HOW TO USE
THE
COMPUTER
MICRO SURVEYOR
INTRODUCTION

The Compucorp 354 Surveyor is an extraordinarily powerful and versatile instrument, created specifically to aid the land surveyor in his day-to-day calculations. Its size and portability make it practical for both field and office use. As with any instrument, practice makes perfect, and you will find that the longer you use it, the more powerful and useful to you it becomes.

To get the most out of your Surveyor, you should read this manual, following the examples with the Surveyor on and running. Our examples are carefully selected to illustrate the use of various features and capabilities, so study them carefully. Thereafter, use the manual as a quick reference guide to specific functions and operations.
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The ON/OFF switch is on the back. Next to it is a connector for the charger/adapter. Move the switch to the "ON" position.

NOTE: When the 354 is switched on, the display may contain almost any combination of numbers or characters while it goes through a clearing cycle. Wait for the display format ⌘ . ⌘ ⌘ ⌘ to appear before pushing any of the keys. The clearing cycle lasts about three seconds.

If you are using the 354 with the adapter/charger, set the voltage switch on the bottom of the charger to the appropriate voltage. See page 105, Batteries and Recharging. Also, be sure that the RUN/LOAD switch in the upper right corner of the keyboard is in the RUN position.
ENTERING NUMBERS

Keying in numbers is as simple as pressing the digit keys in sequence. Press the decimal point key when needed. Changes the sign of the number, from positive to negative, or negative to positive.

Notice that the number is displayed as you enter it. You can not enter more than 13 digits (12 if the first key is decimal point). If you put in too many digits the display goes into error and shows .---.---.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--.--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MAKING CORRECTIONS

Whenever you find you've made a mistake in an arithmetic operation, \(\text{RESET}\) clears the entire calculation so you can start over. \(\text{CLEAR}\) clears the display, so that you can correct an entry error without losing the calculation you were doing.

Although it's usually not necessary, it's a good idea to press \(\text{RESET}\) before starting a calculation, just to be sure there are no leftovers inside.

If you see \(\boxed{\text{E-\text{--}}}\) in the display (it stands for ERROR) that means you've done something mathematically illegal, or have produced a number outside the Surveyor's range (its capacity is \(10^{-9.8}\) to \(10^{9.8}\)). Calculation is stopped. Press \(\text{RESET}\) or \(\text{CLEAR ENTRY}\) to get going again.

The following cause error:

- Divide by zero
- 1/x of zero
- \(\sqrt{\text{of a negative number}}\)
- Arc sine of a number outside the range \(-1\) to \(+1\)
- Asking for an impossible intersection
- Trying to calculate a number outside the Surveyor's range \(10^{-9.8}\) to \(10^{9.8}\)
- \(a^x\) where \(a\) is negative and \(x\) is not an integer
- \(0^x\)
- Parentheses close before open
- More than two parentheses open without a close
When entering angles, use the \( \text{\textit{deg}} \) key. Key in the degrees, press \( \text{\textit{min}} \). The display changes to angle format. Now key in the minutes. Press \( \text{\textit{sec}} \) again and put in the seconds.

Enter 15° 30' 10"
The 354 also is capable of handling decimal degrees, along with degrees and decimal minutes.

For Example: 65.5°

Enter 6 5 5
Press D/M/S

65°43.8'

Enter 6 5
Press D/M/S
Enter 4 3 8
Press D/M/S

Enter 4 3 8
Press D/M/S

Enter 4 3 8
ENTERING BEARINGS

The first requirement in entering a bearing is to identify the direction. The 354 uses a numerical code for identifying the direction.

<table>
<thead>
<tr>
<th>Bearing</th>
<th>Quadrant</th>
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<tr>
<td>NE</td>
<td>1</td>
</tr>
<tr>
<td>SE</td>
<td>2</td>
</tr>
<tr>
<td>SW</td>
<td>3</td>
</tr>
<tr>
<td>NW</td>
<td>4</td>
</tr>
</tbody>
</table>

To indicate direction, touch \textcolor{red}{\text{QUADRANT}}, followed by the appropriate quadrant number. Note the quadrant is displayed on the left. Then enter the degrees, touch \textcolor{red}{\text{D/M/S}}, enter minutes, \textcolor{red}{\text{D/M/S}} and then enter seconds.

To enter N42\degree 15'14.7'' W, do this: \textcolor{red}{\text{QUADRANT}} \textcolor{red}{4} \textcolor{red}{4} \textcolor{red}{2} \textcolor{red}{D/M/S} \textcolor{red}{1} \textcolor{red}{5} \textcolor{red}{D/M/S} \textcolor{red}{1} \textcolor{red}{4} \textcolor{red}{1} \textcolor{red}{7}

and see \textcolor{red}{\text{4 42 15 14.7}}

NOTE: If you make an error in numerical entry and use the \textcolor{red}{\text{CLEAR ENTRY}} key, you must start over, re-entering the quadrant code and the angle.
ENTERING STARTING COORDINATES:

The first step in traversing is to tell the 354 the values of the starting coordinates. To identify your starting north coordinate, simply enter it and touch \( \text{STN} \) and \( \text{NORTH} \), which stores the coordinate value in the north coordinate memory. Enter the starting east coordinate and touch \( \text{STE} \) and \( \text{EAST} \).

DISPLAYING COORDINATES

If at any time, you want to know the coordinates of the point you are on, touch \( \text{NORTH} \) and read the north coordinate, then touch \( \text{EAST} \) and read the east coordinate. As you are traversing, note that at the end of the entry of each course you may touch \( \text{NORTH} \) and \( \text{EAST} \) to read the coordinates for the end point of that course.
SECOND FUNCTION

Many of the function keys on the Surveyor calculate two quantities when pressed (e.g., COS and SIN are on the same key). These keys always display one of the quantities, while the second is stored in the "Second Function" register. Pressing \[ \text{FNC} \] causes exchange of the display with the Second Function register, so you can bring out the second function to work with.

NOTE: That this is an exchange—pressing \[ \text{FNC} \] again will get the numbers back to their original places. The number in the Second Function register is not otherwise changed, until you do another two-function operation.
BEARING-DISTANCE TRAVERSING

The \texttt{DAN\E} and \texttt{FOR\-\WARD} keys are used to perform Bearing-Distance Traversing. As the legends indicate, they take a direction and a length, and convert it to a latitude and departure. They also compute and store the coordinates of the point at the end of the course.

The sequence to follow in calculating a course, given its bearing and distance is:

Enter the Bearing Angle (Direction)
Press \texttt{DAN\E}

Enter the Distance (length)
Press \texttt{FOR\-\WARD}

See: Latitude of Course
Press \texttt{2ND\ Func}

See: Departure of Course
Press: \texttt{NORTH} see North coordinate at end of course.
Press: \texttt{EAST} see East coordinate at end of course.
Bearing-Distance Traverse Example

Entering Starting Coordinates

3 0 0 3 2 0
STN NORTH
STN EAST

300.000
320.000
Enter Data for Course 0-1
Enter Data for Course 1-2

The bearing and distances for course 1-2 is $N7^\circ 7'E$, 163 feet.
Now proceed to course 2-3.

The Bearing and Distance is N66°47'E, 154 feet.
FIELD ANGLES

The 354 is capable of handling entry of Field Angles. For the time being, we'll be using only horizontal angles, although vertical angles may also be used.

NOTE: The **FIELD ANGLE** key. It is above the **QUADRANT** key, and works very much like the **QUADRANT** key. The difference is that the numerical code you enter describes a particular kind of Field Angle, rather than a Quadrant.

The four horizontal Field Angles and their numerical codes are:

- **Right deflection angle**—Code 1
- **Angles turned to the left (counter clockwise)**—Code 2
- **Angles turned to the right (clockwise)** — Code 3
- **Left deflection angle** — Code 4
Field Angles

Suppose you traverse from Point 1 to Point 2. You then Back-Sight to Point 1 and turn an angle to the left of 137°45'. The key sequence for Entry of the angle is:

```
FIELD ANGLE 2
1 3 7 D/M/S 4 5
```

See *

If you set-up on Point 1 and deflect your transit to the left 56°38', the key sequence is:

```
FIELD ANGLE 4
5 6 D/M/S 3 8
```

See *

*NOTE: The Field Angle numerical code appears in the left side of the display. The same basic key sequence holds true for the two other horizontal Field Angles.
Enter the starting codes:

```
1 0 0 0 0 ST_n NORTH
1 0 0 0 0 ST_n EAST
```
Traversing with Field Angles

NOTE: When traversing using Field Angles, all directions are based upon the previous course. For that reason, the initial course MUST be either a Bearing or an Azimuth.

Course 1 should be entered as follows:

```plaintext

QUADRANT 1
5 1 D/M/S 3 5 D/I/E
1 9 6 FORWARD

2ND FUNC
NORTH
EAST

latitude
departure
North coordinate
East coordinate
```
Traversing with Field Angles

The direction of Course 1-2 is measured as a clockwise angle 66°08' turned from a back-sight to point 0. The distance is 152 feet. The key sequence for calculation and description of this course is:

*NOTE: The 354 calculates and displays the resultant bearing of the course when  button is pressed.
Traversing with Field Angles

Course 2-3 also involves a back sight, with an angle of $41^\circ52'$, turned to the left, for a distance of 118 feet.
The Field Angle at Point 3 is a Right Deflection Angle of $19^\circ 33'$, with a distance of 135 feet.
Traversing with Field Angles

The final course in this open traverse is defined by a back-sight with an angle-left 107°26', for a distance of 204 feet.

A QUICK REVIEW

Entering FIELD ANGLES is almost identical to entering Bearings. The only difference is that you use the key instead of the key, and the numerical code you enter indicates a type of FIELD ANGLE, rather than a Quadrant Code.

Traversing with FIELD ANGLES is similar to traversing with Bearings. The only difference here is that after entering the FIELD ANGLE and touching , the resultant Bearing is calculated and displayed. The key sequences are the same.
The **FIELD ANGLE** key is also used to enter elevation angles, for both transits and theodolites.

**FIELD ANGLE—Code 7**

- Zenith
- 90 or 270
- 180 or 270
- Vertical Angle

**FIELD ANGLE—Code 8**

- Zenith
- 0 or 180
- 270 or 90
- Zenith Angle
Elevation Angles

A simple example is a course N29°56'W, for a distance of 345 feet, with a vertical angle of 3°36' above the horizontal.

Since no starting coordinates were entered, pressing and will result in the display of completely meaningless values.

The key sequence for course calculation when using vertical angles is:

- Identify course direction, 
- Enter Course length, 
- Enter Elevation Angle,
POINT TO POINT INVERSING

If you know the NORTH and EAST coordinate value of Points 1 and 2, and you want to find the Bearing or Azimuth from 1 to 2 and the distance between them, follow this key sequence:

1. Enter North coordinate of Point 1
2. Enter East coordinate of Point 1
3. Enter North coordinate of Point 2
4. Enter East coordinate of Point 2
Point to Point Inversing

Example

775N 930E

1100N 1450E

1

2

1100

450

E

N

100

50

ST R

ST R

NORTH

EAST

930

775

N_1

E_1

N_2

bearing

azimuth

distance
INVERSING WHILE TRAVERSING

If you want to inverse while traversing, i.e., to a control survey marker or to force closure, enter the North coordinate of the next point, press \( \text{INV} \), then enter the East coordinate and press \( \text{INV} \). The direction is displayed, either as an Azimuth or bearing, depending on the setting of the BEARING/AZIMUTH switch. Touch \( \text{2ND FNC} \) to display the length of the course. If you touch \( \text{NORTH} \), you see the North coordinate of the new point. Touching \( \text{EAST} \) displays its East coordinate.
To do side-shots from a point in the traverse use the $\text{N} \rightarrow \text{E}$ and $\text{E} \rightarrow \text{N}$ keys with $\rightarrow$ instead of $\text{INVERSE}$ or $\text{FORWARD}$. This way North and East coordinates are not updated.

You can do any number of side-shots from a point. The side-shot can be described either with the direction and length of the leg, the field angle from the previous leg with a length, or by the coordinates of the end of the side-shot. When the length is used, it can be the horizontal length or slope length and elevation angle.
Example

Enter and store starting coordinates:

1 0 0 0 0

STn EAST

1 0 0 0 0

STn NORTH

10,000,000

10,000,000
Calculate Course 0-1

- Quadrant: 1
- Speed (0/M/S): 5
- Forward: 2 0 5

Output:
- Bearing:
- Latitude:
- Departure:
- North coordinate:
- East coordinate:
A side-shot is taken from Point 1, using a backsight with an angle to the right of 60°23', for a distance of 148 feet.

NOTE: That touching \textbf{NORTH} and \textbf{EAST}, displays the coordinate of Point 1. Touching $\mathbf{=}$ rather than $\mathbf{\text{FORWARD}}$ signals the 354 not to update the coordinate memories.
A second side-shot from Point 1 has a Bearing Angle of N17°09'W and a distance of 186 feet.
The final side-shot is an inverse. To do this side-shot, the latitude and departure must be calculated and entered.
To continue the traverse to Point 2, an angle to the right of 294°47' was measured, with a distance of 126 feet.
The 354 has a key, $\Delta$, for entering circular curves into a traverse.

The procedure is:

- Traverse to the center of the curve. (Point B). For tangent curves, this is a $90^\circ$ deflection angle from the previous course.
- Input the central angle ($\Delta$) and press $\Delta$

The first thing displayed is the bearing of course B-C. Pressing $\text{2nd Func}$ displays the length of B-C. Pressing the NORTH and EAST keys will display the coordinates of Point C.
Curves in Traverse

For Example:
Curves in Traverse
Now, traverse to the center of the curve (point 2)
Now enter the central angle:
Follow a rule of thumb to determine whether the central angle is positive or negative. As you move along the arc from the present point (P.C.) to the next point on the traverse (P.T.), if the direction is clockwise, the central angle is positive. If the direction is counter-clockwise, the central angle is negative.

Excluded Areas

**POSITIVE ANGLE**

**NEGATIVE ANGLE**
Curves in Traverse

Included Areas.

POSITIVE ANGLE

NEGATIVE ANGLE
EXAMPLE

The purpose of this example is to calculate a traverse using as many of the keys as possible. It is not meant to be representative of a typical field problem.

The Surveyor has the capability to calculate both the Perimeter and the Area. This is done in two separate memories. If you are interested in knowing Perimeter and/or Area, you must first make sure these memories have no numbers in them.

To clear them:

Enter starting coordinates:

Set BEARING/AZIMUTH switch to BEARING

BRG

AZ

PERIM

AREA
<table>
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<tr>
<th>Course</th>
<th>Field Angle</th>
<th>Bearing</th>
<th>Slope Distance</th>
<th>Vertical Angle</th>
<th>Horizontal Component</th>
<th>Δ Elevation</th>
<th>Latitude</th>
<th>Departure</th>
<th>North</th>
<th>East</th>
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<tr>
<td>0-1</td>
<td>N 7 07 00 E</td>
<td>263,000</td>
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<td>1-2</td>
<td>Right 249°40'</td>
<td>253,000</td>
<td>-8°44</td>
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<td>2-2A</td>
<td>N 71 19 00 W</td>
<td>148,000</td>
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<tr>
<td>2-2B</td>
<td>L.D. 41°26'</td>
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<td>Left 79°09'</td>
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<td>156,000</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-0</td>
<td>N 68 03 00 W</td>
<td>262,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Computer Design Corporation  General offices: 12401 West Olympic Boulevard, Los Angeles, California 90064.
Traverse Example

<table>
<thead>
<tr>
<th>Course</th>
<th>Field Angle</th>
<th>Bearing</th>
<th>Slope Distance</th>
<th>Vertical Angle</th>
<th>Horizontal Component</th>
<th>ΔElevation</th>
<th>Latitude</th>
<th>Departure</th>
<th>North</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td></td>
<td>N 7 07 00 - E</td>
<td>263,000</td>
<td>0°15</td>
<td></td>
<td></td>
<td></td>
<td>5000 000</td>
<td>5000 000</td>
<td></td>
</tr>
</tbody>
</table>

Describe course 0-1:

QUADRANT 1
7 D/M/S 7 D N E
2 6 3
FIELD ANGLE 7 8 D/M/S 1 5
FORWARD
2ND FUNC
NORTH
EAST

bearing
distance
vertical angle
latitude
departure
North coordinate
East coordinate
### Traverse Example

<table>
<thead>
<tr>
<th>Course</th>
<th>Field Angle</th>
<th>Bearing</th>
<th>Slope Distance</th>
<th>Vertical Angle</th>
<th>Horizontal Component</th>
<th>Δ Elevation</th>
<th>Latitude</th>
<th>Departure</th>
<th>North</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-1</td>
<td></td>
<td>N - 7° 07' 00&quot; - E</td>
<td>263,000</td>
<td>8°15</td>
<td></td>
<td></td>
<td></td>
<td>5000 00</td>
<td>5000 00</td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>Right 249°40'</td>
<td>-</td>
<td>253,800</td>
<td>-8°44</td>
<td></td>
<td></td>
<td></td>
<td>5000 00</td>
<td>5000 00</td>
<td></td>
</tr>
</tbody>
</table>

Course 1-2 has a back-sight with an angle right of 249°40', for a distance of 253.8 feet with a vertical angle of 8°44' below horizontal.
Now calculate the horizontal component and change in elevation of courses 1 and 2:

Horizontal component = slope distance x cosine vertical angle
Change in elevation = slope distance x sine vertical angle
The second side-shot from Point 2 is a left-deflection angle of 41°26', for a distance of 96 feet. To Calculate:

<table>
<thead>
<tr>
<th>FIELD ANGLE</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>O/M/S</td>
<td>2 6</td>
</tr>
<tr>
<td>D/E</td>
<td>1 4</td>
</tr>
<tr>
<td>NORTH</td>
<td>9 6</td>
</tr>
<tr>
<td>2ND FUNC</td>
<td>+</td>
</tr>
<tr>
<td>EAST</td>
<td>+</td>
</tr>
</tbody>
</table>

resultant bearing
latitude
North coordinate
departure
East coordinate
A side shot from Point 3, is taken, with an angle to the left of 79°09', for a distance of 204 feet:
The next calculation encountered is a circular curve. We first traverse to the center:

<table>
<thead>
<tr>
<th>Course</th>
<th>Field Angle</th>
<th>Bearing</th>
<th>Slope Distance</th>
<th>Vertical Angle</th>
<th>Horizontal Component</th>
<th>Δ Elevation</th>
<th>Latitude</th>
<th>Departure</th>
<th>North</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>N- 7 07 00 - E</td>
<td>263,000</td>
<td>8°15</td>
<td></td>
<td></td>
<td>258,273</td>
<td>32,245</td>
<td>5259,273</td>
<td>5083,245</td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>Right 249°46'</td>
<td>N- 76 47 00.0 - E</td>
<td>253,000</td>
<td>-8°44</td>
<td></td>
<td>57,354</td>
<td>244,212</td>
<td>5215,627</td>
<td>5276,458</td>
<td></td>
</tr>
<tr>
<td>2-2A</td>
<td>N- 71 19 00 - W</td>
<td>148,000</td>
<td></td>
<td></td>
<td></td>
<td>47,409</td>
<td>-140,200</td>
<td>5383,037</td>
<td>5136,257</td>
<td></td>
</tr>
<tr>
<td>2-2B</td>
<td>L.D. 41°28'</td>
<td>N- 35 21 00 - E</td>
<td>96,000</td>
<td></td>
<td></td>
<td>76,300</td>
<td>55,542</td>
<td>5393,928</td>
<td>5332,001</td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td>S- 34 45 08.2 - E</td>
<td>214,973</td>
<td></td>
<td></td>
<td></td>
<td>5139,000</td>
<td></td>
<td>5212,400</td>
<td>5399,000</td>
<td></td>
</tr>
<tr>
<td>3-3A</td>
<td>Left 73°09'</td>
<td>S- 66 05 51.8 - W</td>
<td>204,000</td>
<td></td>
<td></td>
<td>5056,343</td>
<td></td>
<td>5212,405</td>
<td>5399,000</td>
<td></td>
</tr>
<tr>
<td>3-4</td>
<td>RO 90°</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>5270,826</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-5</td>
<td>Δ127°56'</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

right deflection angle
resultant bearing
latitude
departure
North coordinate of point 4
East coordinate of point 4
Now, enter the central angle. (Positive in this case)
Traverse Example

<table>
<thead>
<tr>
<th>Course</th>
<th>Field Angle</th>
<th>Bearing</th>
<th>Slope Distance</th>
<th>Vertical Angle</th>
<th>Horizontal Component</th>
<th>Δ Elevation</th>
<th>Latitude</th>
<th>Departure</th>
<th>North</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td></td>
<td>N - 7 07 00 - E</td>
<td>263,000</td>
<td>8°15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5000,000</td>
</tr>
<tr>
<td>1-2</td>
<td>Right 249°40'</td>
<td></td>
<td>253,000</td>
<td>-8°44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-2A</td>
<td></td>
<td>N - 71 18 00 - W</td>
<td>148,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-2B</td>
<td>L.D. 41°28'</td>
<td></td>
<td>96,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5139,000</td>
</tr>
<tr>
<td>3-3A</td>
<td>Left 79°08'</td>
<td></td>
<td>204,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-4</td>
<td>RD 90°</td>
<td></td>
<td>156,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-5</td>
<td>Δ127°56'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-0</td>
<td>N - 68 03 00 - W</td>
<td>282,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The final course has a Bearing of N68°03’W and a distance of 282 feet.
The final worksheet looks like this:

<table>
<thead>
<tr>
<th>Course</th>
<th>Field Angle</th>
<th>Bearing</th>
<th>Slope Distance</th>
<th>Vertical Angle</th>
<th>Horizontal Component</th>
<th>Δ Elevation</th>
<th>Latitude</th>
<th>Departure</th>
<th>North</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° 1'</td>
<td>N 7 07 00 E</td>
<td>263,000</td>
<td>8°15</td>
<td>260,278</td>
<td>37,738</td>
<td>258,273</td>
<td>32,245</td>
<td>5258,273</td>
<td>5032,245</td>
<td></td>
</tr>
<tr>
<td>1° 2'</td>
<td>Right 249°40'</td>
<td>253,000</td>
<td>-8°44</td>
<td>250,857</td>
<td>-38,535</td>
<td>57,354</td>
<td>244,212</td>
<td>5315,027</td>
<td>5278,458</td>
<td></td>
</tr>
<tr>
<td>2° 1'</td>
<td>S 1° 16 09 W</td>
<td>148,000</td>
<td></td>
<td></td>
<td></td>
<td>41,499</td>
<td>-140,200</td>
<td>5363,837</td>
<td>5136,257</td>
<td></td>
</tr>
<tr>
<td>2° 1'</td>
<td>E 1° 16 09 W</td>
<td>98,000</td>
<td></td>
<td></td>
<td></td>
<td>78,390</td>
<td>55,547</td>
<td>5383,828</td>
<td>5332,081</td>
<td></td>
</tr>
<tr>
<td>2° 1'</td>
<td>S 2° 24 16 W</td>
<td>5138,000</td>
<td></td>
<td></td>
<td></td>
<td>5138,000</td>
<td></td>
<td>5399,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3° 1'</td>
<td>Left 79°08'</td>
<td>S 86 05 51.0 N</td>
<td>204,000</td>
<td></td>
<td></td>
<td>-82,656</td>
<td>-188,504</td>
<td>5056,343</td>
<td>5212,495</td>
<td></td>
</tr>
<tr>
<td>3° 1'</td>
<td>Right 90°00'</td>
<td>S 55 14 51.0 N</td>
<td>156,000</td>
<td></td>
<td></td>
<td>-88,824</td>
<td>-128,173</td>
<td>5050,075</td>
<td>5278,826</td>
<td></td>
</tr>
<tr>
<td>4° 1'</td>
<td>Δ127°55'</td>
<td>S 1° 10 51.0 N</td>
<td>156,000</td>
<td></td>
<td></td>
<td>4894,315</td>
<td>5262,169</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5° 0'</td>
<td>N 68 03 00 W</td>
<td>282,000</td>
<td></td>
<td></td>
<td></td>
<td>105,410</td>
<td>-261,357</td>
<td>4999,126</td>
<td>5000,611</td>
<td></td>
</tr>
</tbody>
</table>

Traverse Example
The traverse does not close. To check how far off it is, force the closure by inverting.

To calculate the precision of the traverse

Press
To display
the area,
Intersections

INTERSECTIONS

The Surveyor automatically calculates four kinds of intersections:

I  Length and direction known
II  Two directions known
III Two lengths known
IV  Angle between the two legs and length of one leg known

When calculating an intersection, the base leg (A-C in the figure) must be defined. This is done on the Surveyor by traversing, using the FORWARD or INVERSE keys, from A to C. Since the trailing leg of a circular curve input during a traverse is retained as the last leg, it may also be defined as the base leg for intersections.

In all the intersection calculations, there are two knowns. One of them is keyed into the Surveyor, then INTERSECT is pressed. The second known is then entered, and = is pressed. The Surveyor calculates two unknowns, displays one and puts the other in Second Function. Since the knowns are keyed in as decimal numbers (lengths), directions, or field angles, the Surveyor can tell which kind of intersection to perform.

Some of the intersections have two solutions. The second solution is calculated by pressing = a second time. You can go back and forth between the two solutions by repeatedly pressing =. If any key except 2ND FUNC is pressed between two = 's, then the second solution will not be calculated.
If you ask the Surveyor to do an impossible intersection, it will signal by displaying \[=,:::::::===J\].
Be careful when doing the intersection that you are thinking of the directions of the three legs involved in the right way:

- The direction of the base leg, AC, is always from A to C.
- The direction of the intersection leg starting from A is always from A to the intersection point.
- The direction of the intersection leg ending at C is always from the intersection point to C.

Examples of the four intersections are given. For all of them the base leg A-C is defined as follows:

Coordinates of A: 0.000N, 0.000E
Coordinates of C: 50.000N, 100.000E
TYPE 1. DIRECTION AND LENGTH KNOWN

- Traverse the base leg.
- Enter the known direction. This must be an angle, but not a field angle.
- Press \text{INTERSECT}.
- Enter the known length.
- Press \text{=}

The unknown direction is displayed; the unknown length is in Second Function. Press \text{=} again for the second solution.

If you prefer, you may put in the known length before \text{INTERSECT}, and the known direction after. The answers still come out in the same order.

Example:

The direction of AB and the length of BC are known:
Leg AC has been traversed (Page 57)

To get the second solution:

The complete solution:
Intersection
Direction and Length Known

Example:

The direction of BC and the length of AB are known:

Leg AC has been traversed (page 57)
To get second solution:

The complete solution:
Intersection
Two Directions Known

TYPE II – TWO DIRECTIONS KNOWN

- Traverse the base leg
- Enter the first known direction — this must be an angle, but not a field angle
  - Press
- Enter the second known direction — again this must be an angle but not a field angle.
  - Press
A special case of two-directions-known intersection is when the direction of one leg and the angle between the two unknown legs are known. To solve this, you must do some arithmetic to calculate the direction of the second leg, and then do a Type II intersection. The sequence is slightly different, depending on whether the direction of the first or second side is known.

Direction of the first side and relative angle known
- Traverse the base leg
- Enter the direction of the first side
- Press $\text{INTER} \rightarrow \text{[} \text{[} \text{[}$
- Enter the relative angle as a field angle
- Press $\text{[}$

The direction of the second side is displayed
- Press $\text{[}$

The length of the first side is displayed; the length of the second side is in Second Function.

Direction of second side and relative angle known
- Traverse the base leg
- Enter the direction of the second side
- Press $\text{INTER} \rightarrow \text{[} \text{[} \text{[}$

The direction of the first side is displayed
- Enter the relative angle as a field angle
- Press $\text{[}$

The length of the second is displayed. The length of the first side is in Second Function.
Intersection
Two Directions Known

Example: Type IIa

Leg AC has been traversed (page 57)

```
3 1 D/M/S 3 8
INTER-SECT ( +
FIELD ANGLE 2 8 5 D/M/S 2

31 38 00
type of AB
31 38 00
relative angle
2 85 02 00
direction of BC
2 53 24 00
```

A

B

C

0.000N
50.000N
0.000E
100.000E

85°02'
The solution:
Intersection
Two Directions Known

Example: Type II b

Leg AC has been traversed (page 57)

<table>
<thead>
<tr>
<th>9</th>
<th>1</th>
<th>D/M/S</th>
<th>1</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTER-SECT</td>
<td>(</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIELD ANGLE</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>D/M/S</td>
</tr>
</tbody>
</table>

- direction of BC
- relative angle
- direction of AB
The solution:
Intersection
Two Directions Known

If the directions are input in reverse order, the lengths will be calculated in reverse order.

The complete solution is

Direction of BC
145° 00' 00"

Direction of AB
56° 00' 00"

Length of BC
85.302

Length of AB
114.538

Intersection:

3.000N
0.000E

92° 00' 00"

55.902

0.000N
0.000E

50.000N
100.000E
The unknown length of the first direction is displayed. The unknown length of the second direction is in Second Function.

Example:

Leg AC has been traversed (page 57)

(direction of AB) 92 00 00
(direction of BC) 345 00 00
(length of AB) 114.533
(length of BC) 55.905
TYPE III – TWO LENGTHS KNOWN

- Traverse the base leg
- Enter the length of the first leg
- Press \texttt{INTERSECT}
- Enter the length of the second leg
- Press \texttt{=}

The direction of the first leg is displayed, the direction of the second leg is in Second Function. Press \texttt{=} to get the second solution.
Example:

Leg AC has been traversed (page 57)
Intersection
Two Lengths Known

To get the second solution

The complete solution is:

The lengths may be input in reverse order. The directions will be calculated in reverse order.
TYPE IV RELATIVE ANGLE AND LENGTH OF ONE LEG KNOWN

There are two variations:

Length of the first leg and relative angle known
- Traverse the base leg
- Enter the length of the first leg
- Press $\text{INTER-SECT}$
- Enter the relative angle as a field angle.
- Press $\text{ }$

The direction of the first leg is displayed. The length of the second leg is in Second Function. Press $\text{ }$ again for the second solution. If the length calculated is negative, the solution is invalid.

Length of second leg and relative angle known
- Traverse the base leg
- Enter the relative angle as a field angle
- Press $\text{INTER-SECT}$
- Enter the length of the second leg
- Press $\text{ }$

The direction of the first leg is displayed. The length of the first leg is in Second Function. Press $\text{ }$ again for the second solution. If the length calculated is negative, the solution is invalid.
Example: Type IV a

Leg AC has been traversed (page 57)

<table>
<thead>
<tr>
<th>INTERSECT</th>
<th>1 0 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIELD ANGLE</td>
<td>1 9 0</td>
</tr>
</tbody>
</table>

- Length of AB: 106.000
- Relative angle: 190.0000
- Direction of AB: 44 53 35.9
- Length of BC: 35.552
- Direction of AB': 81 58 35.7
- Negative length: solution invalid
The direction of BC can be calculated by going back to the first solution and adding a 90° right deflection to the direction of Leg AB:

To get the first solution back

The complete solution is:
Intersection
Relative Angle and Length of One Leg Known

Example: Type IV b

Leg AC has been traversed (page 57)
Intersection

Relative Angle and Length of One Leg Known

To get the second solution

\[ E \]

There are two valid solutions. Choose one and add the relative angle to the direction of AB to get the direction of BC.

The first solution is wanted:

\[ \text{direction of AB'} \]
\[ \text{length of AB'} \]

The complete solution is:

\[ \text{direction of AB} \]
\[ \text{direction of BC} \]
**ARITHMETIC**

Arithmetic is algebraic — that means you press keys like you write equations.

**Try 2 x 3**

```
2 \times 3 =
```

Add, subtract, multiply, divide and exponentiation work the same way:

**Try some more**

```
2 \div 3 =
```

```
2^3 =
```

```
\sqrt[3]{2} =
```

You can chain operations

```
2 \times 3 - 4 =
```

```
\frac{2 \times 3 - 4}{5} =
```

The examples above are all decimal numbers.
Try some angles:

\[ 2^\circ 15' + 18^\circ 49' = 21^\circ 04' \]

\[ 41^\circ 38'58'' \times 3 = 123^\circ 16'24'' \]

Notice that numbers and angles may be mixed. The rule is: If anything in the algebraic string is an angle, the answer is an angle. The exception to the rule is: Dividing an angle by an angle results in a decimal number.

**Parentheses**

The two parentheses keys are called "open" and "close." They are used to include bracketed operations in algebraic strings.

Example:

\[ \frac{2 \times 3}{(5 + 6)} = \]

\[ \frac{2 \times 3}{(5 + 6)} = \]

\[ \frac{2 \times 3}{(5 + 6)} = \]
Arithmetic
Parentheses

The "bracketed operation" inside the parentheses can include any operation on the keyboard except \text{reset}. In effect, the algebra before the open is suspended, and doesn't continue until close is used.

Several rules about parentheses:
• You can nest the parentheses 2 deep—attempting more causes \text{error}.
• You don't need to press \text{eq} inside the parentheses, although it doesn't hurt. Note that in the above example, there is no \text{eq} after the 6.
• A close not preceded by a corresponding open causes \text{error}.

• Constant Operation
When you press \text{add}, \text{subtract}, \text{multiply}, \text{divide}, \text{a^x} the display and the operation are automatically remembered. Enter another number and press \text{eq} to complete the operation.

You can now simply enter a new number, press \text{eq} again, and the calculation will be completed using the number and operation originally remembered.

Example:
\begin{align*}
2 \times 3 &= \boxed{6} \\
2 \times 4 &= \boxed{8}
\end{align*}
AVERRAGING ANGLES

If you want to average a number of readings, you must use chain algebra to calculate the sum and divide by the number of readings. This way, the sum of the angles won't be reduced to between 0° and 360° (even though it is displayed that way during the chain) before the divide occurs.

As an example, average the following four readings.

\[
\begin{align*}
\text{91°45'} & \quad 9 \quad 1 \quad D/M/S \quad 4 \quad 5 \quad + \quad 91°47' \\
\text{91°47'} & \quad 9 \quad 1 \quad D/M/S \quad 4 \quad 7 \quad + \\
\text{91°46'} & \quad 9 \quad 1 \quad D/M/S \quad 4 \quad 6 \quad + \\
\text{91°45'} & \quad 9 \quad 1 \quad D/M/S \quad 4 \quad 5 \quad : 4 \quad =
\end{align*}
\]
MATH FUNCTIONS

As you might expect, this gives you the square root of the number in the display.

```
2 \sqrt{1}
```

The square root of a negative number causes error (displays \( E---- \)). And if for some reason you take the square root of an angle, you will get a decimal number, not an angle.

```
\frac{1}{x}
```

This obviously gives you the reciprocal of the number in the display.

```
3 \frac{1}{x}
```

If you try to take the reciprocal of zero, you'll get \( E---- \). And the reciprocal of an angle gives you a number, not an angle.
This key considers the display to be degrees, and converts it to the equivalent angle in radians. The display can be either an angle or a number, and the radians calculated are a decimal number.

To convert radians into degrees, do the following sequence:

\[
\frac{1}{\pi} \rightarrow R \frac{1}{\pi}
\]

The result is decimal. Remember that whenever you want to convert a decimal to an angle, press

\[
+ \quad D/M/S \quad =
\]

Example: Convert 180 degrees to radians

\[
180 \quad D/M/S \quad \rightarrow R
\]

Go back to degrees

\[
\frac{1}{\pi} \rightarrow R \frac{1}{\pi}
\]

Display it as an angle

\[
+ \quad D/M/S \quad =
\]
Math Functions

This gives you cosine and sine of the angle in display. The angle can be positive or negative, of any size, and can be either in decimal or angle form. The cosine is displayed; the sine is stored in the Second Function register and can be displayed by pressing \[\text{2nd Func}\].

This gives you the arccosine and arcsine of the number in the display. Arccosine is limited to the range 0 to 180°; arcsine to the range -90° to +90°. If you try to find the arccosine/arcsine of a number outside the range -1 to +1, you get \[\text{ERR}\].

ARITHMETIC & FUNCTIONS COMBINED

You can combine arithmetic with math functions. Simple conversion from slope length and vertical angle to horizontal length and elevation difference uses this.

Example:

<table>
<thead>
<tr>
<th>Slope length: 58.86 feet</th>
<th>Vertical angle: 8º 56'</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (\times) 8 (\times) 8 6 (=)</td>
<td>8 (\div) M/S 5 6 (\cos) (\sin) (=)</td>
</tr>
</tbody>
</table>

Notice that the constant multiply feature was used to compute the elevation difference.
**TRIG FUNCTIONS**

You can do all the normal circular trig functions on the Surveyor.

Here is a reference table of the forward functions.

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>DISPLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>COS θ</td>
<td>[COS θ]</td>
</tr>
<tr>
<td>SIN θ</td>
<td>[SIN θ]</td>
</tr>
<tr>
<td>TAN θ</td>
<td>[TAN θ]</td>
</tr>
<tr>
<td>SEC θ</td>
<td>[SEC θ]</td>
</tr>
<tr>
<td>CSC θ</td>
<td>[CSC θ]</td>
</tr>
<tr>
<td>COT θ</td>
<td>[COT θ]</td>
</tr>
</tbody>
</table>

Here are the inverse trig functions:

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>DISPLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>COS⁻¹ x</td>
<td>[COS⁻¹ x]</td>
</tr>
<tr>
<td>SIN⁻¹ x</td>
<td>[SIN⁻¹ x]</td>
</tr>
<tr>
<td>TAN⁻¹ x</td>
<td>[TAN⁻¹ x]</td>
</tr>
<tr>
<td>SEC⁻¹ x</td>
<td>[SEC⁻¹ x]</td>
</tr>
<tr>
<td>CSC⁻¹ x</td>
<td>[CSC⁻¹ x]</td>
</tr>
<tr>
<td>COT⁻¹ x</td>
<td>[COT⁻¹ x]</td>
</tr>
</tbody>
</table>
Storage Registers

STORAGE REGISTERS

The Surveyor has ten registers for storing data. The registers are named 0 through 9. The data in a register can be changed only through use of the \( \text{ST}_n \) key. When the Surveyor is turned off, all data is lost.

To store the displayed number or angle in a register, press \( \text{ST}_n \) followed by a digit to name the register. The previous contents of that register are lost.

To recall from a register, press \( \text{RCL}_n \) followed by a digit to name the register. The contents of the register are not disturbed.

Storing during a calculation sequence won’t disturb the sequence. Similarly, a register may be recalled for use during a calculation sequence.

Example:

\[
\begin{array}{c}
2 \ 3 \ \text{ST}_6 \ \ 6 \\
2 \ \times \ \text{RCL}_6 \ \ 6 \ = \\
2 \ \times \ \text{RCL}_6 \ \ 6 \ + \ \text{ST}_7 \\
-5 \ = \\
\end{array}
\]

\[
\begin{array}{c}
\begin{array}{c}
23 \ \text{stored} \\
in \text{register 6}
\end{array} \\
\begin{array}{c}
46 \ \text{stored} \\
in \text{register 7}
\end{array} \\
\text{sequence completed}
\end{array}
\]
Register Arithmetic

You can do arithmetic directly into and out of the registers. The sequences are given below. The letter $n$ means any digit key, 0-9, to name a register.

- $\text{ST}_n + n$ adds the display to register $n$
- $\text{ST}_n - n$ subtracts the display from register $n$
- $\text{ST}_n \times n$ multiplies the display into register $n$
- $\text{ST}_n \div n$ divides the display into register $n$

For all the store-arithmetic operations, the display is not changed, and the register contains the result of the arithmetic.

- $\text{RCL}_n + n$ adds register $n$ to the display
- $\text{RCL}_n - n$ subtracts register $n$ from the display
- $\text{RCL}_n \times n$ multiplies register $n$ into the display
- $\text{RCL}_n \div n$ divides register $n$ into the display

For all the recall-arithmetic operations, the register is not changed, and the display shows the result of the arithmetic.

As with direct register storing and recalling, register arithmetic can be done during calculation sequences.
RECTANGULAR ➔ POLAR

The \( \vec{N} \) and the \( \vec{E} \) keys perform another function, along with the traversing operations. They convert polar coordinates to rectangular coordinates and vice-versa.

If you know the latitude and departure of a leg, and want to convert it to its corresponding direction and horizontal length:
- Enter the latitude (positive North, negative South)
- Press \( \vec{N} \)
- Enter the departure (positive East, negative West)
- Press \( = \)

The direction of the leg is displayed, and the horizontal length is put in the Second Function register.

If you know the direction and horizontal length of a leg, and want to convert it to its corresponding latitude and departure:
- Enter the direction
- Press \( \vec{D} \)
- Enter the horizontal length
- Press \( = \)

The latitude of the leg is displayed (again positive North, negative South), and the departure (positive East, negative West) is put in the Second Function register.
Try an example: Direction – N56°37'W, length 275 feet.

Another example: Latitude = -300, Departure = 400
PROGRAMMING

The Surveyor can be programmed to remember sequences of keystrokes. Programming is a valuable time saver. It lets you work through a calculation once and then have it ready to automatically work for you as often as it is needed.

The Surveyor has two separate program memories. Each memory holds up to 80 keystrokes. Programs remain in the memories as long as the Surveyor is turned on.

Here are a few basic rules to keep in mind when using the programming feature of the Micro Surveyor:

- There is room in each of the two memories for 80 program steps. If you go past 80 steps, you are back at step 01 and your original program steps are erased by the new steps.
- Programming is essentially working a particular calculation sequence when the Surveyor is in LOAD.
- Once loaded the Surveyor works through the sequence automatically when it is needed.
- If you make a mistake while loading a program, switch from LOAD to RUN and back to LOAD. Start loading the program again at Step 01.
- Use the Start/Stop button at the points in the program where you want the program to stop for a variable to be entered or a calculation to be displayed.
- Once the program is loaded, switch to RUN to run the program.
- The Start/Stop button starts the program running until the first programmed stop is encountered.
- The two 80 step memories are separate. The program switch controls which of these 2 memories is being used. The program switch cannot be used as a program step. You can only switch from one memory to the other when the RUN/LOAD switch is in the RUN position.
If you use  or  when a program is running, the program stops, the display is cleared.  starts the program again from Step 01.

With these basic rules in mind here is the step by step procedure for writing a simple program.

The area of a circle is given by:

\[ A = \pi r^2 \quad (\pi = 3.14159) \]

With programming, calculating the area once, let's you automatically find the area for a circle of any radius.

To write a program to calculate the area of a circle, put the program memory switch in the "1" position , . Place the RUN/LOAD switch in the LOAD position .

The display looks like this:

The two digit number at the far right of the display tells you the step number to be loaded next. Every time you press a key this number increases by one. Step 01 follows step 80.
**Programming**

To load the program to calculate the area of a circle.

<table>
<thead>
<tr>
<th>Do This</th>
<th>Remarks</th>
<th>See This</th>
</tr>
</thead>
<tbody>
<tr>
<td>START STOP</td>
<td>Stop the program to enter the variable (r).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This stop also displays the calculated Area.</td>
<td></td>
</tr>
<tr>
<td>x</td>
<td>Calculates ( r^2 )</td>
<td></td>
</tr>
<tr>
<td>÷</td>
<td>Calculates ( A )</td>
<td></td>
</tr>
</tbody>
</table>
The program is loaded and ready to run. To run the program:

**Do This**

1. Press **START**
2. Enter **r**
3. Press **START**
4. **A** is displayed

**See This**

To enter a new **r**, go back to 2.
This table shows the calculated areas of circles with several different radii.

<table>
<thead>
<tr>
<th>r</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.141</td>
</tr>
<tr>
<td>2</td>
<td>12.566</td>
</tr>
<tr>
<td>3</td>
<td>28.273</td>
</tr>
<tr>
<td>4.26</td>
<td>57.010</td>
</tr>
</tbody>
</table>

A very practical program can be written that rotates the bearings of a traverse as each leg is entered.

Switching to memory 2 allows us to preserve the circle program in memory 1 and load the new program into memory 2.

Do This | Remarks | See This
---|---------|---
RUN | | |
LOAD | | |
+ | This adds the entered (unrotated) bearing to the angle of rotation that will be stored in register 0. | | |
Calculates and enters the rotated bearing for traversing.

Displays the rotated bearing and stops for the entry of the distance.

Calculates North and East coordinates of the rotated leg.

Displays the North coordinate.

Displays the East coordinate.
With the program loaded, here is how to run it.

**Do This**

1. Calculate and enter the angle of rotation (+ or -)
   
   ![CHG SIGN 4 D/M/S 3 2]

2. Store the angle of rotation into register 0
   
   ![STπ 0]

3. Store the beginning North and East coordinates
   
   ![CLEAR ENTRY STπ NORTH STπ EAST]

4. Enter the unrotated bearing
   
   ![QUADRANT 2 D/M/S 3 0]
<table>
<thead>
<tr>
<th>Do This</th>
<th>Remarks</th>
<th>See This</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. START STOP</td>
<td>The rotated bearing displays.</td>
<td></td>
</tr>
<tr>
<td>6. Enter the distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. START STOP</td>
<td>North coordinate displays</td>
<td></td>
</tr>
<tr>
<td>East coordinate displays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Go back to 4. to continue traversing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Go back to 1. to start a new traverse.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Here is another sample program that reduces stadia measurements to their horizontal and vertical components. The input variables are the stadia distance, the vertical angle (horizontal is zero), and the distance from the midhair stadia reading to the upper (or lower) hair readings.

The equations are:

\[ H = S \cos^2 \alpha \text{ (horizontal distance)} \]
\[ V = S \sin \alpha \cos \alpha - M \text{ (change in elevation)} \]

Where

\[ S = \text{Stadia Distance} \]
\[ \alpha = \text{Vertical Angle} \]
\[ M = \text{Midhair Distance} \]
To load the program:

<table>
<thead>
<tr>
<th>Do This</th>
<th>Remarks</th>
<th>See This</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PROG</td>
<td>This program will replace the circle program in program in memory 1.</td>
<td></td>
</tr>
<tr>
<td>RUN</td>
<td>Recalls $\alpha$ which will be pre-stored in register 0</td>
<td></td>
</tr>
<tr>
<td>LOAD</td>
<td>Calculates $\cos \alpha$</td>
<td></td>
</tr>
<tr>
<td>RCL $\pi$</td>
<td>Calculates $\cos^2 \alpha$</td>
<td></td>
</tr>
<tr>
<td>Do This</td>
<td>Remarks</td>
<td>See This</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| RCL x  | Calculates $S \cos^2 \alpha$  
(S is pre-stored in register 1) |  |
| x  | Displays H |  |
| 1 | Calculates $\cos \alpha$ |  |
| START STOP | Calculates $\sin \alpha \cos \alpha$ |  |
Calculates $S \sin \alpha \cos \alpha$

Subtract $M$ (midhair distance pre-stored in register 2) from $S \sin \alpha \cos \alpha$ in display

Displays $V$ (vertical distance)
Programming

To run the program:

**Do This**

1. Enter α and store in register 0.
   
   ![Image of register 0 with value 9 and D/M/S 7]

   ![Image of STn 0]

2. Enter S and store in register 1.
   
   ![Image of register 1 with value 148]

   ![Image of STn 1]

3. Enter M and store in register 2.
   
   ![Image of register 2 with value 74]

   ![Image of STn 2]

**See This**

![Blank space for register 3]

![Blank space for register 4]

![Blank space for register 5]
With this program you can quickly reduce all your stadia notes. Try the program with the stadia measurements shown below.

<table>
<thead>
<tr>
<th>Stadia Measurements</th>
<th>Calculates H and V</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>( S )</td>
</tr>
<tr>
<td>9°17'</td>
<td>148</td>
</tr>
<tr>
<td>4°13'</td>
<td>82.5</td>
</tr>
<tr>
<td>6°20'</td>
<td>110</td>
</tr>
</tbody>
</table>
PROGRAMMING HINTS, TRICKS AND NOTES

1. When a program is stopped, you can do any keyboard calculations. But if the program is stopped in the middle of a sequence (algebra, register storage, etc.) then many of the keyboard operations will try to complete the sequence. For this reason, using the program steps \( \times \) \( \text{START} \) \( + \) is not good practice, since you must be careful when doing keyboard operations at the STOP.

2. If a program is stopped somewhere other than at the beginning, you can go to the beginning by switching to LOAD and back to RUN.

3. When a program is running (not at a STOP) if you press \( \text{STOP} \) or \( \text{RESET} \) the program will stop and go back to the beginning.

4. If you cause \( \text{GIB} \text{---} \) when programming (by pressing two keys at once, for instance), the \( \text{GIB} \text{---} \) will stay on the display. What is in program may be incorrect. You must switch back to RUN, \( \text{RES} \text{ET} \), and begin the program again.

5. The two programs, PROG 1, and PROG 2, are independent. You must be in RUN to switch from one to the other, and when you do, the program goes to beginning.

6. If you don't have a STOP somewhere in the program, it will continuously loop.

7. It is sometimes convenient to have the program show a special number when it is stopped for entry of data. That way you know where the program is and what data is to be entered.

If a 1 had been put into the sample program before the first \( \text{START} \) \( \text{STOP} \), then the display always shows 1.000 when the program stops for the entry of a.
BATTERIES AND RECHARGING

The Micro Surveyor may operate from the AC voltage adapter supplied with the computer or from the batteries when operation from the AC line is inconvenient.

The batteries supplied with the Micro Surveyor may be discharged and recharged approximately 1000 times during their useful life. When fully discharged, the batteries may be recharged in 16 to 20 hours by connecting the computer to the AC adapter and the adapter to the AC line. Battery recharging occurs regardless of the position of the ON/OFF switch and does not interfere with calculations.

The AC adapter supplies 300 to 350 milliamperes of charging current to the batteries. For this reason only Compucorp part number 3400017 or similar nickel-cadmium batteries rated for at least three ampere-hours should be used in the Micro computer. If you do need to use other types in an emergency, DO NOT connect the AC adapter. Attempting to recharge a rechargeable battery rated at less than 3 ampere-hours or a dry cell may burst the batteries and damage the computer. Such damage is NOT covered by warranty or equipment service agreement.

To replace the batteries, turn the Micro Surveyor over, squeeze together the two round plungers at the top of the case, and pull the door open. Remove the batteries and replace with fresh ones, observing the polarity shown in the illustration.

All nickel-cadmium batteries exhibit an apparent reduction of capacity after a number of cycles of partial discharging and recharging. You may easily correct this by running the computer on batteries until the display goes completely blank, and then recharging the batteries for 16 to 20 hours. Care must be taken not to continue the discharge period beyond the point when the display goes blank. You may use the computer during the recharge period.

The Micro Surveyor concentrates many thousands of logic circuits into a small volume, so the metal label on the bottom may feel noticeably warm to the touch. This temperature is normal and should cause no alarm provided it does not exceed 120°F (49°C).
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
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<td>AC Adapter</td>
<td>105</td>
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<td>Angles</td>
<td>4</td>
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<tr>
<td>Averaging of</td>
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<tr>
<td>Display of</td>
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<tr>
<td>Elevation</td>
<td>23</td>
</tr>
<tr>
<td>Vertical</td>
<td>23</td>
</tr>
<tr>
<td>Zenith</td>
<td>23</td>
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<tr>
<td>Entry of</td>
<td>4</td>
</tr>
<tr>
<td>Area</td>
<td>43</td>
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<tr>
<td>Arithmetic</td>
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</tr>
<tr>
<td>Batteries</td>
<td>105</td>
</tr>
<tr>
<td>Bearing</td>
<td>6</td>
</tr>
<tr>
<td>Display of</td>
<td>6</td>
</tr>
<tr>
<td>Entry of</td>
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<td>Quadrant Codes</td>
<td>6</td>
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<td>Charger</td>
<td>105</td>
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<td>Corrections</td>
<td>3</td>
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<td>Curves in Traverse</td>
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<tr>
<td>Codes</td>
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</tr>
<tr>
<td>Entry of</td>
<td>15</td>
</tr>
<tr>
<td>Example</td>
<td>16</td>
</tr>
<tr>
<td>Traversing with</td>
<td>17</td>
</tr>
<tr>
<td>Intersections</td>
<td>56</td>
</tr>
<tr>
<td>Direction and Length Known</td>
<td>58</td>
</tr>
<tr>
<td>Relative Angle and One Length Known</td>
<td>73</td>
</tr>
<tr>
<td>Two Directions Known</td>
<td>62</td>
</tr>
<tr>
<td>Two Lengths Known</td>
<td>70</td>
</tr>
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<td>Inversing, Point to Point</td>
<td>25</td>
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<td>Math Functions</td>
<td>82</td>
</tr>
<tr>
<td>Numerical Entry</td>
<td>2</td>
</tr>
<tr>
<td>On-Off Switch</td>
<td>1</td>
</tr>
<tr>
<td>Parentheses</td>
<td>79</td>
</tr>
<tr>
<td>Perimeter</td>
<td>43</td>
</tr>
</tbody>
</table>