CO-OP 41

Instrument Module

USER'S MANUAL

Tripod Data Systems, Inc.

CO-OP 41 Instrument Module

Reference Manual

Notice

This manual and the keystroke procedures contained herein are provided on an "as is" basis. Information in this manual is subject to change without notice. Though an extensive effort has been made to supply you with accurate and useful information, Tripod Data Systems, Inc. makes no warranty of any kind with regard to this manual or to the keystroke procedures contained herein, including, but not limited to, any implied warranties of merchantability and fitness. Tripod Data Systems, Inc. shall not be liable for errors or for any incidental or consequential damages in connection with the furnishing, performance, or use of this manual.

If you have any comments about this product, complete the comments section on the warranty card and return it to Tripod Data Systems.

Table Of Contents

Introduction

The Instrument Module reference manual is a reference manual designed for users already familiar with the Data Collector's operation and use. If you are new to the data collector, you should first turn to the Survey Module User's Manual to familiarize yourself with it's workings.

How To Use This Manual

This manual is devided into four sections. Section I - The Interface Functions, details each instrument setup program and and special procedures that need to be used with a particular instrument. Section II - Instrument Reading Functions, describes the functions common to all the instruments. Section III - New CO-GO Functions, explains some new support routines handling curves and directional windings. Finnaly, Section IV - Offset Stakeout, describes the road offset stakeout, and slope stakeout program. In each section the functions are laid out in alphabetical order.

For description of special terms used in this manual, such as SCROLLING MENUS, see the CO-OP 41 Surveying Module Reference Manual.

Format For Keyword Entries

Name Gives the name of the function.

Purpose Describes what the function does.

Keystrokes Shows what keys need to be pressed in order to execute the function

Entry Conditions Describes what needs to be done, or set up before executing the function.

Operation Explains how the function works, and what information to enter. Also explains any information that the function calculates.

Remarks Special things to keep in mind when using the function.

Examples Illustrates some of the different ways you can use the function.

Section I - Instrument Reading Functions

NSTAK

Name : Instrument Stakeout

Purpose : Performs a stakeout using an electronic total station.

Keystrokes : When the appropriate total station function is executed, this function is assigned to the **[STAKE]** key. To undo this you need to assign the **STAKE** function back to the keyboard.

Entry Conditions : Must have the total station hooked up to the DC and have executed the appropriate total station function.

Operation : When this function is executed the DC will prompt for the point number that your station is occupying.

```
OCPD PT?
```

When this has been keyed in the DC will prompt for the backsight and foresight point so that it will know how your instrument is set up.

```
BS PT?
FS PT?
```

Once these are keyed in the DC will display the angle right and distance to the foresight point (press **[R/S]** to scroll to the next display).

```
<RT=#.####
DIST=#.####
```

When you press the [R/S] key after the DIST=#.#### prompt the DC will trigger the total station to take a sample distance. The DC will then display the GO or COME distance, and if working with elevation the CUT or FILL distance (press [R/S] to view the next information).

```
GO #.####
COME #.####
CUT #.####
FILL #.####
```

At this point pressing the [R/S] key will cause the DC to take another reading from the total station. If you wish to move to a new point then execute this function again (if you want to do another stake out from the same point, and using the same backsight, then just press [R/S] at the OCPD PT? and the DC will skip to the FS PT? prompt).

RPSTK

Name : Random Point Stakeout

Purpose : Allows a point to be staked out from a random position, provided the position is accessible to two known points.

Keystrokes : [XEQ] 'RPSTK'

Entry Conditions : The instrument must be set at a position accessible to 2 known points.

Operation : When this function is executed the CO-OP 41 will prompt for the control point numbers of the two accessible points.

```
1ST PT?
2ND PT?
```

After the two point numbers have been keyed in the CO-OP 41 will prompt for the horizontal circle reading to the first control point.

```
CIR TO 1?
```

At this point press [R/S] and the CO-OP 41 will read the angle and distance information from the connected total station.

When the distance information has been entered the CO-OP 41 will prompt for the circle reading to the second known point.

```
CIR TO 2?
```

Press [R/S] at this prompt and the CO-OP 41 will cause the total station to automatically take the reading to the second point.

When the information for the second point has been entered the CO-OP 41 will show the precision of closure for your readings.

PREC=#.####

Pressing [R/S] after this will cause the CO-OP 41 to prompt for the point number to store the station position to.

STA PT NO?

Once this has been keyed in the DC now has the position and backsight of your station stored. If you don't want to store the station point, just press [R/S]. The CO-OP 41 will now start prompting for information for the actual staked point. The first prompt will be for the point number of the stake out point.

STK PT?

When this point is keyed in (it must be a known point) the CO-OP 41 will show the circle reading to that point.

CIR=#.####

Pressing [R/S] will display the horizontal distance to the point.

H.D.=#.####

Pressing [R/S] again will cause the total station to take a reading. The CO-OP 41 will then show the GO or COME distance, and if working with elevation the CUT or FILL

distance (press [R/S] to view the next information).

```
GO #.####
COME #.####
CUT #.####
FILL #.####
```

Press [R/S] after viewing this, the CO-OP 41 will prompt for STK PT? again. If you want to take another shot from the same stake point, just press [R/S]. If you wish to switch to stake out another point, key in the new point number.

SSHOT

Name : Instrument Side Shot

Purpose : Automatically triggers an electronic total station to take a side shot, reads and stores the information to the DC.

Keystrokes : [1/X]
(When an instrument setup program is executed (TOPCON, NIKON,...) this function is assigned to the **[1/X]** key.

Entry Conditions : A total station must be hooked to the DC, and the appropriate total station function must have been executed.

Operation : Before you execute this function your total station should be all set up to take a side shot. When you execute this function the DC will instruct the total station to take a side shot reading and store the data to the next point number. Pressing **[R/S]** after completion of this function will cause the total station to do another side shot (pressing the **[SSHOT]** key will have the same effect).

TRAVERS

Name : Instrument Traverse

Purpose : Automatically triggers a total station to enter a traverse into the DC.

Keystrokes : [LN]
(When an instrument setup program is executed (TOPCON, NIKON,...) this function is assigned to the [LN] key.

Entry Conditions : A total station must be hooked to the DC, and the appropriate total station function must have been executed.

Operation : Before you execute this function your total station should be all set up to take a traverse reading. When you execute this function the DC will instruct the total station to take a traverse reading and store the data to the next point number. Pressing [R/S] after completion of this function will cause the total station to do another traverse.

(This page intentionally left blank)

Section II - The Interface Functions

These functions (such as **NIKON**, **TOPCON**, **KERN**, **LIETZ**) are used to set the DC up to talk to the respective instruments. When executed the functions will assign several keys to functions that will take readings directly from the instruments. The keys that are assigned are as follows:

SSHOT is assigned to the [1/X] key
TRAVERS is assigned to the [LN] key
NSTAK is assigned to the [COS] key *

You can execute the **CTR** function to reassign the **[SSHOT]** and **[TRAVERS]** keys, but you need to assign the STAKE function back to the **[COS]** key to reassign the **NSTAK** function. All of these functions are executed by using the **[XEQ]** key (to execute the **KERN** function you would **[XEQ]** 'KERN'). As these functions are all similar a slightly different format is used for describing these functions, as shown below.

Instruments Lists the instruments the function will set up the DC to communicate with.

Cable Needed The part number of the cable required to link the DC to the total station.

Remarks Points out any details of operation that are unique to the function.

Communication Settings What the serial port on the DC is set to when the function is executed.

If you want to assign the normal **STAKE** function back to the **[COS]** key, execute the **CTR** function.

KERN

Instruments : E1
E2
DM550

Cable Needed : CKRN001A

Remarks : When you execute one of the Instrument Reading Functions, and the CO-OP 41 wants an angle and distance reading from the total station the CO-OP 41 will display the following.

MEASUR...R/S

This is telling you to press the **MEASUR** key on the total station, and wait until the measurement is completed. Then press the **[R/S]** key on the CO-OP 41. This will trigger the total station to send the reading to the CO-OP 41, and allow the CO-OP 41 to read it.

The DM550 will only give out distance. You will be prompted to enter the zenith and horizontal angles.

Communication Settings :

1200 Baud
7 data bits
Even Parity
2 stop bit

LIETZ

Instruments : SET2/SET3
SDM3FR/SDM3F
SDM3ER/SDM3E
DT20E

Cable Needed : CLTZ001A

Remarks : The following chart shows which of the Lietz instruments takes zenith, and/or horizontal angles. If the instrument does not take a reading, then you will be prompted to enter them.

	Distance	Zenith <	Horizontal <
SET2	Y	Y	Y
SET3	Y	Y	Y
SDM3FR	Y	Y	N
SDM3F	Y	N	N
SDM3ER	Y	Y	N
SDM3E	Y	N	N
DT20E	Y/N	Y	Y

Communication Settings :

1200 Baud
8 data bits
No Parity
1 stop bit

NIKON

Instruments : DTM5/DTM1/DTM20
NTD2/3/4

Cable Needed : CNKN001A

Remarks : There are no special options for this function.

Communication Settings :

1200 Baud
8 data bits
No Parity
2 stop bit

PENTAX

Instruments : PX/PD
PTS-10
PTS-II

Cable Needed : CPTX001A

Remarks : When executed the DC will put up a scroll menu for selection of which Pentax total station you are using.

PTS ↑
PX/PD ↑

PX/PD ↑ The PX/PD has only one way communication. It automatically sends out he distance when the measurment is completed. When an angle reading is needed you will be prompted for it. When you execute one of the Instrument Reading Functions, and the CO-OP 41 wants the distance reading from the PX/PD the CO-OP 41 will prompt:

PRESS MEAS

At this point you should press the **MEAS** key on the PX. The PX/PD will send the reading to the CO-OP 41 when the measurement is completed. The CO-OP 41 will then prompt for the zenith and horizontal angles.

PTS-10 ↑, **PTS-II** ↑ The PTS must be set up in slope/distance modes to take angle, and distance readings. When needed the CO-OP 41 will prompt for setting up the instrument into these modes.

When a traverse or side-shot is requested the first prompt will be.

PRESS SLP/V

At this point press the **SLP/V** key (if you are not already in distance mode) on the instrument. Next, if you are using a PTS-10, the CO-OP 41 will prompt.

* AIM...R/S

This is telling you to press the **AIM** key, and wait for a star (*) in the display of the instrument (this means that it is done aiming). When the star appears, press **[R/S]** on the CO-OP 41.

If you are using a PTS-II, the CO-OP 41 will prompt.

MEAS, R/S

Press the **MEAS** key on the instrument, wait for about 3 seconds, then press **[R/S]** on the CO-OP 41.

In certain other functions there will be a prompt.

V/H, R/S

For this press the **V/H** key on the instrument, to set it to the proper mode, then press **[R/S]** on the total station.

Communication Settings :

1200 Baud
8 data bits
No Parity
1 stop bit

TOPCON

Instruments : GTS3
GTS3B
E1
E2

Cable Needed : CTPC001A

Remarks : When executed the DC will put up a scroll menu for selection of which Topcon total station you are using.

GTS3 ↑
GTS3B ↑
E1/E2 ↑

GTS3 ↑ The GTS3 does not allow the DC to automatically trigger a reading so the DC prompts the user through the process of taking a reading. When you execute one of the Instrument Reading Functions, and the CO-OP 41 wants an angle and distance reading from the total station the CO-OP 41 will display the following.

MSR 3X...R/S

This is telling you to press the **MSR** key 3 times on the total station, and wait until the measurement is completed. Then press the **[R/S]** key on the CO-OP 41. This will trigger the total station to send the reading to the CO-OP 41, and allow the CO-OP 41 to read it.

GTS3B ↑ Select this option when you are using a GTS3B total station, and using it's power port to communicate with the CO-OP 41. When requested the DC can automatically trigger the total station to take a reading.

E1/E2 † Select this option when you are using the E1 total station, and using it's data port for communication. If you are using a newer GTS3B and communication with the instrument by it's data port, you should also select this option. It should be noted that there may be some problems when 1/2 second accuracy is selected on the E2 total station - a different accuracy should be used if possible.

> When using a GTS3B or E1 total station you must set the mode 12 to zero on the instrument, or the CO-OP 41 will prompt for distance. Consult your instrument manual on how to set mode 12 to 0.

Communication Settings :

1200 Baud
7 data bits
Even Parity
1 stop bit

WILD

Instruments : T2000/1600/1000

Cable Needed : CWLD001A

Remarks : When executed the DC will put up a scroll menu to check what type of total station you have.

T2000/1600 ↑
T1000 ↑

Once selected the DC will put up a scroll menu to check if you have a GRE3 connected to the total station (the GRE3 allows the Wild total station to take distance measurements).

WITH EDM ↑
NO EDM ↑

WITH EDM ↑ With an EDM attached the total station can automatically take distance readings.

NO EDM ↑ Without an EDM the total station cannot take distance readings. When a distance reading is needed you will be prompted for it.

This function assumes that the Wild total station is set at 2400 baud, if your instrument is not set to 2400 baud, or you are not sure, then do the following.

1) Press the following keys on the total station

SET MODE 70 RUN 4 RUN

2) Your Wild total station should now be set to 2400 baud. If the parity is not even then press the following keys on the total station

SET MODE 71 RUN 2 RUN

T1600

When using the T1600, you need to set mode 74 to 1. This will make the T1600 act like a T2000. The key sequence is:

SET MODE 74 RUN 1 RUN

Failing to do so will result in ERR22 when you command the T1600 to take a shot.

Communication Settings :

2400 Baud
7 data bits
Even Parity
1 stop bit

ZEISS

Instruments : ELTA 4
ELTA 46R

Cable Needed : CZEI001A

Remarks : There are no special options for this function.

Operation :

Setting Up the Elta 46R

1. Level the instrument.
2. Turn the knob on the front panel (the display side) to INDEX V. The middle display should read **V 1.**
3. sight a target then push the trigger once, the display should read **V 2.**
4. Loosen the horixontal and vertical clamp. Turn the 46R 180 degrees horizontally and flop the scope to sight the target again.
5. Push the trigger again. The display should read **V 1 Ind in**, the vertical index is set.
6. Turn the front knob to TH+D. Turn the knob on the right hand side under DISTANCE to I. For long distance measuring turn the side knob to II. Now the instrument is ready.

Taking a measurement

1. Execute the ZEISS program on the CO-OP 41 and select the ELTA 46R option. This only has to be done once.
2. Sight the target.
3. Push the Side shot or Traverse key on the CO-OP 41.

4. The CO-OP 41 will display the back sight angle and then display **TH+D, TRIGR.** This is to remind you that the Elta 46R has to be in the TH+D mode. Push the trigger on the Elta 46R once, wait for about 5 seconds and push the trigger again.
5. When the measuring is completed, the Elta 46R will send the data to the CO-OP 41. The rest of the procedures are all automatic.
6. Sometimes you will see the CO-OP 41 display **TH, TRIGR** instead of **TH+D, TRIGR.** This will happen when the CO-OP 41 only needs the horizontal angle but not the distance. When this message shows, turn the knob to the TH mode then push the trigger once. For horizontal angles you only need to push the trigger once.

Communication Settings :

1200 Baud
7 data bits
Odd Parity
2 stop bit

(This page intentionally left blank)

Section III - New CO-GO Functions

Directional Windings

Directional winding is a technique for improving angular accuracy by taking multiple readings. It only uses the upper horizontal motion to turn the scope, so it is especially suited for a directional theodolite. It is different from the **W** (Winding) program which requires the use of both the upper and lower motions.

This technique requires four readings for each horizontal angle, two direct and two reverse. "Reverse" means taking a reading with the scope flipped over. It also has an option to include multiple vertical angles. The four horizontal readings it requires are as follows:

1. BS-DIR (backsight direct)
   Turn your scope directly to the backsight. You don't have to zero the horizontal reading for this initial reading.

2. BS-RVR (backsight reversed)
   Flop the scope, loosen the upper motion, turn the scope right to the backsight again.

3. FS-RVR (foresight reversed)
   Turn the scope right to the foresight. The scope should still be reversed at this point. The reverse zenith angle will also be prompted for at this point if the vertical winding option is on.

4. FS-DIR (foresight direct)
   Flop the scope, loosen the upper motion, turn the scope right to the foresight again. The scope should be back to its normal position. The direct zenith angle will also be prompted for at this point if the vertical winding option is on.

The average of the horizontal angle is computed as follow:

direct angle right = foresight direct - backsight direct
reverse angle right = foresight reverse - backsight reverse
split = absolute value (direct angle right - reverse angle right)
average HA = (direct angle right + reverse angle right) / 2

The split is used for rejection limits. If the split between the direct angle and reverse angle is greater than the specified limit, the measurement will be rejected.

If the vertical winding option is on, the vertical angle will be computed as follows.

vertical sum = direct zenith + reverse zenith
vertical error = 360 - vertical sum
adjusted zenith = direct zenith +/- (vertical error / 2)

The vertical error is used for rejection limits. If the error is greater than the specified limit, the set will be rejected.

If the vertical angles have no error, the sum of the direct zenith and reverse zenith should add up to exactly 360. If the sum is less than 360, half of the vertical error will be added to the direct zenith. If the

sum is greater than 360, half of the vertical error will be subtracted from the direct zenith.

DW

Purpose: Execute this program to set up the directional winding procedure.

Keystrokes: [XEQ] [ALPHA] DW [ALPHA]

Entry conditions: None.

Operation: When executed the CO-OP 41 puts up a scroll menu for enabling or disenabling the directional winding option.

ENABLE DW ↑
DISABLE DW ↑

ENABLE DW ↑ When Directional winding is enabled, you will no longer be able to enter the horizontal angle by azimuth or bearing. You will be always prompted for the four readings.

DISABLE DW ↑ Disable the directional winding mode and return to the standard 3-way promptings for horizontal angle.

If the DW mode is selected, the CO-OP 41 prompts you for the number of sets for each angle right measurement.

SETS?

Each set includes four readings, or 6 readings if the vertical winding is also on. If more than one set is specified, the final angle is the average of all the sets.

Then the CO-OP 41 prompts for the horizontal error limit in seconds, such as 25 for 25 seconds, 125 for 1 minute and 25 seconds.

HOR ERR SEC?

If the split between the direct angle and reverse angle is larger than this error limit, the set will be rejected, and you will have to retake all the readings for this set.

Then the CO-OP 41 will prompt for the vertical error limit in seconds.

VER ERR SEC?

If the sum of the direct and reverse zenith angles is greater or less than 360 by this limit, the set will be rejected. When a set is rejected, you would need to retake all the horizontal and vertical angles for that set.

If you don't want to do vertical winding, just press **[R/S]** at the prompt to disable it.

The **DW** program will stop here. Execute the traverse or the side shot program to see the promptings. Be sure that you have a valid backsight before you execute the next traverse or side shot (you only need to set the backsight after occupying a new point). The readings will be prompted as follows.

BS-DIR=? (direct backsight)

Enter the direct backsight reading and press **[R/S]**. If your data collector is hooked up to a total station, just press the **[R/S]** at the prompts. Of course, the appropriate instrument program would have to be executed beforehand.

BS-RVR=? (reverse backsight)
FS-RVR=? (foresight reversed)

ZA-RVR=?	(reverse zenith, only if vertical winding is on)
FS-DIR=?	(foresight direct)
ZA-DIR=?	(direct zenith, only if vertical winding is on)

Enter the values for these angles or press **[R/S]** at the prompt for reading the angles from the total station.

After all these angles are entered, the CO-OP 41 will display the horizontal split between the direct angle and the reverse angle.

H SPLT=0.xxxx

Press **[R/S]** to continue. If the vertical winding option is on, the CO-OP 41 will display the vertical errors.

V ERR=0.xxxx

Press **[R/S]** to continue. If either the horizontal split or the vertical error is greater than the error limits, the CO-OP 41 will display **TRY AGAIN**. You would then need to press the **[R/S]** to restart the prompting of the set. If the errors are within the specified limit, the CO-OP 41 will display the mean angles of the set.

MN H<=xx.xxxx	(mean horizontal angle)

Press **[R/S]** to continue.

MN V<=xx.xxxx	(mean vertical angle)

Press **[R/S]** to continue. If only one set is required, the mean angles will be used as the horizontal angle right and the zenith angle

for the foresight and the CO-OP 41 will go back to continue the rest of the traverse or side shot program. If more than one set is required, the CO-OP 41 will display:

R/S SET n

Press **[R/S]** to continue on to the next set. When all the sets are satisfied, the CO-OP 41 will display the mean angles of all the sets.

MN H<=xx.xxxx (mean horizontal angle)

Press **[R/S]** to continue.

MN V<=xx.xxxx (mean vertical angle)

Press **[R/S]** to complete the rest of the traverse or side shot program.

Example:

[XEQ] [ALPHA]	
DW [ALPHA]	ENABLE DW ↑
[ENTER]	SETS?
1 [R/S]	HOR ERR SEC?
20 [R/S]	VER ERR SEC?
25 [R/S]	30.0000

Now do a traverse

[SHIFT] [TRAVRS]	BS-DIR=?
0 [R/S]	BS-RVR=?
180 [R/S]	FS-RVR=?
307.0325 [R/S]	ZA-RVR=?
268.1203 [R/S]	FS-DIR=?
127.0330 [R/S]	ZA-DIR=?
91.4747 [R/S]	H SPLT=0.0005
[R/S]	V ERR=-0.0010
[R/S]	MN H<=127.0327
[R/S]	MN V<=91.4752
[R/S]	

HORIZ

Purpose: This program computes the field data for the layout of a horizontal circular curve by one of four methods:

1) PC deflections and chord length.
2) PI deflections and distances.
3) Tangent distances and offsets.
4) Chord distances and offsets.

The required information on the curve is the PC or PI station, radius or degree of curve, and the central angle. Field data for any specified station can be computed or, if a stationing interval is given, the field data for successive stations can be computed automatically.

Keystrokes: [XEQ] [ALPHA] HORIZ [ALPHA]

Entry conditions: None.

Operation: When executed the CO-OP 41 prompts for one or two of the three inputs.

```
:RADIUS=?
:DEGREE=?       (degree of curvature
                entered as D.MS)
:DETLA=?        (entered as D.MS)
```

If only one of the above is known, the CO-OP 41 will prompt for one of the following inputs.

```
:ARC LENG=?
:TANGENT=?
:CHORD=?
:MIDOR=?              (mid-ordinate)
:EXTERNL=?            (external)
```

Then the CO-OP 41 will display the radius, degree of curve, delta, and arc length of the curve. If you don't have a printer pluged-in, press [R/S] to view the succesive curve data.

R=xxx.xxxx	(radius)
D=xx.xxxx	(degree of curvature in D.MS form)
DELTA=xxx.xxxx	(central angle in D.MS form)
L=xxx.xxxx	(arc length)

Then the CO-OP 41 prompts for the station of PC or PI.

```
:PC=?
:PI=?
```

Enter PC or PI. The CO-OP 41 will then display the stations of PC, PI, and PT of the curve.

PT=xxxx.xxxx	(point of tangent)
PI=xxxx.xxxx	(point of intersection of tangents)
PC=xxxx.xxxx	(point of curvature)

Then the CO-OP 41 will bring up a scroll menu for selecting one of the four methods to layout the curve.

PC DEF ↑	(PC deflections and distances)
PI DEF ↑	(PI deflections and distances)
TAN OFFSET↑	(Tangent distances and offsets)
CH OFFSET ↑	(Chord distances and offsets)

Use the [R/S] key to scroll the menu and press the [**ENTER**] key to select an option. Once the layout method is selected, the CO-OP 41 prompts for the station or the auto stationing interval.

```
:STA=?
:AUTO INTVL=?
```

:STA If a single station is entered, the CO-OP 41 will display the field data for the selected layout.

For PC deflection:

SC=xx.xxxx	(short chord from previous sta. to current sta.)
LC=xx.xxxx	(long chord from PC to current station)
<=xx.xxxx	(deflection angle from tangent to long chord)
STA=xxx.xxxx	(current station)

For PI deflection:

DIST=xxx.xxx	(distance from PI to current station)
<=xx.xxxx	(deflection angle from tangent to line joining PI and current station)
STA=xxx.xxxx	(current station)

For tangent offset:

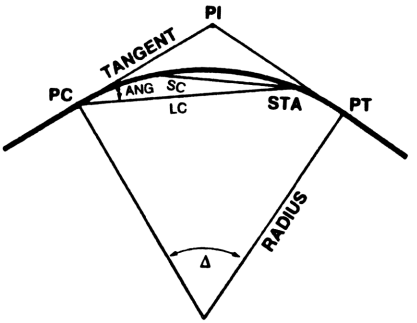
TO=xx.xxxx	(tangent offset)
TD=xx.xxxx	(tangent distance)
STA=xxx.xxxx	(current station)

For chord offset:

CO=xx.xxxx	(chord offset)
CD=xx.xxxx	(chord distance)
STA=xxx.xxxx	(current station)

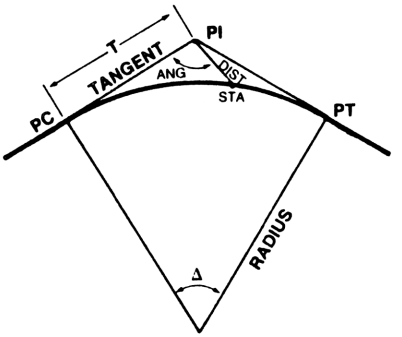
:AUTO INTVL If auto stationing interval is entered, the CO-OP 41 will begin computing field data from the current station. After each set of computations press the [R/S] key to continue automatically to the next station. Computation will finally halt at the PT of the curve.

Remark: The degree of curvature is by arc definition.



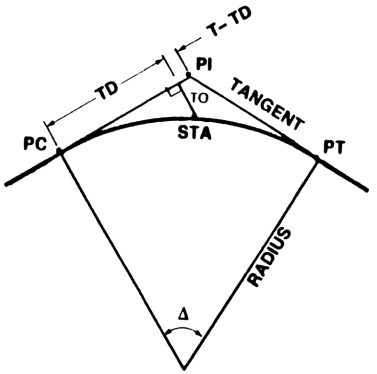
PC Deflections

STA - current station
ANG - deflection angle from tangent to long cord
LC - long chord from PC to current station
SC - short chord from previous station to current station
Δ - central angle
PI - point of intersection of tangents
PC, PT - ends of curve



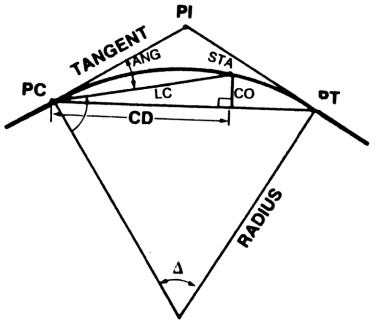
PI Deflections

STA - current station
ANG - deflection angle from tangent to line joining PI and current station
DIST - distance from PI to current station



Tangent Offsets

STA - current station
TD - tangent distance
TO - tangent offset
T - distance from PC to PI



Chord Offsets

STA - current station
CD - chord distance
CO - chord offset
L - length of curve from PC to PT

Example: Compute field data for PC deflections for a curve with a central angle of 35 degrees 30 minutes of curve of 12 degrees 30 minutes. Start at station 8+00 and use a stationing interval of 100 feet up to and including the station at the PT. The station at the PI is 9+32.12.

```
[XEQ] [ALPHA]
HORIZ [ALPHA]          :RADIUS=?
[R/S]                  :DEGREE=?
12.3 [R/S]             :DELTA=?
35.3 [R/S]             R=458.3662
[R/S]                  D=12.3000
[R/S]                  DELTA=35.3000
[R/S]                  L=284.0000
[R/S]                  :PC=?
[R/S]                  :PI=?
932.12 [R/S]           PT=1069.3958
[R/S]                  PI=932.1200
[R/S]                  PC=785.3958
[R/S]                  PC DEF     ↑
[ENTER]                :STA=?
800 [R/S]              SC=14.6036
[R/S]                  LC=14.6036
[R/S]                  <=0.5446
[R/S]                  STA=800.0000
[R/S]                  PC DEF     ↑
[ENTER]                :STA=?
[R/S]                  :AUTO INTVL=?
100 [R/S]              SC=99.8018
[R/S]                  LC=114.3059
[R/S]                  <=7.0946
[R/S]                  STA=900.0000
[R/S]                  SC=99.8018
[R/S]                  LC=212.6495
[R/S]                  <=13.2446
[R/S]                  STA=1000.000
[R/S]                  SC=69.3296
[R/S]                  LC=279.4790
[R/S]                  <=17.4500
[R/S]                  PT=1069.3958
```

[R/S] PC DEF ↑

RESECTION

Purpose: This program is designed to locate a point from three known points.

Keystrokes: [XEQ] [ALPHA] RESECT [ALPHA]

Entry conditions: The coordinates of the three known points have to be stored in the current job file.

Operation: When executed the CO-OP 41 prompts for the point numbers of the three known points. The points must be arranged in clockwise order as 1, 2, 3. The point to be located would be the fourth point.

```
1ST PT?
2ND PT?
3RD PT?
```

Enter the point numbers of the three known points in clockwise order. Then the CO-OP 41 prompts for the circular angle readings from point 1 to point 3.

```
CIR TO 1?
CIR TO 2?
CIR TO 3?
```

Then the CO-OP 41 will display the distances from the station to the three known points.

```
DIST1=xxx.xx
DIST2=xxx.xx
DIST3=xxx.xx
```

Then the CO-OP 41 will prompt for the station point number.

```
STA PT NO?
```

Enter the point number if you wish to store the point, or you can just review the coordinate of the station by recalling the top row keys.

TRANSIT

Purpose: This function uses the transit rule to adjust a traverse after the points have been stored.

Keystrokes: [XEQ] [ALPHA] TRANSIT [ALPHA]

Entry conditions: All the points along the traverse must be stored in the random points file.

Operation: When executed the CO-OP 41 will bring up a scroll menu, allowing you to select a closed or open traverse.

```
CLOSE TRAV    ↑
OPEN  TRAV    ↑
```

When open traverse is selected, the CO-OP 41 prompts for the last point on the traverse and the correct coordinate of this point.

```
LAST PT?
CORRECT N?
CORRECT E?
```

Each point number will be displayed while its coordinates are being adjusted. The adjusted coordinates will be printed if an HPIL printer is in the loop. After all the adjustments are done, the CO-OP 41 beeps to signal completion.

Example:

1. Enter the job on page 114-116 of the surveying user's manual into your CO-OP 41.

2. Enter the following point number into the random points file.

	[shift] RDMPTS
PT?	1 [R/S]
PT?	2 [R/S]
PT?	3 [R/S]
PT?	4 [R/S]
PT?	5 [R/S]
PT?	0 [R/S]

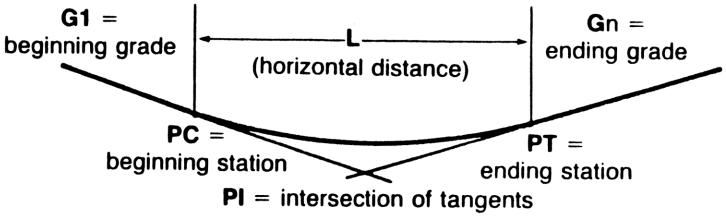
3. Execute the transit rule program and select the close traverse option.

   [EXQ] [ALPHA] TRANSIT [ALPHA]

   CLOSE TRAV ↑ [ENTER]

4. Watch the display for the point numbers and wait until the CO-OP 41 beeps.

VERT



Purpose: This function computes station and elevation data for vertical curves and straight grades.

Keystrokes: [XEQ] [ALPHA] VERT [ALPHA]

Entry conditions: None.

Operation: When executed the CO-OP 41 will bring up a scroll menu, allowing you to select curves or grades.

```
CURVE      ↑
GRADE      ↑
```

CURVE ↑ When curve is selected, the CO-OP 41 prompts for the station for PC or PI.

```
:PC=?
:PI=?
```

Enter the station for either PC or PI, and press [R/S]. Then the CO-OP 41 prompts for the elevation for the station.

```
EL=?
```

Then the CO-OP 41 prompts for the beginning and ending grades.

```
GRADE BEG%=?
GRADE END%=?
```

Enter the beginning grade and ending grade and press [R/S]. Then the CO-OP 41 prompts for one of the three inputs, if it is known.

:L=?	Horizontal length of curve.
:EL0=?	Elevation of high or low point.
:STA=?	Station through which the curve passes.

Enter data for one of the above and press [R/S]. If station is entered, the CO-OP 41 prompts for the elevation for the station.

Then the CO-OP 41 displays the beginning station, the PC.

```
PC=xxxx.xx
```

Press [R/S], the CO-OP 41 will display the elevation of the PC.

```
EL=xxx.xx
```

Then the CO-OP 41 will bring up a scroll menu for selection of functions.

```
EL TO STA  ↑
STA TO EL  ↑
AUTO STAS  ↑
HIGH OR LOW↑
```

EL TO STA Elevation to station. The CO-OP 41 prompts for the elevation and computes the station. Press [R/S] to view the station.

STA TO EL Station to elevation. The CO-OP 41 prompts for the station and computes the elevation. Press [R/S] to view the elevation.

AUTO STAS Auto stations. The CO-OP 41 prompts for the stationing interval and automatically computes successive stations and elevations along the curve beginning from the current station. The current station is originally set to the PC. When **EL TO STA** or **STA TO EL** is executed, that station becomes the current station.

HIGH OR LOW Compute and display the high or low point of a vertical curve.

GRADE When grade is selected, the CO-OP 41 prompts for the beginning station and its elevation.

```
STA1=?
EL1=?
```

Enter the station and the elevation of a known station. Then the CO-OP prompts for the percent of the grade.

```
GRADE%=?
```

Then the CO-OP 41 will bring up the same scroll menu as the curve function. You can select any one of the four functions except for the HIGH OR LOW, because these make no sense on a straight grade.

Remarks: This program is based on an equal tangent parabolic vertical curve.

Example: Compute elevation for stations along a 400 foot vertical curve with a PI station at 14+24.08 and elevation 104.77. The beginning grade is -5.1% and the ending grade is 2.4%. Use a stationing interval of 100 feet, starting with the first even station after the PC.

```
[EXQ] [ALPHA]
VERT [ALPHA]          CURVE      ↑
[ENTER]               :PC=?
[R/S]                 :PI=?
1424.08 [R/S]         EL=?
104.77 [R/S]          GRADE BEG%=?
5.1 [CHS] [R/S]       GRADE END%=?
2.4 [R/S]             :L=?
400 [R/S]             PC= 1224.0800
[R/S]                 EL= 114.9700
[R/S]                 EL TO STA  ↑
[R/S]                 STA TO EL  ↑
[ENTER]               STA=?
1300 [R/S]            STA=1300.0000
[R/S]                 EL=111.6384
[R/S]                 EL TO STA  ↑
[R/S] [R/S]           AUTO STAS  ↑
[ENTER]               INTERVAL=?
[R/S]                 STA=1400.0000
[R/S]                 EL=108.8994
[R/S]                 STA=1500.0000
[R/S]                 EL=108.0354
[R/S]                 STA=1600.0000
[R/S]                 EL=109.0464
[R/S]                 PT=1624.0800
[R/S]                 EL=109.5700
[R/S]                 EL TO STA  ↑
```

Find out the station and elevation of the low point.

```
[R/S] [R/S] [R/S]     HIGH OR LOW↑
[ENTER]               STA0=1496.0800
[R/S]                 EL0=108.0340
```

Find out the station has an elevation of 109.00 feet.

[R/S]	EL TO STA ↑
[ENTER]	EL=?
109 [R/S]	EL=109.0000
[R/S]	STA=1597.5886
[R/S]	STA=1394.5714

Note: The Offset Stake Out program in the following section (Section IV) IS NOT INCLUDED in the regular instrument ROM. The Offset Stake Out program is a special program that may be added to the instrument ROM for an additional charge.

Section IV - Offset Stake out

Offset Stake out Program (OFSTK)

This program is designed for staking out the center line and right-of-way of a road. Only the turning points on the center line of a road need to be specified. Any other points on the center line or road side can be computed by equal spacing or by offsets.

Main Features

1. A road can consist of straight lines and curves. A vertical curve can be superimposed on a straight line or horizontal curve segment. If elevation is on, the grade between two end points of a road segment is automatically computed.

2. The center line of the road is specified by known points stored in the data collector.

3. The staking out is done entirely by stations. Point numbers are only used for defining the center line of the road. Once you have designated a starting station for the beginning point of the center line, you can refer to any point on the road by its station.

4. Points on the right-of-way are computed as offsets from the center line, you can also specify a grade and curb height when staking out the right-of-way.

5. An auto stationing interval is used for staking out evenly spaced stations. When staking out a curve, this station

interval can be applied to either the inner, center, or outer circle of the curve. The curve length of these three circles are different, but the program will automatically adjust for it.

6. This program can produce a "cut sheet". A cut sheet is a data sheet that contains cut and fill insformation. This data usually is produced by a surveyor as a result of a staking out operation.

7. Includes Slope Stakes program.

Laying Out of A Road

The first step in laying out a road is to create in the job coordinate file, a series of points along the center line of the road. A point must be created at each change in either the horizontal or vertical direction of the road. Points on straight line segments may be created using the TRAVRS, SIDES or PTDIR functions. End points of a curve may be created by executing the CURVE function while doing a traverse.

The next step is to create a random points file of point numbers on the center line of the road. The CO-OP Surveying User's Manual, Reference Manual, and Plotter Manual provide useful information on how to create a random point file. The appropriate rules are summarized here:

1. A sequence of simple point number integers indicate points connected by simple straight line segments

2. To enter a horizontal curve into a random point file, key in both the beginning point of the curve (BC) and the ending point of the curve (EC) in response to the PT? prompt as follows: -BC.00EC. The beginning point number is used as the real part, and the ending point number is used as the fractional part of the number with leading zeroes added to the fractional part, to bring the fractional part up to four digits. The negative sign is required to indicate a horizontal curve. After this point has been keyed in, the CO-OP 41 will prompt for RADIUS? Key in the radius in feet. A positive radius indicates a curve that has the center on the right side of the

center line and thus curves to the right, and a negative radius indicates a curve that has the center on the left side of the center line, and thus curves to the left.

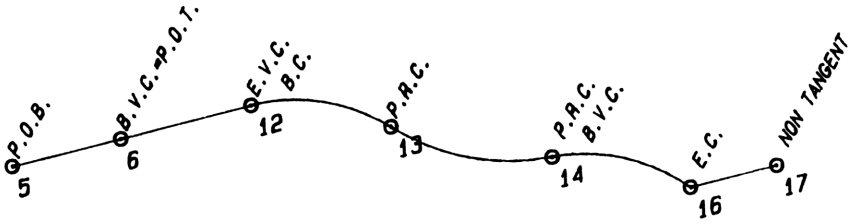
> Note: If you review a random point file using the RDMRCL function, the radius will be shown as the number of feet keyed in divided by 10,000 (e.g. 100 feet will appear as 0.0100).

3. If a random point file starts with a horizontal curve, the BC must be entered twice, once as a single integer, and once as the integer part of a real number.

4. To enter a vertical curve, key in the starting point as a negative integer followed by the ending point as a positive integer.

5. As always the random point file must be ended with a zero.

Example of A Random Points File



Example of a random points file containing the layout of the road above (enter points into the random points file by excuting the **RDMPTS** program) :

[SHIFT] [RDMPTS]	PT?	execute the RDMPTS program
5 [R/S]	PT?	5 is the beginning of a road
6 [CHS] [R/S]	PT?	5 to 6 is a straight line, 6 is also the beginning point of a vertical curve.
12 [R/S]	PT?	6 to 12 is a vertical curve.
12.0013 [CHS]		

[R/S]	RADIUS?	12 to 13 is a horizontal curve
800 [R/S]	PT?	radius 800 feet, curve turns to the right.
13.0014 [CHS]		
[R/S]	RADIUS?	13 to 14 is a horizontal curve
1000 [CHS] [R/S]	PT?	radius 1000 feet, curve turns to the left.
14 [CHS] [R/S]	PT?	14 also is the beginning point of a vertical curve so it needs to be restated.
14.0016 [CHS] [R/S]	RADIUS?	14 to 16 is a horizontal curve, a vertical curve is also superimposed on it.
800 [R/S]	PT?	radius 800 feet, curve turns to then right.
17 [R/S]	PT?	16 to 17 is a straight line.
0 [R/S]	0.00	end of random points file.

Since the CO-OP 41 let's you create and store multiple random points files, you can cut a long road into several sections and store each of them in a different random points file.

Setting Up

After the center line of the road is entered, you are ready to go out to the field. Once in the field, you will need to set up the instrument and to find its position. One of following three methods can be used to determine the position of the instrument.

1. Run the **RPSTK** program. This is a two points resection which requires the angles and distances between the instrument and the two known points to be entered.

2. Run the **RESECT** program. This a three points resection that only requires the angles to be entered.

3. Set up the instrument on a known point.

If you use method 1 or 2, you need to follow the program up to where it asks you to enter the station point number. A point has to be created for storing the coordinate of the instrument's position.

After you have the road layout in the random point file and the instrument position defined, the next step is to execute the offset stake out program (**OFSTK**). You can assign this program to the **[LOG]** key which is not assigned by the CO-OP 41. Since the instrument module uses bank switching*, you need to select the bank where the **OFSTK** program resides. The way to select this bank is to execute the **OFSTK** function. The following key strokes will select the bank and assign the program to the **[LOG]** key.

[XEQ] [ALPHA] OFSTK [ALPHA]

This will select bank 2. The CO-OP 41 will display **STEAK PT.** Ignore the display and proceed to do the key assignment.

[USER] [SHIFT] [ASN] [ALPHA] OFSTK [ALPHA] [LOG] [USER]

> * Bank switching means the memory of the instrument module is actually divided into two halves (we refer them as banks). Only one bank is active at a time and the other bank is hidden. Whenever you execute the **OFSTK** program by keying [XEQ] [ALPHA] OFSTK [ALPHA], you select the bank that contains the **OFSTK** program. Whenever you execute one of the following functions- **TRANSIT, VERT, HORIZ, RESECT,** you will select the other bank that contains these programs. Once a bank is selected, it will stay active until you select the other bank.

Using The Program

The **OFSTK** program uses a two level tree structured command menu for ease of use. You can always press the **[OFSTK]** key to go to the top of the main menu and select a first level command (assuming you've assigned the **OFSTK** function to a key).

The eight first level commands are:

STAKE PT	↑	(stake out next point)
AUTO STA	↑	(auto advance to next station)
SLOPE STK	↑	(Slope stakes)
CHNG STA	↑	(enter a new station)
SETUP	↑	(setup instrument position)
INTVL/OFST	↑	(enter station interval and offset dist.)
SS/WIDTH	↑	(Set slope ratio and surface width)
STORE	↑	(Store the last stake point and cut)

SETUP

This function is for specifying the occupied point, backsight point, offset, and the station interval. This function needs to be executed whenever you move the instrument or after any other COGO functions have been executed.

OCCUPY PT?

Enter the point number occupyied by the instrument. The instrument's poistion and point number can be determined by one of the three methods noted above.

BS PT?

The backsight point has to be a known point that can be seen from the instrument's position. The CO-OP 41 will then prompt for the circular reading of the backsight.

BS CIR?

Enter the angle or press the **[R/S]** if you are connecting to an instrument.You don't have to zero onto the backsight. You can just turn the gun to the backsight and enter the circular reading. This is to orientate the horizontal angle. All the horizontal angles in the following stake out will be expressed as circular angles.

The stake out is usually carried out in the order that the center points are entered in the random points file. However, you don't have to start from the beginning of the road, you can select any point on the center line to start with. The CO-OP 41 will next prompt for the starting point.

START PT?

The starting point has to be a point in the random points file. If you don't want to change the starting point, you can stop here and press the **[OFSTK]** key to stake out the next point. However, if you enter a new starting point, you will also need to enter it's station.

START STA?

This is the station of the starting point. Station 14+50.25 is entered as 1450.25. This program will use "station" rather than "point number" to refer to a point on the center

line. Since the center line is layed out by point numbers in the random points file, we need a reference to relate the point number to the station.

From here the **SETUP** function will branch into to the **INTVL/OFST** command.

INTVL/OFST

This function lets you set the auto stationing interval and the offset of the right-of-way.

There are two ways to designate the next station for staking out. One is by specifying the next station, the other is by using the auto stationing interval to advance to next station. The station interval can also be changed by the **AUTO STA** command. The first prompt of this function will ask for the station interval.

STA INTVL?

The interval should be entered in feet. If you don't want to change the interval, just press the **[R/S]** key to skip over this prompt. The next prompt is asking for the offset of the right-of-way.

OFFSET DIST?

The offset is the distance normal or radial to the center line. This distance is used to compute the position of points on the right-of-way. The offset distance can also be changed by the **STAKE PT** command.

AUTO STA

This command allows you to designate the next station by moving from the current station with a distance equal to the stationing interval. However, if the next station will thus pass a turning point, the next turnning point will be designated as the next station. Each point in the random points file is treated as a turning point.

When you are staking out along a straight line, you can move an equal distance on the center line and then do offset right or offset left to stake out both sides of the right-of-way. The points you mark on the right-of-way will also have the same spacing as the center line's. But when you are on a horizontal curve, the curve on the right-of-way would have different radius than that of the center line. If you apply the stationing interval to the center line and then offset to right or left, the spacing on the two sides of the road will be different from the center line's. In this case, you must do the center line or one of the right-of-way's by itself and apply the same stationing interval to all three lines of the curve. This command provides you with this capability.

The five options of the command are:

ADV CENTER ↑
ADV RIGHT ↑
ADV LEFT ↑
ENTER ADV ↑
CHNG INTVL ↑

ADV CENTER ↑ The auto stationing is based on the center line. The distance between two stations on the center line is equal to the

stationing interval. The CO-OP 41 will compute and display the next station.

```
STA=xxxx.xx
```

If the next station is at a turning point and the following road segment is a vertical curve, the CO-OP 41 will prompt for the beginning and ending grade.

```
GRADE BEG%? X.XX
GRADE END%? X.XX
```

In the displays above, the X.XX's are the computed values. You can press [R/S] to accept these values or enter different values (see vertical curve on page 76)

ADV RIGHT ↑ When auto advancing to the next station by the stationing interval, the distance is measured on the right side of the right-of-way. If the current segment of the road is on a horizontal curve, the distance between stations on the center line would be different from the stationing interval.

ADV LEFT ↑ Advance to the next station by the auto stationing interval measured on the left side of the right-of-way.

ENTER ADV ↑ If you don't want to use the auto stationing interval for the next station, you can enter the next station distance. When you use this option, the distance is measured on the center line. This option will also ignore the next turnning point and cross it if it is in the way. This option will prompt for the distance.

```
FEET?
```

CHNG INTVL↑ Change the auto stationing interval. This option will prompt for the stationing interval.

STA INTVL?

CHNG STA ↑

This function allows you to select the next station anywhere along the road by specifying the station number. Please note the station is based on the center line. There are two options in the command.

NEW STA ↑
SHOW STA ↑

NEW STA ↑ Enter a new station as the next station. A station is the horizontal distance from the station 0. It is computed by traversing along the road from the beginning station of the road. The CO-OP 41 will prompt for the station.

STATION?

Enter the station and press the **[R/S]**. Station 5+80.50 is entered as 580.50, station 12+25.50 is entered as 1225.50.

SHOW STA ↑ Display the current station. The CO-OP 41 will display **STA=xxxx.xx**.

STAKE PT

After the next station is designated, you can choose one of the three points at this station to stake out. These are the center point, offset right, and offset left. This

function will pull up a scroll menu for selection of the stake out point.

```
CENTER PT ↑
OFFSET RT ↑
OFFSET LF ↑
CHNG OFST ↑
ENTER AZM ↑
```

CENTER PT ↑ Select the center point at the station to stake out next. The CO-OP 41 will display the horizontal distance, circular angle and elevation to the point.

CIR= xxx.xxxx	press [R/S] to continue.
H. D.= xxx.xxx	press [R/S] to see the next display
EL=xxx.xxx	press [R/S] to continue
HI?	enter instrument height and press [R/S]
H ROD?	enter rod height and press [R/S]

Enter the instrument height and rod height only when they are changed. You can just press the **[R/S]** to use the old values. The CO-OP 41 will now go into the normal procedure for staking out a point. It will prompt for the zenith angle and slope distance of the next measurement. If you are connecting to a total station, just press the **[R/S]** when you are prompted for the data. Then the CO-OP 41 will display the **COME** or **GO** message and the **CUT** or **FILL** message if the elevation is on.

When you press the **[R/S]** key after viewing the message, the CO-OP 41 will pull up a

scroll menu to give you a chance to store the data.

```
CONTINUE  ↑
STORE     ↑
```

CONTINUE ↑ Select this option to continue to take another shot of the same point. Repeat this option until you are satisfied with the measurement.

STORE ↑ Select this option to store the coordinate and/or the cut and fill information of the staking point. This command is also in the top level menu. If this command is executed from the top level menu, it has to be right after staking the point, or the last point data would be lost.

The two options of this command are:

```
STORE PT  ↑
STORE CUT ↑
```

STORE PT ↑ Store the coordinate of the staking point. This option will prompt for the point number to store the coordinate.

```
PT=? xx
```

Where the "xx" is the default next point number. You can just press the [R/S] to take the default number, or you can enter a new point number. In general, the default next point number will be incremented automatically. But if you executed any other COGO function, this number will be incorrect. So it is important to check this number before you take the default.

When raw data is enabled, each of these points will be recorded as a side shot from

the instrument position. Any new stations will also be recorded in the raw data file. If you want to save additional notes in the raw data file, you can execute the **NOTE** function at this point.

STORE CUT † Store cut sheet data. You must have the raw data enabled to store the cuts and fills. After a point is horizontally staked, select the **STORE CUT** option immediately, the calculated elevation and the actual elevation of the point will be stored in the raw data file. When you print the raw data file (execute **PRAW** or **PCUT**), you will see something like this.

```
STATION=12+50 RT 25.0 ELEV=256.78
GRADE=259.56 FILL 2.78
```

The above line states that the station is 12+50, offset right 25 feet. The elevation of the point is 256.78 feet, the design grade is 259.56 feet. The fill is 2.78 feet.

OFFSET RT † Select a point on 90 degree deflection to the right from the center line. The distance from the center line is the specified offset distance. If the current road segment is a horizontal curve, then the direction of the offset point is on the radial angle (toward or away from the center). If elevation is on, the CO-OP 41 will prompt for a percent grade from the center line point to the offset point.

```
GRADE%?
```

If you don't care about the grade, just press the [R/S] key to ignore the prompt. If the offset point is higher or lower than the center line, enter the percent of grade. If

the street has no grade but you want to stake the top of the curb, enter 0 for the grade.

If the grade is entered, the CO-OP 41 will also prompt for the curb height.

CURB HI"?

The inch symbol (") after the CURB HI means the curb height should be entered as inches. To ignore the curb height, key in 0.

OFFSET LF ↑ Offset to the left. This function works exactly like the OFFSET RT ↑, except the stake out is done to the left of teh center line.

CHNG OFST ↑ Change the offset distance. When the **[ENTER]** key is pressed at this option, the CO-OP 41 will prompt for the offset distance.

OFFSET DIST?

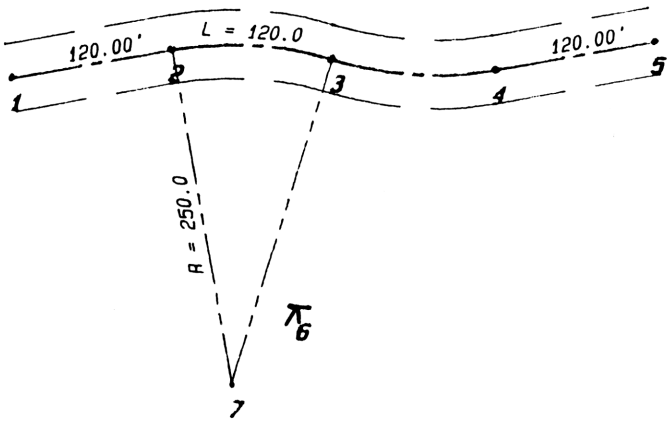
Enter the offset distance and press the **[R/S]** key. The CO-OP 41 will return to the beginning of of the STAKE PT command.

ENTER AZM If you don't want to use the 90 degree deflection or the radial angle, you can enter the offset azimuth directly. The distance will still be the preset offset distance. The CO-OP 41 will prompt for the azimuth.

AZIMUTH?

This offset azimuth will be for the next stake point only.

Example Of Setup and Staking Out



Coordinates & Elevations				Distances and bearings
1.	5000.0000	5000.0000	100.00	1-2 120.00' N 75.0000 E
2.	5031.0583	5115.9111	110.00	2-3 R=250.0 turn right
3.	5033.6490	5234.7342	110.00	Arc L.= 120.0
4.	5036.2396	5353.5573	110.00	3-4 R=250.0 turn left
5.	5067.2979	5469.4684	100.00	Arc L.= 120.0
6.	4850.0000	5225.0000	100.00	4-5 120.00' N 75.0000 E
7.	4789.5768	5180.6159	110.00	

You can enter these coordinates by the COORST function, or follow the traverse given below.

Traverse To Enter Roadway

[SHIFT][JOBS]	NEW JOB ↑
[ENTER]	JOB NAME?
ROAD [R/S]	N/E ONLY ↑
[R/S] [R/S]	ELEV ON ↑

[ENTER]	PTS?
10 [R/S]	RAWDAT OFF ↑
[ENTER]	N=E=5000 ↑
[ENTER]	1.00
[SHIFT][TRAVRS]	HI?
5 [R/S]	H ROD?
5 [R/S]	:AZIMUTH?
75 [R/S]	:H DIST?
120 [R/S]	CH EL?
10 [R/S]	:AZIMUTH?
[SHIFT] [LR]	ARC L?
120 [R/S]	RADIUS?
250 [R/S]	TURN RIGHT ↑
[ENTER]	F TAN?75.0000
[R/S]	VIEW DATA ↑
[R/S]	STORE PT ↑
[ENTER]	R/S REPEAT
[SHIFT][LR]	ARC L?
120 [R/S]	RADIUS?
250 [R/S]	TURN RIGHT ↑
[R/S]	TURN LEFT ↑
[ENTER]	F TAN?102.3007
[R/S]	VIEW DATA ↑
[R/S]	STORE PT ↑
[ENTER]	R/S REPEAT
[SHIFT][TRAVRS]	HI?
[R/S]	H ROD?
[R/S]	:AZIMUTH?
75 [R/S]	:H DIST?
120 [R/S]	CH EL?
10 [CHS] [R/S]	:AZIMUTH

Store coordinate of point 6.

[SHIFT][COOR-ST]	PT?
6 [R/S]	N?
4850 [R/S]	E?
5225 [R/S]	EL?
100 [R/S]	N?

Setting Up The Random Points File

Now let's enter a random points file to describe the center line of this road.

[SHIFT] [RDM-PTS]	PT?	Execute the RDMPTS function.
1 [R/S]	PT?	#1 is the beginning point.
2 [R/S]	PT?	
2.0003 [CHS] [R/S]	RADIUS?	Enter a curve specifier.
250 [R/S]	PT?	Radius 250 feet, turn right.
3.0004 [CHS] [R/S]	RADIUS?	Enter another curve specifier.
250 [CHS] [R/S]	PT?	Radius 250 feet, turn left.
4 [CHS] [R/S]	PT?	make 4-5 a vertical curve.
5 [R/S]	PT?	
0 [R/S]	0.0000	End of the road.

Assign the **OFSTK** program to the **[LOG]** key and run the setup command.

[XEQ] [ALPHA]		
OFSTK [ALPHA]	STAKE PT ↑	Ignore this display for now.
[USER]		Exit user mode.
[SHIFT] [ASN]		
[ALPHA] OFSTK		
[ALPHA] [LOG]		Assign the key.

[USER]		Go back to user mode.

Setup the instrument at point 6.

[OFSTK]	STAKE PT ↑	execute the program.
[R/S][R/S]		
[R/S][R/S]	SETUP ↑	Scroll to the setup command,
[ENTER]	OCCUPY PT?	and execute the setup command.
6 [ENTER]	BS PT?	Instrument setup at point 6.
1 [R/S]	BS CIR?	Backsight to point 1.
0 [R/S]	START PT?	Zero on backsight.
1 [R/S]	START STA?	Point 1 is the beginning point of the road.
1000 [R/S]	STA INTVL?	Beginning of road is station 10+00.
50 [R/S]	OFFSET DIST?	Station interval 50 feet.
25 [R/S]	STA=1000.00	Offset distance 25 feet.
	STAKE PT ↑	Setup procedure complete, ready for staking.

The current station is at the beginning of the road, station 10+00.

Let's advance to station 11+00 by executing the auto advance command twice.

[R/S]	AUTO STA ↑	Scroll to the auto advancing command.
[ENTER]	ADV CENTER↑	
[ENTER]		Advance 50 feet on the center line.
	STA=1050.00	Displaying new station.
	STAKE PT ↑	Back to top of command tree.
[R/S]	AUTO STA ↑	
[ENTER]	ADV CENTER ↑	
[ENTER]	STA=1100.00	Advance another 50 feet, now the new station is 11+00.

The station 11+00 is 100 feet from the beginning of the road. The azimuth of this segment is 75.0000, so its offset-right should be on the direction of azimuth 165.0000 (75.0000 + 90.0000). Since the elevations of point 1 and point 2 are 100 and 110 feet respectively, the elevation of station 11+00 should be 108.33 feet (at a 8.33 % grade). Let's stake a point on the right hand side of the right-of-way.

[OFSTK]	STAKE PT ↑	Start from the top of the command tree.
[ENTER]	CENTER PT ↑	Select the stake command.
[R/S]	OFFSET RT ↑	Scroll to offset right option.
[ENTER]	GRADE%?	Select the option.

2 [CHS] [R/S]	CURB HI"?	-2% grade from center line to the curb.
6 [R/S]	HI?	6 inch of curb height.
5 [R/S]	H ROD?	5 feet for height of instrument.
5 [R/S]	CIR=17.3125	5 feet for height of rod.

You should now turn the gun to the circular angle of 17.3125.

[R/S]	H.D.=194.658	The horizontal distance of the stake point is 194.658 feet.
[R/S]	EL=108.333	The elevation of the stake point is 108.333 feet.
[R/S]		

If your data collector is connected to a instrument, the CO-OP 41 will read the distance and angle from the instrument. If you are manually entering the data, the CO-OP 41 will prompt you for the measurement. Let's assume we are in manual mode.

	ZENITH<?	Prompt for the zenith angle.
87.3250 [R/S]	SLOPE D?	Prompt for slope distance.
194.8 [R/S]	GO 0.037	Right on the first time!
[R/S]	CUT 0.004"	
[R/S]	CONTINUE ↑	Option to take another shot.
[R/S]	STORE ↑	Option to store the stake point

		or to store the cut or fill.
[ENTER]	STORE PT ↑	Option to store coordinate of the stake point.
[ENTER]	PT=? 6	Is the next point #6?
9 [R/S]	STORE PT ↑	Store stake point coordinate to point 9.
[R/S]	STORE CUT↑	
[ENTER]	STORE PT ↑	store cut sheet.
[OFSTK]	STAKE PT ↑	Go back to top of command tree.

The current station is only 20 feet from the next turning point (point 2) and it is less than the auto stationing distance (50 feet). So if we do another auto advance, the next station will be at the turning point.

[OFSTK]	STAKE PT ↑	Go to top of the command tree.
[R/S]	AUTO STA ↑	
[ENTER]	ADV CENTER↑	
[ENTER]	STA=1120.00	Displaying the next station.
	STAKE PT ↑	Back to top of the command tree.

When you are on a horizontal curve, the offsets will be in the radial direction. When you advancing on a horizontal curve, the station distance is measured by the arc length of the curve.

Now let's go to segment 4-5 to work with the vertical curve.

[OFSTK]	STAKE PT ↑	Start from the top again.
[R/S][R/S]		
[R/S]	CHNG STA ↑	
[ENTER]	NEW STA ↑	Want to specify a new station.
[ENTER]	STATION?	Asking for new station.
1450 [R/S]	STA=1450.00	90 feet from point 4.
	GRADE BEG%? 0.00	Computed beginning grade is 0.00 %
[R/S]		Accept it as is
	GRADE END%?-16.7	Computed ending grade is -16.7%
[R/S]		Accept it as is
	STAKE PT ↑	Ready for staking.

Let's go to stake the center point of station 14+50 and see what kind of numbers we will get.

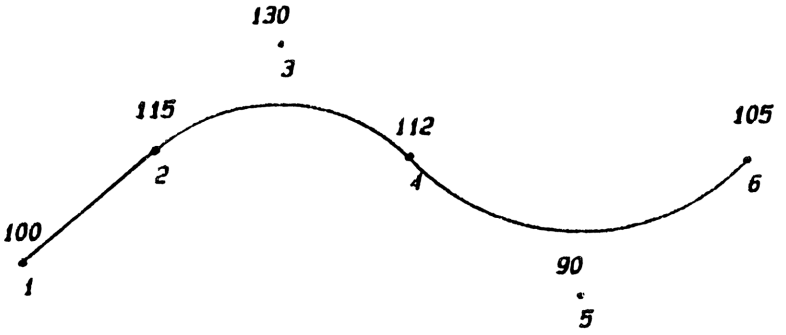
[ENTER]	CENTER PT ↑	
[ENTER]	HI?	No change of height of instr.
[R/S]	H ROD?	No change of height of rod.
[R/S]	CIR=102.0647	Circular angle to the stake point.
[R/S]	H.D.=300.567	Horizontal distance.

[R/S]	EL=104.375	Design elevation of the point.

The parameters of this vertical curve are:

PC: 13+60, EL = 110
PT: 14+80, EL = 100
Horizontal dist = 120
Beginning grade = 0%
Ending grade = -16.67%

Vertical Curve Example



Coordinates and elevations

1.	5000.00	5000.00	100.00
2.	5000.00	5250.00	115.00
3.	5000.00	5450.00	130.00
4.	5000.00	5650.00	112.00
5.	5000.00	5900.00	90.00
6.	5000.00	6150.00	105.00
7.	4900.00	5050.00	100.00

Horizontal distances

1-2	250.00
2-4	400.00
4-6	500.00

The above figure is a profile of a terrain. The elevations are shown above each point. Let's assume that two vertical curves will be put on this road. One is between points 2-3-4, and the other is between points 4-5-6.

This program uses beginning and ending grades to model a vertical curve. It does not need to know the PI (point of intersection) of the curve. The beginning grade is determined by the grade of the previous segment. The ending grade is computed by the following equation:

```
END.G = (2 * (EL.PT - EL.PC) / LENG) - BEG.G

where END.G = ending grade
        BEG.G = beginning grade
        EL.PC = elevation of PC
        EL.PT = elevation of PT
        LENG = horizontal length of the curve
```

When you come to the PC of a vertical curve, the CO-OP 41 will show you the computed values of both the beginning and ending grades. You can either press the [R/S] key to accept the value or enter a different value as you wish.

The following example shows how to set up the random points file for the above two vertical curves.

[SHIFT][RDM-PTS]	PT?	
1 [R/S]	PT?	
2 [CHS][R/S]	PT?	PC of the 1st vertical curve.
4 [CHS][R/S]	PT?	4 is the PT and also the PC for the next curve. Point 3 is not needed.
6 [R/S]	PT?	PT of the 2nd curve. Point 5 is not needed.
0 [R/S]	0.0000	End of random points file.

Now use the COOR-ST function to enter the coordinates of the example road into a job file so you can follow the next example.

[OFSTK]	STAKE PT	↑	Start from the top.
[R/S] [R/S]			
[R/S] [R/S]	SETUP	↑	Scroll to SETUP

[ENTER]	OCCUPY PT?	Execute the command
7 [R/S]	BS PT?	Instrument at point 7
1 [R/S]	BS CIR?	Enter backsight point
0 [R/S]	START PT?	Backsight at zero
1 [R/S]	START STA?	Point 1 is the beginning
1000 [R/S]	STA INTVL?	Set start station to 1000

We don't care about the station interval and the offset distance in this example. So we can stop here for the setup.

Now let's go to the beginning of the first curve to see what kind of values the CO-OP 41 will show us.

[OFSTK]	STAKE PT ↑	Start from the top again
[R/S] [R/S]		
[R/S]	CHNG STA ↑	Scrall to station menu
[ENTER]	NEW STA ↑	
[ENTER]	STATION?	
1250 [R/S]	STA=1250.00	
	GRADE BEG%?6.00	
		Computed beginning grade
[R/S]	GRADE END%?-7.50	
		Computed ending grade

The 6% beginning grade is inherited from the previous segment's (segment 1-2) straight grade. The -7.5% ending grade is computed by the following equation.

```
END.G = (2 * (112 - 115) / 400) - 0.06
      = -0.075
```

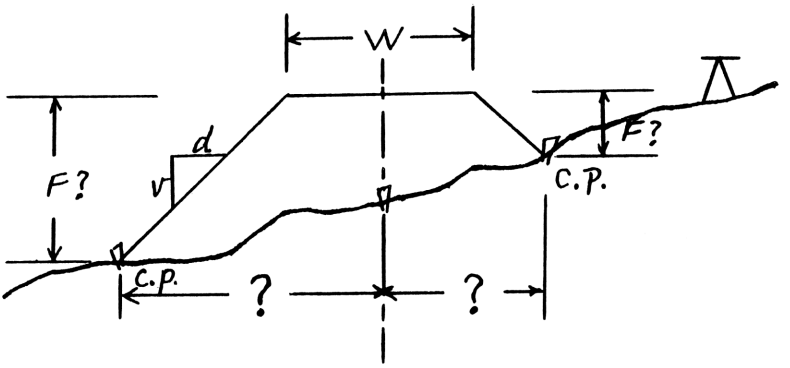
Let's proceed to see the values for the second curve.

```
[OFSTK]          STAKE PT  ↑
[R/S]            AUTO STA  ↑     Advance 400
                                 feet to pass
                                 the 1st curve
[ENTER]          ADV CENTER↑
[R/S] [R/S]
[R/S]            ENTER ADV ↑     Direct enter
                                 advancement
[ENTER]          FEET?
400 [R/S]        STA=1650.00     New station
                 GRADE BEG%?-7.50
                                 Beginning grade
[R/S]            GRADE END%?4.70
                                 Ending grade
```

As you can see, the beginning grade is the same as the ending grade of the previous curve. The ending grade is computed as follows:

```
END.G = (2 * (105 - 112) / 500) - (-0.075)
      = 0.047
```

SLOPE STK



When grading involves large embankments or excavation operations, the slope stakes command can be used for staking the intersection point between design side-slope lines and the natural ground surface. This location is referred to as a 'catch point'.

This command uses a trial-and-error procedure to find the catch point (C.P.). The equation used for computing the catch point is:

C.P. = F * SS + W/2

where F= fill or cut
SS = side slope ratio (d/v)
W= top or bottom width

This command is part of the **OFSTK** program, so you have follow the setup and stationing

procedure of this program. Once you have determined the station, you can execute this command.

This command first prompts for the instrument height and the rod height.

HI?
H ROD?

These values only needed to be entered when they are changed. You can just press [R/S] to use its old value.

Then this command will prompt for the design grade (elevation) of the top or bottom of the road.

GRADE?

Since the true location of the catch point is dependent on the actual terrain of the natural ground surface, it is not possible for the CO-OP 41 to give a precise COME or GO message on the 1rst try. The procedure is therefore iterative. You can speed it up by making an initial estimate of the cut or fill in response to the next prompt.

CUT/FILL?

If you enter this initial estimate, the CO-OP 41 will display

GO xx.xx

You can also ignore the initial estimate by pressing the [R/S] key.

All the COME and GO messages given by this command are referenced to the center line station, not from the point of view of the instrument. The rod man should move on a direction normal or radial to the center line.

When you execute the slope stakes command, you don't need to tell the program on which side of the center line you are staking. This program will figure it out automatically.

The CO-OP 41 will then prompt for the measurements of the next shot or read them directly from the instrument. After computing the next estimate of the C.P., it will display:

COME xx.xx or GO xx.xx

Press the **[R/S]** key after viewing the message. The CO-OP 41 will then put up a scroll menu:

CONTINUE ↑
STORE PT ↑

Select **CONTINUE** for next shot or select **STORE PT** for storing the catch point coordinates.

SS/WIDTH

Set side slope ratio and top or bottom width of road.

This command first prompts for the side slope ratio.

SLOPE RATIO?

Side slope ratio is given as so many units horizontally to so many units vertically. This ratio should be given as a positive number. For instance, a 2-to-1 slope ratio means the bank in question goes 2 ft horizontally for each 1 ft vertically. You can also just press the [R/S] to use its old value and go to the next prompt.

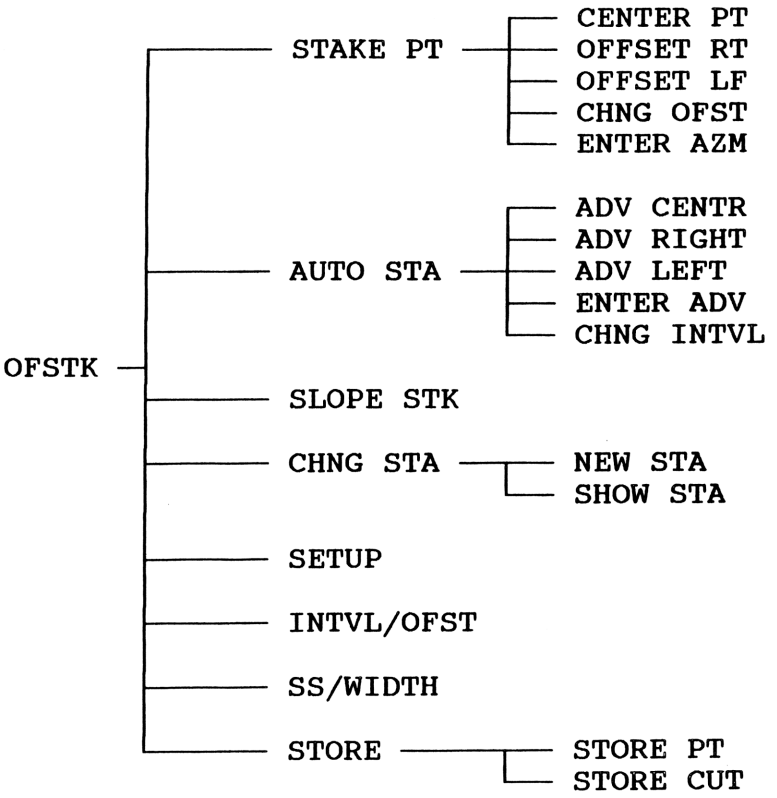
This command then prompts for the top or bottom width of the road.

ROAD WIDTH?

Enter the width in feet and press **[R/S]** or you can just press **[R/S]** to use its old value.

Quick Reference

It is advised that you assign the **OFSTK** program to a key. Whenever you want to execute a different command in this program, press the **OFSTK** key to start from the top of the command tree and then branch off to the desired command.



Warranty

The CO-OP 41 Data Collector Instrument Module is warranted by Tripod Data Systems, Incorporated, against defects in materials and workmanship for one (1) year from the date of original purchase. If you sell your unit or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original one (1) year period, Tripod Data Systems, Inc. will, at our option, repair or replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to our company headquarters.

What is not covered

This warranty does not apply if the product has been damaged by accident or misuse, or as the result of service or modification by someone other than an authorized representative of Tripod Data Systems, Inc. Also not covered: equipment which has been altered, defaced or has had the serial number removed.

No other express or implied warranty is given. The repair and replacement of a CO-OP 41 Data Collector Instrument Module is your exclusive remedy.

IN NO EVENT SHALL TRIPOD DATA SYSTEMS, INC. BE LIABLE FOR CONSEQUENTIAL DAMAGES. And in any event, the company's liability shall not exceed the purchase price of the CO-OP 41 Data Collector Instrument Module.

Obligation to make changes

Products are sold on the basis of specifications applicable at the time of manufacture. Tripod Data Systems, Inc. shall have no obligation to modify or update products sold.

Service Information

You must notify Tripod Data Systems, Inc. of any service requirements before returning a unit for service. If you have any questions concerning warranty or service arrangements, please contact us. After arrangements have been made, products requiring service shall be sent to the following address:

Tripod Data Systems, Inc.
605 NW 5th Street, Suite 2A
Corvallis, OR 97330
1-800-426-8026

Tripod Data Systems, Inc.

CORVALLIS, OREGON

PRINTED IN U.S.A.