, please reference other Leica and surveying materials.

10.3.1 Basic principles

Surveying with RT-SKI can create a series of points in a Grid (X, Y, Z or Northing, Easting, Height) coordinate system. Such points can be used as a basis for calculating further points with COGO.

The Controller contains COGO for GPS which can be used with the coordinate database in your CR333 or CR344 Controller. Points can be generated and stored in the database. After creating points with COGO, they can then be staked out in the field with the RT-SKI staking out feature.

COGO can be accessed either from MAIN MENU (Controller shell) or within a Real Time Rover Mission.

To select from MAIN MENU [0000], go to SELECT/ENTER, Applications. The APPLICATIONS MENU panel [2000] will appear giving the application programs that are currently available. If DTM Stakeout and QuickSlope Slope Staking has not been purchased the Applications function will lead directly to the SELECT/ENTER COGO GPS panel [2100]. Otherwise you have to chose COGO.

To select COGO within a Real time Rover Mission, select MENU in the main survey mission panel [1110], then select APPLICATIONS.

The following COGO functions are supported:

```
[2100]   SELECT/ENTER COGO GPS
Inverse                Distance Offset
Traverse               Point in Arc
Line-Line Intersect    3 Point Arc
Line-Arc Intersect     Point Dist Offset
Arc-Arc Intersect

CONT
```

Inverse allows you to compute the Distance, Azimuth and Height Difference by selecting two points.

Traverse allows you to compute a Traverse Point by entering distance and azimuth from an existing point.

Line-Line Intersect allows you to compute an Intersection Point by selecting four points to create two intersecting lines.

Line-Arc Intersect allows you to compute Intersection Point(s) by selecting two points to create a line and selecting a point for the centre of an arc and entering its radius.

Arc-Arc Intersect allows you to compute Intersection Point(s) by selecting two centre points of Arc and entering the corresponding two radii.

Distance-Offset allows you to compute a Point on a line from a point that is offset perpendicular to the line by selecting two points for the line and the offset point.

Point in Arc allows you to compute a Point along an arc by selecting two points on the arc, entering the radius of the arc and distance along the arc.

3 Point Arc allows you to compute the Radius and Centre Point of an arc by selecting three points on arc.

Point Distance Offset allows you to compute an Offset Point by defining a line from two points, distance and offset from first defined point.

COGO Function Overview :

Function Name	Input	Output
Inverse	Line (from 2 Points)	Distance between 2 Points Azimuth of Line, Height Difference between 2 Points
Traverse	Point Distance Azimuth	Offset Point
Line-Line Intersect	2 Lines (4 Points)	Intersecting Point
Line-Arc Intersect	Line (2 Points) Arc (Centre Point, Radius)	Intersecting Point(s) of Line and Arc
Arc-Arc Intersect	2 Arcs (Centre Points, Radii)	Intersecting Point(s) of Arcs
Distance-Offset	Line (2 Points) Offset Point	Intersecting Point on Line Offset, Distance
Point in Arc	Arc (2 Points on Arc, Radius) Arc Distance	Offset Point
3 Point Arc	Arc (3 Points on Arc)	Centre Point of Arc Radius
Point Dist Offset	Line (2 Points) Offset, Distance	Offset Point

10.3.2 Units

COGO will only compute points that are available in a Grid coordinate system. Points in a geodetic coordinate system with a transformation set attached can be used for COGO computation, as well as points entered in grid coordinates.

Linear dimensions may be displayed in meters, international feet or US survey feet. Azimuth may be displayed in degree-minute-second, gon or decimal degree; depending on units selected in Configuration.

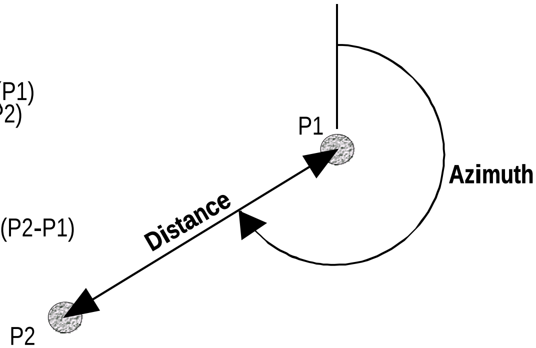
10.3.3 COGO functions

Use the **Error! Bookmark not defined.** or **Error! Bookmark not defined.** cursor keys to toggle between the input fields.
Point ids can be entered manually by typing its identification, they can be loaded from the GEODB using **LOAD** (F1) or they can be measured on the spot and directly be used for calculation, using **MEAS** (F2). Whenever points have been measured previously to entering a COGO function, the last measured points will be input as default values.

10.3.3.1 Inverse

<u>Input</u>
Start point of line (P1)
End point of line (P2)

<u>Output</u>
Distance
Azimuth
Height Difference (P2-P1)



This function is for calculating the inverse between two grid points.

```
[2110]   SELECT Inverse

Start Point Id: Toronto NE
End Point Id  : Denver SW



LOAD    MEAS              COMPUT  LAST    NONE
```

Enter the Start and End Points to be inversed.

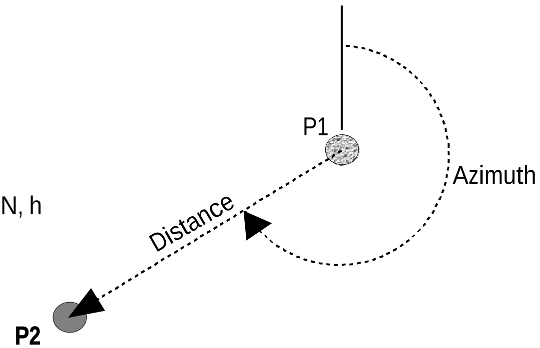
Pressing **COMPUT** will now compute the inverse of the two points.

```
[2111]   RESULT Inverse

Distance :       210.238 m
Azimuth  :     244°54’21”
HeightDif:        20.000 m

CONT
```

10.3.3.2 Traverse

Input
Start point (P1)
Distance
Azimuth

Output
New Point (P2) E, N, h



This function is for calculating a new point by defining a start point and entering its distance and azimuth to the new point.

```
[2120]   SELECT Traverse

Point Id: ATLANTA SE
Distance:       100.000 m
Azimuth :     300°30’00”

LOAD   MEAS          COMPUT  LAST   NONE
```

Enter the start **Point, Distance** and **Azimuth** to be traversed.

Pressing **COMPUT** will now compute the new traverse point.

```
[2021]   RESULT Traverse

Y/East  :      123.837 m
X/North :       55.754 m
Height  :       30.000 m
Point Id: NEW POINT

CONT     STORE
```

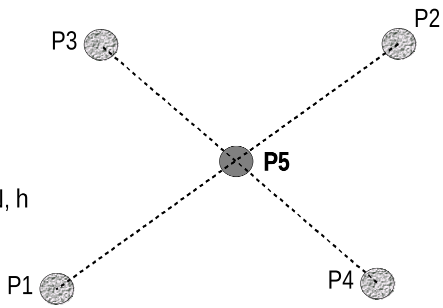
The height of the start point is displayed as the computed height. The user may edit the computed height for the newly traversed point.

Enter the Point Id, edit the height if necessary and press **STORE** to record the result.

10.3.3.3 Line-Line Intersection

Input
Line 1 Point 1 (P1)
Line 1 Point 2 (P2)
Line 2 Point 1 (P3)
Line 2 Point 2 (P4)

Output
New Point (P5) E, N, h



This function is for calculating the intersection point of two lines. The lines are defined by four sets of coordinates.

```
[2130]   SELECT Line-Line Intersection

Line1 Point1 : DENVER SW
Line1 Point2 : OTTAWA NE
Line2 Point3 : VANCOUVER NW
Line2 Point4 : ATLANTA SE

LOAD     MEAS               COMPUT   LAST     NONE
```

Enter **Point1**, **Point2**, **Point3** and **Point4** to define the two intersecting lines.

Select **COMPUT** to calculate the intersection point.

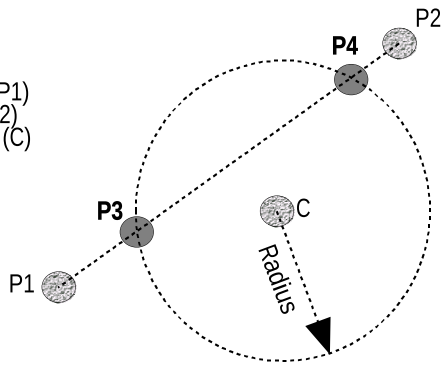
```
[2131]   RESULT Line-Line Intersection

Y/East  :      101.255 m
X/North :       94.714 m
Height  :      100.000 m
Point Id: NEW POINT

CONT     STORE
```

After computation, enter the **Point Id**, edit the **Height** if necessary and select **STORE** to record result.

10.3.3.4 Line-Arc Intersection

Input
Start Point Id of Line (P1)
End Point Id of Line (P2)
Centre Point Id of Arc (C)
Radius of Arc

Output
Solution 1 E, N, h (P3)
Solution 2 E, N, h (P4)



This function is for calculating the intersection point(s) of a line and an arc. The line is defined by a start and end point and the arc is defined by a centre point and its radius.

```
[2140]   SELECT Line-Arc Intersection

Start Point Id: DENVER SW
End Point Id  : TORONTO NE
Center of Arc : ATLANTA SE
Radius of Arc :      250.500 m

LOAD    MEAS            COMPUT  LAST    NONE
```

Enter **Start Point Id** and **End Point Id** to define line. Enter **Center** point id and **Radius** to define arc.

Select **COMPUT** to calculate the intersection point(s).

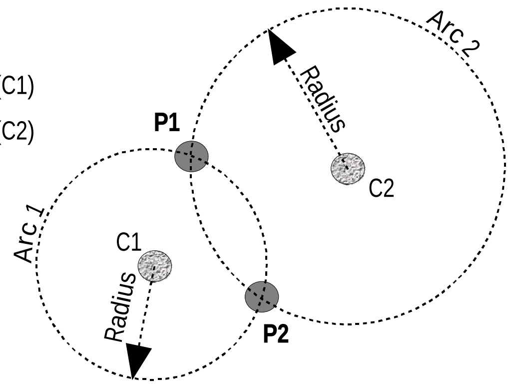
```
[2141]   RESULT Line-Arc Intersection
Solution: 1
Y/East  :      -39.526 m
X/North :       27.067 m
Height  :      100.000 m
Point Id: NEW POINT

CONT    STORE           SOLUT2
```

After computation, **SOLUT2** or **SOLUT1** allows user to display the two possible solutions. To store a result, enter **Point Id**, edit **Height** if necessary and press **STORE** to record the point.

10.3.3.5 Arc-Arc Intersection

Input
Centre Point Id of Arc 1 (C1)
Radius of Arc 1
Centre Point Id of Arc 2 (C2)
Radius of Arc 2

Output
Solution 1 (P1) E, N, h
Solution 2 (P2) E, N, h



This function is for calculating the intersection points of two arcs. Each arc is defined by a centre point and its radius.

```
[2150]    SELECT Arc-Arc Intersection
Use Solution        : LEFT    (P1 -> P2)
Center Point of Arc1: DENVER SW
Radius of Arc1      :      100.000 m
Center Point of Arc2: TORONTO NE
Radius of Arc2      :      250.000 m

LOAD    MEAS    RIGHT   COMPUT  LAST    NONE
```

Enter **Center** point of arc 1 and arc 2. Enter corresponding **Radii** of arc 1 and 2. Use **RIGHT** to display the right intersection point as the first solution.

Select **COMPUT** to calculate the intersection point(s).

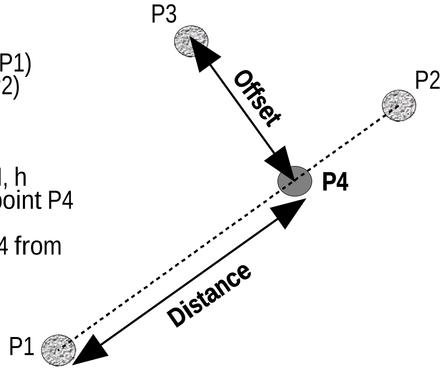
```
[2151]     RESULT Arc-Arc Intersection
Solution: LEFT    (P1 -> P2)
Y/East  :      -29.806 m
X/North :      140.145 m
Height  :      100.000 m
Point Id: NEW POINT

CONT    STORE           RIGHT
```

After computation, **RIGHT** or **LEFT** allows user to view the other possible solutions. To store the result, enter **Point Id**, edit **Height** if necessary and press **STORE** to record point.

10.3.3.6 Distance-Offset

Input
Start Point of Line (P1)
End Point of Line (P2)
Offset Point (P3)

Output
New Point (P4) E, N, h
Offset distance of point P4 from line
Distance of point P4 from start point P1.



This function is for calculating a point on a line from an offset point perpendicular to the line.

```
[2160]   SELECT Distance Offset

Start Point Id : DENVER SW
End Point Id   : OTTAWA NE
Offset Point Id: VANCOUVER NW


LOAD    MEAS          COMPUT  LAST    NONE
```

Enter **Start Point Id** and **End Point Id** to define line. Enter **Offset Point Id** to define offset point perpendicular to line.

Pressing **COMPUT** will compute the intersecting point on the line, it's distance from the start point of the line and the perpendicular distance to the offset point.

```
[2161]   RESULT Distance-Offset
Y/East  :      -29.806 m
X/North :      140.145 m
Height  :      100.000 m
Point Id: NEW POINT
Ofs/Dist:     -107.648 m          210.365 m

CONT    STORE
```

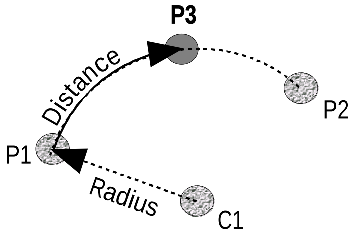
After computation, the **Ofst** is the perpendicular distance of the offset point from the line. A positive Offset indicates that the offset point is on the right hand side of the line. A negative value indicates the opposite. **Dist** is the distance of the new intersecting point from the start point of the line. A positive distance indicates that the calculated point lies in the same direction as the end point of the line. A negative distance indicates the opposite.

To store the new point on the line, enter **Point Id**, edit **Height** if necessary and press **STORE** to record point.

10.3.3.7 Point in Arc

Input
Start Point of Arc (P1)
End Point of Arc (P2)
Radius of Arc
Arc Distance from Start

Output
New Point (P3) E, N, h



This function is for calculating a point on an arc by defining the arc distance from the start point of the arc.

```
[2170]    SELECT Point in Arc

Start Point Id: VANCOUVER NW
End Point Id  : OTTAWA NE
Radius        :      250.000 m
Arc Distance  :       10.000 m

LOAD    MEAS            COMPUT   LAST    NONE
```

Enter the **Start Point** of the arc, the **End Point** of the arc and it's **Radius** to define the arc. Enter the **Arc Distance** from the Start Point of the arc.

Press **COMPUT** to compute the new point on the defined arc.

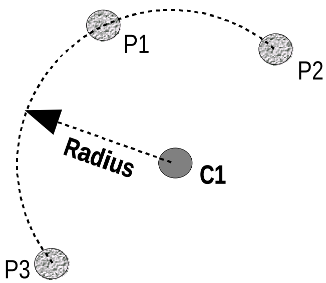
```
[2171]    RESULT Point in Arc

Y/East  :       19.372 m
X/North :      173.485 m
Height  :       10.000 m
Point Id: NEW POINT

CONT    STORE
```

To store the new point on arc, enter the **Point Id**, edit the **Height** if necessary and press **STORE** to record.

10.3.3.8 Three Point Arc

Input
Three points on Arc circumference (P1, P2, P3)

Output
Centre point of Arc (C1) E, N, h
Radius of Arc



This function is for calculating the centre point and radius of an arc by defining three points on the arc circumference.

```
[2180]    SELECT 3 Point Arc

Point Id 1 : VANCOUVER NW
Point Id 2 : TORONTO NE
Point Id 3 : ATLANTA SE

LOAD    MEAS            COMPUT   LAST    NONE
```

Define the arc by entering three **Point Id** that lie on the circumference.

COMPUT will compute the centre point of the arc and its radius.

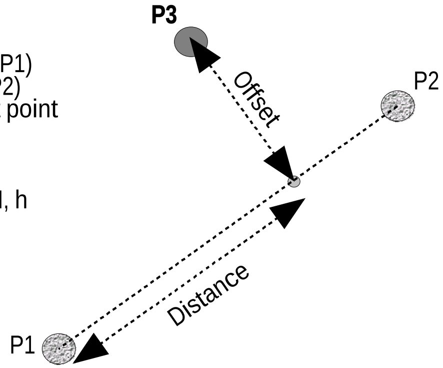
```
[2181]    RESULT 3 Point Arc
Y/East   :      107.847 m
X/North  :       84.890 m
Height   :       10.000 m
Radius   :      129.683 m
Point Id: NEW POINT

CONT    STORE
```

To store the centre point of the arc, enter **Point Id**, edit its **Height** if necessary and press **STORE** to record point.

10.3.3.9 Point Distance Offset

Input
Start Point of Line (P1)
End Point of Line (P2)
Distance from start point
Offset from Line

Output
New Point (P3) E, N, h



This function is for calculating an offset point by defining a line from two points, offset distances from line and first point of line.

```
 [2190]   SELECT Point Distance Offset

 Start Point Id: DENVER SW
 End Point Id  : OTTAWA NE
 Distance      :       150.000 m
 Offset        :       -30.000 m

 LOAD     MEAS     DIST-E  COMPUT           NONE
```

Enter the **Start Point Id** and the **End Point Id** to define the line. Enter **Distance** of the point on the line from the start point. If you want to enter the distance from the end point press **DIST-E**. A positive distance represents a point on the line that lies in the same direction as the end point. A negative distance indicates the opposite. Enter the **Offset** as the perpendicular distance of the Offset Point to be created from the defined line. A positive offset indicates that the new point is on the right side of line. A negative distance indicates the opposite.

Pressing **COMPUT** will compute the new point.

```
[2191]   RESULT Point Distance Offset

Y/East  :      151.709 m
X/North :      152.665 m
Height  :      100.000 m
Point Id: NEW POINT

CONT     STORE
```

To store the Offset Point, enter the **Point Id**, edit the **Height** if necessary and press **STORE** to record point.

10.4 GSI coding system

This section describes the GSI coding system as used by Leica GPS. The GSI system is used by many other Leica electronic survey instruments and software. GSI files from Leica GPS equipment are produced via Workbench Data Manager or by using the **Convert to GSI** option in the SELECT/ENTER menu.

GSI-8 and GSI-16 data format is supported. By default the system is set to GSI-16. If you want to use GSI-8 change the GSI Data Format in CONFIGURATION, **Coding system.**

A GSI record is composed of two blocks, a measurement block and a code block.

10.4.1 The Measurement block

Measurement blocks are produced from GSI records that have been recorded through GPS in the GEODB. They consist of the point Id and the Easting, Northing and elevation in metres.

10.4.2 The Code block

The code block is written in the Controller when the GSICOD key is pressed. The following panel appears:

```
[1490]  ADD GSI Code Block          CQ: 0.03
Code No: 123          Id:POINT 01
Info 1 :              Info 2 :
Info 3 :              Info 4 :
Info 5 :              Info 6 :
Info 7 :              Info 8 :

STORE    REC-TM            CODE     NONE     LAST
```

The code number may now be entered. This will always correspond to Word 1 in the code block. Up to 8 further "info's" (code block Words 2-9) may then be entered. If GSI-16 data format has been configured only Info 1-4 will be displayed. Toggle to Info 5-8 by using **PG-DN.**

Most users who utilise the GSI coding system will already possess a software or instrument that uses this system and be familiar with it. Further information about the production of GSI files from GPS is contained in the Technical Reference Help or in the Data Manager help system. Information about the GSI system in general is available from your local Leica representative.

10.5 Calculation of phase-centre eccentricities

For mechanical and electrical reasons the 2 GPS frequencies L1 and L2 do not have identical phase centres. This difference will only affect the GPS measurements if different Antenna Types are being used at the Reference and Rover stations. If identical Antennas are being used at both the Reference and at the Rover, the so-called Phase Centre Eccentricities will be identical at both stations and will therefore cancel.

If different Antenna Types are used at the Reference and Rover, the Phase Centre Eccentricities have to be calculated and included in the computation.

When using RT-SKI with Leica Antennas at both stations, any Phase Centre Eccentricities are automatically calculated and applied. RT-SKI obtains this information from Configuration, Sensor/Antenna Type on the Controller.

When a Third Party Antenna is going to be used, the Phase Centre Eccentricities have to be known. These can be calculated. A method for doing this is given below.

Phase Centre Eccentricities between all Leica Antennas will be handled automatically by RT-SKI as stated above.

Phase Centre Eccentricities of Third Party Antennas may be entered in the Configuration, Sensor/Antenna Type menu of RT-SKI.

Points to Note

One has to carefully distinguish between „antenna offsets“ and „phase centre eccentricities“.

The antenna offset is the height of an antenna reference point (usually the mean L1 and L2 phase centre) above a fixed mark. With Leica equipment the antenna offset will vary with the type of set-up (pole, tripod and height hook, pillar) and with the type of antenna used (internal, AT302, AT303). These offsets are given in the Technical Reference Help.

Phase centre eccentricities are relative values between different antenna types giving the height of the L1 or L2 phase centre above the L1 or L2 phase centre of a chosen reference antenna. No absolute values are necessary, as always baselines between 2 antennas are computed. Leica has chosen the SR299/SR399 with internal antenna as the reference antenna.

Third Party Antennas

The definition of user defined antenna types is possible when using RT-SKI on the CR244 or CR344 Controllers. This is especially useful, if you are working with non-Leica antenna types at the reference station. For user defined antenna types the phase centre eccentricities for L1 and L2 have to be entered.

The easiest way to determine the correct values is to calibrate the user-defined antenna against the SR299/399 internal, as this is the Leica reference antenna.

Therefore set up the 2 antennas (i.e. the SR299/399 internal and the antenna to be calibrated) a few metres apart at a stable location. Record data at a 30 second interval for 24 hours. Enter the antenna offsets. For Leica equipment this is the „antenna offset“ mentioned in the introduction and given in the Technical Reference Help. If the antenna offset is unknown for the user defined antenna, you can easily determine a value by comparing the height component of the GPS baseline vector against a precisely levelled height.

Process the baseline in SKI. In the Configuration/Processing Parameters menu you must set the parameter ‘Phase frequency’ to L1 only.
Select the station that had the SR299/399 internal as the reference station.
When the result appears, note the height component of the baseline computation. (L1)

Process the baseline again. In the Configuration/Processing Parameters menu you must set the parameter ‘Phase frequency’ to L2 only.
Select the SR299/399 internal as reference.
When the result appears, note the height component of the baseline computation. (L2)

The phase centre eccentricities may now be computed as:

$$\Delta L1 = (L1-L2)/2$$
$$\Delta L2 = (L2-L1)/2$$

10.6 Notes on Handshake for Communication Ports

OFF means that no handshake will be used.

RTS/CTS is used for a software handshake. When receiving data, the Controller/PC will inform the modem when it is ready to receive the data. The data will then be sent if present. Conversely, when sending data, the modem will inform the Controller when it is ready to receive data. Data will then be sent from the Controller/PC to the modem.

SATELLINE is used for transmission and reception of real time data using a Satelline radio modem, be this RTCM or RT-SKI data. **CHAN** (F6) allows to switch to predefined channels even if you are within a mission. Use the right cursor key to switch between the two models Satelline 2ASx or 2ASxE, press the cursor down key and enter a channel number. For the 2ASx the range is 0 to +15, and for the 2ASxE the range is –80 to +80. Channel 0 is assigned to the base frequency of the radio modem. By increasing or decreasing the channel number you will increase or decrease the frequency band in steps of 12.5Mhz or 25Mhz depending on the model used.

PAC-CREST is used for transmission and reception of real time data using a Pacific Crest radio modem, be this RTCM or RT-SKI data. **CHAN** (F6) allows to switch to pre-configured channels even if you are within a mission. Note that you have to disconnect the power of your radio modem for a short period of time before you are able to actually change the channel. Contact your local Leica or Pacific Crest dealer to allocate different frequencies to different channels. Channel 0 is assigned per default to the base frequency of the radio modem.

RADIO FIX fixes the modem to be always active after the first data is ready to be sent. It is only used with data transmission.

RADIO CTS is a handshake designed to save power with radio modems that use the RTS/CTS control. The modem will only be activated when data has to be sent. It is only used with data transmission.

RADIO DT will save power on modems that do not support the CTS control. The data is sent to the modem after a specified time ΔT milliseconds. It is only used with data transmission.

GSM is used for transmission and reception of real time data using cellular phones supporting AT command language. If handshake is set to GSM two more function keys are available. With **TELNR** (F5) you can store the name and telephone number of the reference station and whether you are using an analog modem or not. Note: Telephone number is only required for the real time rover mission. With **PIN** (F6) the pin code required to get access to certain GSM networks may be entered. Additionally you may enter the PUK code. **DISCNT** (F2) is only available within the real-time rover mission. It allows you to disconnect the phone connection without leaving the mission in order to save air time. Press **CONNCT** (F2) in return to re-establish the connection.

Leica Geosystems AG
CH-9435 Heerbrugg
(Switzerland)
Telephone +41 71 727 31 31
Fax +41 71 727 47 02
www.leica.com

G2-519-0en- IX.98- Printed in Switzerland, Copyright by Leica Geosystems AG, Heerbrugg, Switzerland