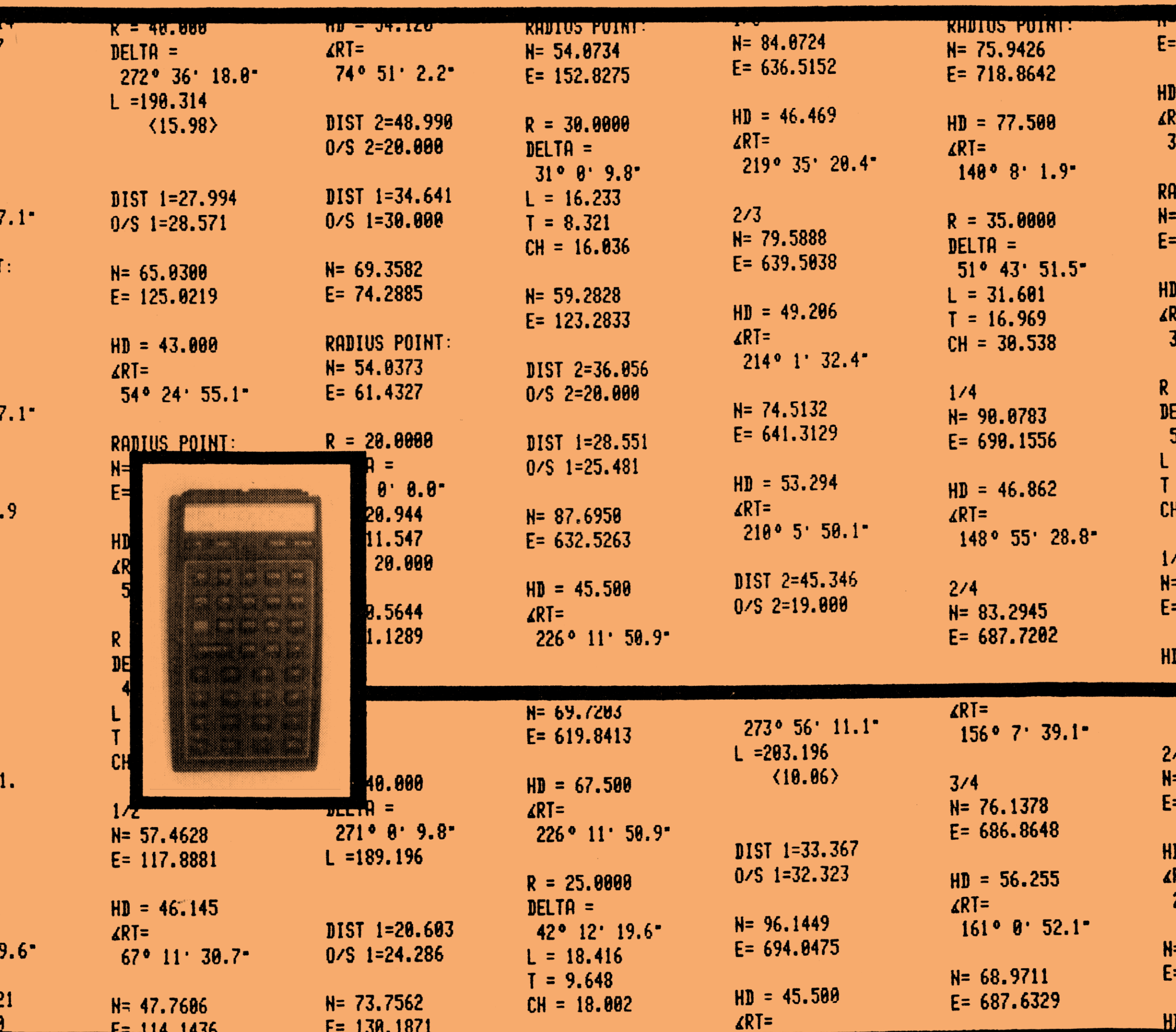
HP-41CV/CX

Geometrics Solutions



NOTICE

HP-41CV/CX

Geometrics Solutions

TED J. KERBER, L.S.

Software by D'Zign
P. O. BOX 1370 • PACIFICA, CA 94044

This book is dedicated to my wife, Phyllis, with my heartfelt thanks for her continued support, enthusiam and coffee.

published by D'Zign Land Survey & Development
Pacifica, California 1986

ISBN 0-9616846-2-3

About the book

This is the second in a series of solutions books designed to aid the surveyor and engineer with calculations encountered on a day-to-day basis.

Surveyors favor the Hewlett-Packard 41 series over other available hand-helds, but no new software for the 41 has been generally available since the first survey applications book, and most of those programs are outdated.

These solution books are presented as an alternative to high-priced ROMs, most of which contain more traverse, inverse, intersection etc. programs. They have the added advantage that the user may customize them to his/her needs, add to them, or modify the type of output.

A printer is not a requirement, but a convenient option. If you have access to a card reader, having the programs on cards is the best way to assure error-free input of the program steps, and a mag card programming service is available through the publisher.

The author has an aversion to typing in long program names, and has assigned simple keystrokes as global labels for the programs, but the user should feel free to assign any name to the programs, if it aids in remembering how to address the programs.

Most of the sub-routines included in the utilities programs may be used in other programs besides those contained in this book. Or, they may act as guides when doing your own programming. It is hoped that other surveyors and engineers will write (and publish) new programs.

If the programs in this book can provide a starting point or stepping stone for new software, it will have been well worth the writing.

CONTENTS

Cul-de-sacs

Cul-de-Sac

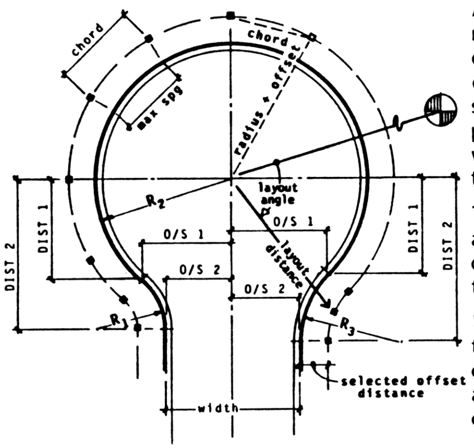
This program solves cul-de-sac problems for design, plotting or layout, with the option of output with or without coordinates. The amount of input information depends on the requested output requirements. For instance, it isn't necessary to input any coordinate or bearing information unless you want the output to show the coordinates. It isn't necessary to input coordinate or backsight information unless the layout option is selected.

In the latter case, the layout information can be assumed for field use; that is, when prompted for coordinate input of the center point, you can input N=100 and E=0, and use N=0 and E=0 for the required backsight information. Then you just occupy the center point and sight back downstation. For the bearing input you would just use "north".

This will also work for a cul-de-sac with a center point that is offset from the street centerline, just by setting the backsight on an offset equal to the centerline offset.

In it's simplest form, this program furnishes the designer with a quick calculation of the cul-de-sac curve data using different trial return curves, or with the coordinate option, quick plotting information is obtained to check the different curves against the terrain shown on a topographic map of the area.

In the field, the barest minimum of information is needed in order to calculate all of the information needed for layout of the curb and gutter offset hubs in just a few minutes.



As shown, the **layout** mode calculates the radial inverses from the center point, directly to the offset hubs. The offset distance to be used and the maximum spacing between the curve points are pre-selected by response to the prompts which are called up by a "Y" response to the **LAYOUT?** prompt.

The maximum spacing selected is the spacing at the curb line. The distance between the offset hubs is automatically adjusted to use the selected maximum distance.

If **layout mode** and **coordinate mode** are used together, the output distance along centerline and the output offset are to the actual curve return point, but the coordinates are those of the offset hub.

For the main curve area, a chord for use in double-chaining of the points is calculated, rather than output of a lot of angles. Since the instrument is at the center of this curve the radially inversed distance to the hubs is always the same.

This program has been designated as "CD". Size the calculator at 045 prior to running it, and initialize the program by keystroking [XEQ] [ALPHA] [C] [D] [ALPHA]. The routines used are guided by prompts, beginning with:

1 **LAYOUT?**

If the calculated solutions are to include radial stakeout of the returns, answer [Y] and the additional prompts (marked *) will appear. If layout is not desired, answer [N] and go to step number 4

[R/S]

2 **OFFSET DIST?***

Input the distance by which you wish to offset the stakes to be set

[R/S]

3 **MAX SPG?***

At this point you can select the maximum spacing which you want between the offset hubs. Input the maximum distance between staked points at the curb line

[R/S]

4 **SHOW COORDS?**

If the coordinates of the solution points are required, answer [Y]. If this option is selected, the coordinates of the radius point will also be calculated.

When the option for LAYOUT has already been selected, the coordinates which are output at the B.C. and E.C. will be those of the **offset hub** location. If layout has not been selected, the coordinates output are the actual E.C. and B.C. locations.

When the answer to this prompt is yes, the additional prompt (marked **) for beginning coordinates will appear.

If the coordinates are not required, answer [N] and proceed at step 9

[R/S]

5 **INTER-X N↑E****

This refers to the actual center point of the main radius for the cul-de-sac. Input the N-coordinate of the intersection point

[ENTER↑]

Input the E-coordinate of the intersection point

[R/S]

6 **BACKSITE?****

Any point with known coordinates may be used. Input the N-coordinate of the backsight point

[ENTER↑]

Input the E-coordinate of the backsight point

[R/S]

7 **BRG=?****

Input the bearing of the centerline of the street [R/S]

8 **QD=?**

Input the quadrant code, using the direction **toward** the cul-de-sac [R/S]

9 **RADII?**

Input the first radius, beginning on the left side and proceeding clockwise around the cul-de-sac. If the cul-de-sac is offset in such a way that the central radius is tangent to the outside line of the street at this point (there is no return curve) input 0 [ENTER↑]

Input the central radius [ENTER↑]

Input the last return radius. If there is no return at this point, input 0 [R/S]

10 **WIDTH?**

Input the width of the street [R/S]

11 **OFFSET?**

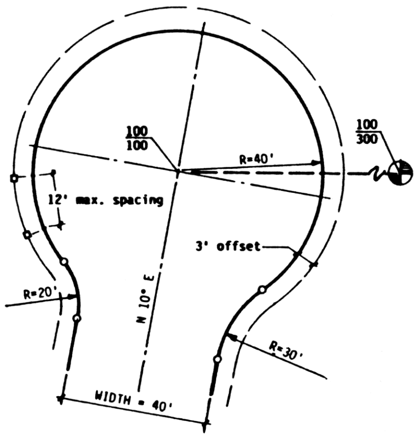
input the amount of offset from the centerline of the street to the main radius point of the cul-de-sac. If the radius point is on the centerline of the street, input 0. If the offset is to the left, [CHS] . [R/S]

Output is automatic, and will print out all of the required data in the same order that the radii were input. If you do not have a printer attached to the calculator, continue stroking the [R/S] key to obtain the output.

We will use the cul-de-sac shown to the right for our first keystroke example, and use both the coordinate output and layout modes.

Assume that a hub offset of 3' is wanted, and use a maximum between points of 12' for the example problem.

Use a coordinate value of N100/E300 for the backsight point, and follow the keystrokes shown in the example on the next page.



keystrokes: [XEQ]

[ALPHA] [C] [D] [ALPHA]

prompt: LAYOUT?

keystrokes:

[Y] [R/S]

prompt: OFFSET DIST?

keystrokes:

[3] [R/S]

prompt: MAX SPG?

keystrokes:

[1] [2] [R/S]

prompt: SHOW COORDS?

keystrokes:

[Y] [R/S]

prompt: INTER-X N↑E

keystrokes:

[1] [0] [0] [ENTER↑]

[1] [0] [0] [R/S]

prompt: BACKSITE?

keystrokes:

[1] [0] [0] [ENTER↑]

[3] [0] [0] [R/S]

prompt: BRG=?

keystrokes:

[1] [0] [R/S]

prompt: QD=?

keystrokes:

[1] [R/S]

prompt: RADII?

keystrokes:

[2] [0] [ENTER↑]

[4] [0] [ENTER↑]

[3] [0] [R/S]

prompt: WIDTH?

keystrokes:

[4] [0] [R/S]

prompt: OFFSET?

keystrokes:

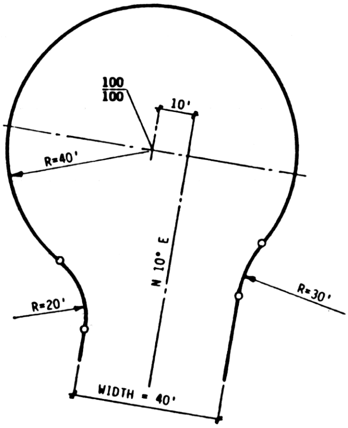
[0] [R/S]

output:

```
DIST 1=29.814
O/S 1=26.667

N= 73.4145
E= 66.2034

HD = 43.000
∡RT=
 141° 48' 37.1"

RADIUS POINT:
N= 62.9040
E= 52.8419

HD = 60.000
∡RT=
 141° 48' 37.1"

R = 20.0000
DELTA =
 48° 11' 22.9"
L = 16.821
T = 8.944
CH = 16.330

1/2
N= 67.0440
E= 69.3301

HD = 45.019
∡RT=
 132° 56' 31.9"

N= 59.9520
E= 69.5836

HD = 50.289
∡RT=
 127° 12' 59.6"

DIST 2=44.721
O/S 2=20.000
```

```
R =40.000
DELTA =
 272° 36' 18.0"
L =190.314
  (15.98)

DIST 1=27.994
O/S 1=28.571

N= 65.0300
E= 125.0219

HD = 43.000
∡RT=
 54° 24' 55.1"

RADIUS POINT:
N= 43.0721
E= 140.7334

HD = 70.000
∡RT=
 54° 24' 55.1"

R = 30.0000
DELTA =
 44° 24' 55.1"
L = 23.256
T = 12.247
CH = 22.678

1/2
N= 57.4628
E= 117.8881

HD = 46.145
∡RT=
 67° 11' 30.7"

N= 47.7606
E= 114.1436

HD = 54.120
∡RT=
 74° 51' 2.2"

DIST 2=48.990
O/S 2=20.000
```

Cul-de-Sac



The cul-de-sac to the left has an offset center point which is 10' left of the centerline of the street. Other than that, it is the same as the previous example.

The only difference in input for this one would be after the last prompt, **OFFSET?**, where you would enter -10 instead of 0.

For a keystroke example, we will calculate the cul-de-sac with just the coordinate output. The prompt for the coordinates of the center point will appear, but not the layout prompts for spacing, hub offset and backsight coordinates. Begin by stroking [XEQ] [ALPHA] [C] [D] [ALPHA], and then:

prompt: **LAYOUT?**
keystrokes:
[N] [R/S]
prompt: **SHOW COORDS?**
keystrokes:
[Y] [R/S]
prompt: **INTER-X N↑E**
keystrokes:
[1] [0] [0] [ENTER↑]
[1] [0] [0] [R/S]
prompt: **BRG=?**
keystrokes:
[1] [0] [R/S]
prompt: **QD=?**
keystrokes:
[1] [R/S]
prompt: **RADII?**
keystrokes:
[2] [0] [ENTER↑]
[4] [0] [ENTER↑]
[3] [0] [R/S]

prompt: **WIDTH?**
keystrokes:
[4] [0] [R/S]
prompt: **OFFSET?**
keystrokes
[1] [0] [CHS] [R/S]
output:

```
DIST 1=34.641
O/S 1=30.000

N=69.3582
E=74.2885

RADIUS POINT:
N=54.0373
E=61.4327

R = 20.0000
DELTA =
 60° 0' 0.0"
L = 20.944
T = 11.547
CH = 20.000

N=50.5644
E=81.1289

DIST 2=51.962
O/S 2=20.000

R =40.000
DELTA =
 271° 0' 9.8"
L =189.196

DIST 1=20.603
O/S 1=24.286

N=73.7562
E=130.1871

RADIUS POINT:
N=54.0734
E=152.8275

R = 30.0000
DELTA =
 31° 0' 9.8"
L = 16.233
T = 8.321
CH = 16.036

N=59.2828
E=123.2833

DIST 2=36.056
O/S 2=20.000
```

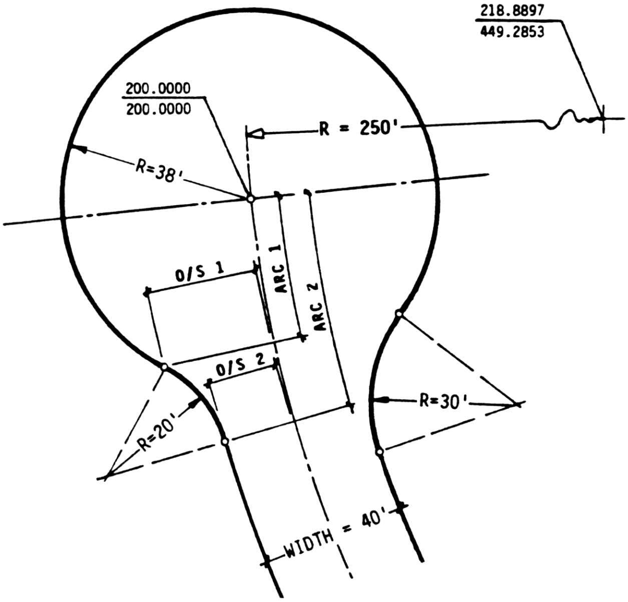
notes

Curved Cul-de-Sac

This group of program routines is used to obtain solutions for cul-de-sacs which occur at the end of a curved centerline alignment, as shown below. The program is fully prompted and begins the prompt sequence as soon as the program CDC is executed.

When used for designing the cul-de-sac, the routine solves for the offsets from centerline at the beginning and ending points, and outputs the centerline arc length for calculation of the stations opposite the return points.

Using the coordinate option, the coordinates for these points are also output, along with the coordinates of the radius point at each return. Using this routine, the coordinates of the main center point and the centerline radius point must be known (or assumed).



As with the other programs, a layout routine is included to allow field calculations of the offset hubs for staking. Layout is inversed directly, with the center point used as the instrument setup position, and the coordinates of a backsight point are also input during the initial prompting sequence. The offset distance and the maximum spacing between the offset hubs is pre-selected by the user.

As shown in the example above, the cul-de-sac return curves do not have to be symmetrical (and the center point of the cul-de-sac does not have to be on the centerline of the street). Use of the routine for a condition where the center is offset from the center of the street alignment will be shown in a second example.

The keystroke procedures and detailed examples are on the following pages. It is suggested that a sketch of the cul-de-sac be available for reference while using the program, to insure that the radii are input in the correct order.

This program has been designated as "CDC". Size the calculator at 045 prior to running it, and initialize the program by keystroking [XEQ] [ALPHA] [C] [D] [C] [ALPHA]. The routines used are guided by prompts, the first of which is:

1 **LAYOUT?**

If the calculated solutions are to include radial stakeout of the returns, answer [Y] and the additional prompts (marked *) will appear. If layout is not desired, answer [N] and go to step number 4

[R/S]

2 **OFFSET DIST?***

Input the distance by which you wish to offset the stakes to be set

[R/S]

3 **MAX SPG?***

At this point you can select the maximum spacing which you want between the offset hubs. Input the maximum distance between staked points at the curb line

[R/S]

4 **SHOW COORDS?**

If the coordinates of the solution points are required, answer [Y]. If this option is selected, the coordinates of the radius point will also be calculated.

When the option for LAYOUT has already been selected, the coordinates which are output at the B.C. and E.C. will be those of the **offset hub** location. If layout has not been selected, the coordinates output are the actual E.C. and B.C. locations.

When the answer to this prompt is yes, the additional prompt (marked **) for beginning coordinates will appear.

If the coordinates are not required, answer [N] and proceed at step 7

[R/S]

5 **INTER-X N↑E****

This refers to the actual center point of the main radius for the cul-de-sac. Input the N-coordinate of the intersection point

[ENTER↑]

Input the E-coordinate of the intersection point

[R/S]

6 **BACKSITE?***

Any point with known coordinates may be used. Input the N-coordinate of the backsight point

[ENTER↑]

Input the E-coordinate of the backsight point

[R/S]

7 **RADIUS N↑E?****

Input the N-coordinate value of the main alignment radius point [ENTER↑]

Input the E-coordinate [R/S]

8 **RADII?**

Input the radii, beginning with the radius of the centerline alignment (if the curve is to the left, [CHS]) [ENTER↑]

The radius of the **outside** return is input next. If the cul-de-sac is offset in such a way that the central radius is tangent to the outside line of the main alignment at this point (there is no return curve) input 0 [ENTER↑]

Input the central radius [ENTER↑]

Input the radius of the last return. Again, if there is no return curve at this point, input 0 [R/S]

Note that, after the input of the centerline radius for the main alignment, the input of the radii is clockwise for an alignment which curves to the right and counter-clockwise for a curve to the left.

9 **WIDTH?**

Input the width of the street [R/S]

10 **OFFSET?**

Input the amount of offset. If the center point of the cul-de-sac is not offset from the centerline alignment, input 0. If the offset is to the left, [CHS] [R/S]

Output will begin with the curve data and arc length/offset data for the outside return and proceed in the same order as the input. When **coordinate** or **layout routines** were requested, the coordinates of the radius point for each return will also be output. In the **layout mode** the coordinates of the return points are those of the offset hubs, but the arc and offset are still to the actual curve point.

In the layout mode the main curve is not divided into a series of angles for layout, but the chord distance from the last hub, for maintaining the required spacing of the hubs is given (shown <XX.xx> in the output) so that the hubs may be quickly double-chained using the last hub and the center point.

For a first example of the keystroke procedures which would be used in solving for the curve data and curve point locations for the cul-de-sac shown on page 7, we begin with the calculator sized at least at size 045.

keystrokes: [XEQ]

[ALPHA] [C] [D] [C] [ALPHA]

prompt: **LAYOUT?**

keystrokes:

[N] [R/S]

prompt: **SHOW COORDS?**

keystrokes:

[N] [R/S]

prompt: **RADII?**

keystrokes:

[2] [5] [0] [ENTER↑]

[2] [0] [ENTER↑]

[3] [8] [ENTER↑]

[3] [0] [R/S]

prompt: **WIDTH?**

keystrokes:

[4] [0] [R/S]

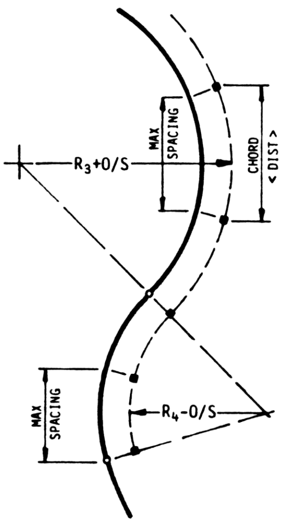
prompt: **OFFSET?**

keystrokes:

[0] [R/S]

output:

```
R = 20.0000
DELTA =
 42° 5' 24.0"
L = 14.692
T = 7.695
CH = 14.364

ARC 1= 26.865
O/S 1= 25.485

ARC 2= 39.036
O/S 2= 20.000

R = 38.0000
DELTA =
 268° 7' 8.9"
L = 177.823

R = 30.000
DELTA =
 48° 54' 46.4"
L = 25.611
T = 13.644
CH = 24.840

ARC 1= 25.981
O/S 1= 29.123

ARC 2= 51.618
O/S 2= 20.000
```



Next, as an example of the **layout mode**, we can use the same cul-de-sac, but assume that we are set up at the intersection point (center point of the main radius) and want to stake out the returns for curb and gutter. We will use a 3' offset line, and a maximum 12 feet between points, to ensure that the curbs will be smoothly curved.

As shown to the left, the maximum spacing selected is the spacing at the actual curb line. The distance between the offset hubs is adjusted automatically to not exceed the selected distance at the curb.

For the central portion the chord distance to pull between the offset hubs is given, and the hubs may be set by double-taping using the chord distance from the last hub and a distance from the center point that is equal to the radius + the offset.

The keystroke procedures for obtaining the angles and distances for layout are shown on the next page. Assume a backsight coordinate of N=100 and E=200.

Curved Cul-de-Sac

keystrokes: [XEQ]

[ALPHA] [C] [D] [C] [ALPHA]

prompt: LAYOUT?

keystrokes:

[Y] [R/S]

prompt: OFFSET DIST?

keystrokes:

[3] [R/S]

prompt: MAX SPG?

keystrokes:

[1] [2] [R/S]

prompt: SHOW COORDS?

keystrokes:

[N] [R/S]

prompt: INTER-X N↑E

keystrokes:

[2] [0] [0] [ENTER↑]

[2] [0] [0] [R/S]

prompt: BACKSITE?

keystrokes:

[1] [0] [0] [ENTER↑]

[2] [0] [0] [R/S]

prompt: RADIUS N↑E

keystrokes:

[2] [1] [8] [.] [8] [8] [9] [7]

[ENTER↑]

[4] [4] [9] [.] [2] [8] [5] [3]

[R/S]

prompt: RADII?

keystrokes:

[2] [5] [0] [ENTER↑]

[2] [0] [ENTER↑]

[3] [8] [ENTER↑]

[3] [0] [R/S]

prompt: WIDTH?

keystrokes:

[4] [0] [R/S]

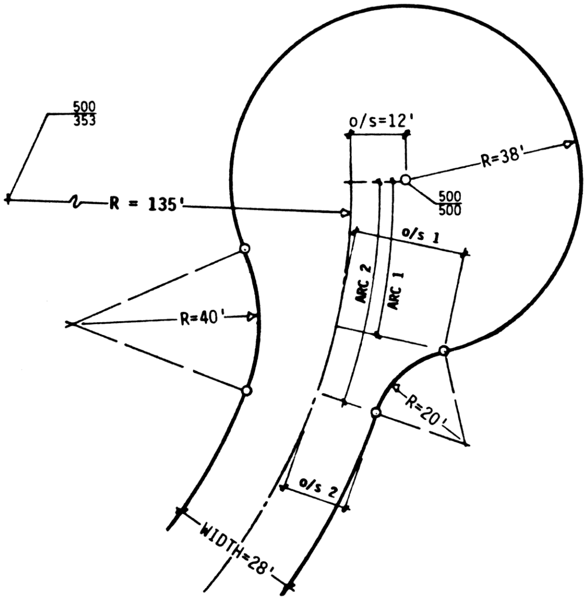
prompt: OFFSET?

keystrokes:

[0] [R/S]

output:

```
R = 20.0000
DELTA =
 42° 5' 24.0"
L = 14.692
T = 7.695
CH = 14.364

ARC 1= 26.865
O/S 1= 25.485

HD = 41.000
∡RT=
 34° 37' 49.2"

RADIUS POINT:
HD = 58.000
∡RT=
 34° 37' 49.2"

1/2
HD = 42.574
∡RT=
 26° 23' 10.4"

HD = 46.793
∡RT=
 20° 32' 9.5"

ARC 2= 39.036
O/S 2= 20.000

R = 38.0000
DELTA =
 268° 7' 8.9"
L = 177.823
  (16.77)

R = 30.00
DELTA =
 48° 54' 46.4"
L = 25.611
T = 13.644
CH = 24.840

ARC 1= 25.981
O/S 1= 29.123

HD = 41.000
∡RT=
 302° 44' 58.2"

RADIUS POINT:
HD = 68.000
∡RT=
 302° 44' 58.2"

1/3
HD = 42.763
∡RT=
 312° 57' 33.8"

2/3
HD = 47.537
∡RT=
 320° 34' 21.3"

HD = 54.219
∡RT=
 324° 47' 39.3"

ARC 2= 51.618
O/S 2= 20.000
```



In addition to being an example of a cul-de-sac with an offset center point, we can also use the one shown to the left as an example of a cul-de-sac on an alignment with a curve to the left.

In using this keystroke example we will assume that we are designing the cul-de-sac, and want to calculate the coordinates for plotting.

With the calculator sized at 045 keystroke [XEQ] [ALPHA] [C] [D] [C] [ALPHA].

Program execution is started and the first prompt appears:

prompt: **LAYOUT?**

keystrokes:

[N] [R/S]

prompt: **SHOW COORDS?**

keystrokes:

[Y] [R/S]

prompt: **INTER-X N↑E**

keystrokes:

[5] [0] [0] [ENTER↑]

[5] [0] [0] [R/S]

prompt: **RADIUS N↑E**

keystrokes:

[5] [0] [0] [ENTER↑]

[3] [5] [3] [R/S]

prompt: **RADII?**

keystrokes:

[1] [3] [5] [CHS] [ENTER↑]

[2] [0] [ENTER↑]

[3] [8] [ENTER↑]

[4] [0] [R/S]

prompt: **WIDTH?**

keystrokes:

[2] [8] [R/S]

prompt: **OFFSET?**

keystrokes:

[1] [2] [R/S]

output:

```
R = 20.0000
DELTA =
 58° 14' 58.7"
L = 20.333
T = 11.143
CH = 19.469
```

```
ARC 1= 31.758
O/S 1= 24.386

N= 462.8507
E= 507.9958

RADIUS POINT:
N= 443.2985
E= 512.2041

N= 450.0087
E= 493.3634

ARC 2= 46.190
O/S 2= 14.000

R = 38.0000
DELTA =
 280° 42' 21.3"
L = 186.171
```

Curved Cul-de-Sac

R = 40.000
DELTA =
44° 48' 49.5"
L = 31.286
T = 16.492
CH = 30.495

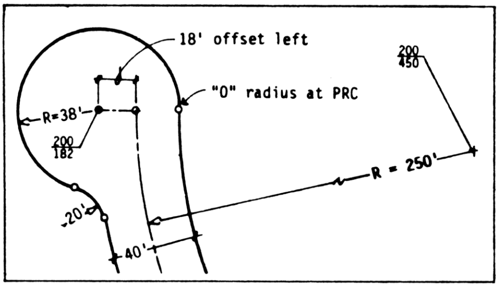
ARC 1= 17.689
O/S 1= 22.049

N= 485.2423
E= 464.9827

RADIUS POINT:
N= 469.7078
E= 428.1224

N= 454.7487
E= 465.2200

ARC 2= 51.745
O/S 2= 14.000



As a last example of this routine, the cul-de-sac shown above is at the end of an alignment curve to the right and is offset to the left. In addition, this is an example of a "0" radius on one side. The curb line on the right side of this street forms a smooth line as it joins the curve of the cul-de-sac at a PRC opposite and radial to the center point of the main cul-de-sac radius.

To demonstrate the output, we will solve for the coordinates, without the layout option. The calculator is sized at 045, and we begin with [XEQ] [ALPHA] [C] [D] [C] [ALPHA].

prompt: **LAYOUT?**

keystrokes:

[N] [R/S]

prompt: **SHOW COORDS?**

keystrokes:

[Y] [R/S]

prompt: **INTER-X N↑E**

keystrokes:

[2] [0] [0] [ENTER↑]

[1] [8] [2] [R/S]

prompt: **RADIUS N↑E**

keystrokes:

[2] [0] [0] [ENTER↑]

[4] [5] [0] [R/S]

prompt: **RADII?**

keystrokes:

[2] [5] [0] [ENTER↑]

[2] [0] [ENTER↑]

[3] [8] [ENTER↑]

[0] [R/S]

prompt: **WIDTH?**

keystrokes:

[4] [0] [R/S]

prompt: **OFFSET?**

keystrokes:

[1] [8] [CHS] [R/S]

output:

R = 20.0000
DELTA =
62° 17' 41.2"
L = 21.745
T = 12.087
CH = 20.690

ARC 1= 32.450
O/S 1= 31.259

N= 163.5949
E= 171.1065

RADIUS POINT:
N= 144.4343
E= 165.3731

N= 148.2664
E= 185.0026

ARC 2= 48.200
O/S 2= 20.000

R = 38.0000
DELTA =
253° 20' 28.7"
L = 168.022

R = 0.000

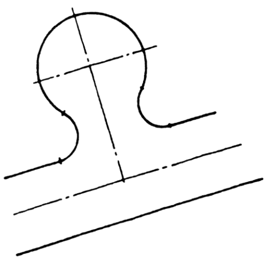
ARC 1= 0.000
O/S 1= 20.000

N= 200.0000
E= 220.0000

notes

Bulbs

A cul-de-sac that is designed in such a way that the return curves are also tangent to the line of the adjacent street is called a "bulb". There are a number of variations of this used by different designers, but the most common type is one that has a "real" throat width. In other words, the only difference between this cul-de-sac and any other is that there is no tangent line between the return curves of the cul-de-sac and the return curves of the street going by it.



The bulb shown to the left is typical of the type which may be resolved using this program. The program allows for the bulb occurring along the outside or inside of a curved street.

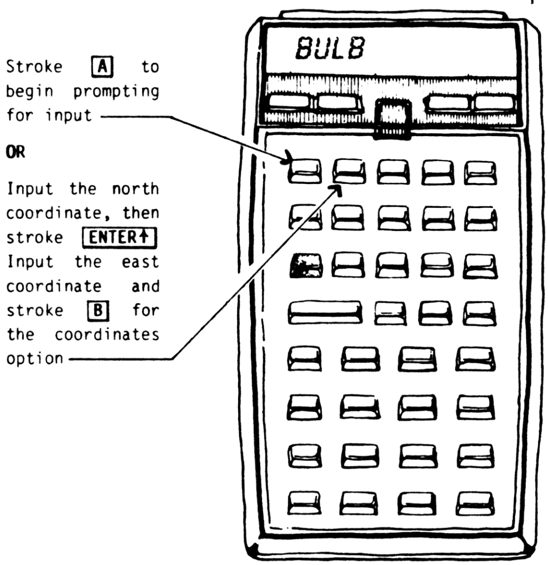
The program has been designated as "**BB**", and works a little differently than the programs for cul-de-sacs, in that after execution, it will halt and wait for you to select the option you want. The options are whether you want the output with or without having the coordinates output.

If coordinates are not wanted, simply keystroke [A] after the program halts (the display will show 360). For the option with coordinates, you will input the coordinates of the street centerline intersection with the centerline of the bulb, and then keystroke [B].

This program does not contain a layout option, it takes far more program steps. The layout may be done using the **cul-de-sac** program and one of the **street intersection** programs which follow.

The two buttons used for this routine are shown in the sketch to the right. When coordinate output is requested, it will output the coordinates of the three radius points, along with the design information and curve data.

If the bulb is on a curved street, the street centerline arc opposite the return points is also given. On a straight street the distance is half of the width of the bulb street plus the return radius. This allows the "street side" to be staked by offsets from centerline.



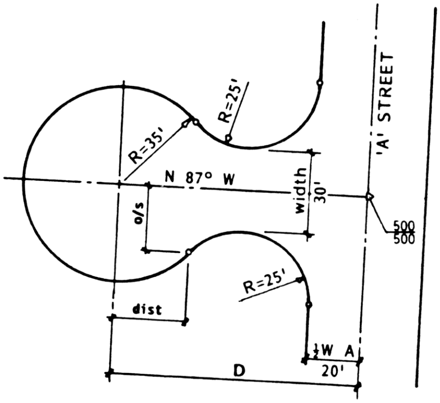
To make this program easy to access, it has been given a global lable of "**BB**". The calculator should be sized at least at 040 before beginning. Initialize the program by keystroking [XEQ] [ALPHA] [B] [B] [ALPHA]. The program will clear the registers and reset the flag status, and then halt.

1		If coordinates are to be calculated, input the N-coordinate value of the intersection of the streets and stroke	[ENTER↑]
2		Input the E-coordinate value for the streets' intersection and stroke	[B]
3	**or**	If coordinates are not wanted, stroke	[A]

The prompts marked* will only appear if the coordinate calculation option has been chosen

4	**BRG=?***	Input the bearing of the cul-de-sac street	[R/S]
5	**QD=?***	Input the quadrant code in the direction **toward** the center of the cul-de-sac	[R/S]
6	**CURVE?**	If the main street (the collector) is curving at the point where the bulb street intersects, answer [Y] [R/S] . If the street is straight, answer [N] [R/S]. When the **Y** answer is given, an additional prompt (marked**) will appear	
7	**OUTSIDE?****	Answer this prompt [Y] [R/S] if the bulb is on the side of the street away from the main alignment's radius point, or [N] [R/S] if it is on the side toward the radius point	
8	**RADII?**	If the bulb does occur at a curve in the main alignment, input the main-line radius first	** [ENTER↑]
9	**or**	Input the radius of the return	[ENTER↑]
10		Input the center radius of the cul-de-sac	[R/S]
11	**1/2W A?**	Input the half-width of the street	[R/S]
12	**WIDTH?**	Input the width at the "throat" of the cul-de-sac	[R/S]

Output is automatic and will first print out the distance from the streets' intersection to the center of the cul-de-sac.



If the bulb is on a curve, the centerline arc distance on the main alignment will be output next, followed by the data for the center curve, the distance and offset to the PRC points and the curve data for the returns.

If coordinate output was selected, the coordinates for the radius points will also be output.

If you do not have a printer attached to the calculator, continue stroking the [R/S] key for the output.

As a first example we can calculate the data for the bulb shown above. We will assume that we do not need the coordinates.

keystrokes: [XEQ]

[ALPHA] [B] [B] [ALPHA]

display: **360.0000**

keystroke: [A]

prompt: **CURVE?**

keystrokes:

[N] [R/S]

prompt: **RADII?**

keystrokes:

[2] [5] [ENTER↑]

[3] [5] [R/S]

prompt: **1/2W A?**

keystrokes:

[2] [0] [R/S]

prompt: **WIDTH?**

keystrokes:

[3] [0] [R/S]

output:

```
D = 89.721

CENTER:
DELTA =
 276° 22' 45.7"
L =168.736

RETURNS:
DIST = 26.087
O/S = 23.333

DELTA =
 138° 11' 22.9"
L = 60.297
T = 65.451
CH = 46.709
```

If coordinates had been wanted, the initial keystrokes would have been:

keystrokes:

[5] [0] [0] [ENTER↑]

[5] [0] [0] [B]

followed by the additional prompts: **BRG=?**

keystrokes:

[8] [7] [R/S]

prompt: **QD=?**

keystrokes:

[4] [R/S]

then:

prompt: **CURVE?**

keystrokes:

[N] [R/S]

prompt: **RADII?**

keystrokes:

[2] [5] [ENTER↑]

[3] [5] [R/S]

prompt: **1/2W A?**

keystrokes:

[2] [0] [R/S]

prompt: **WIDTH?**

keystrokes:

[3] [0] [R/S]

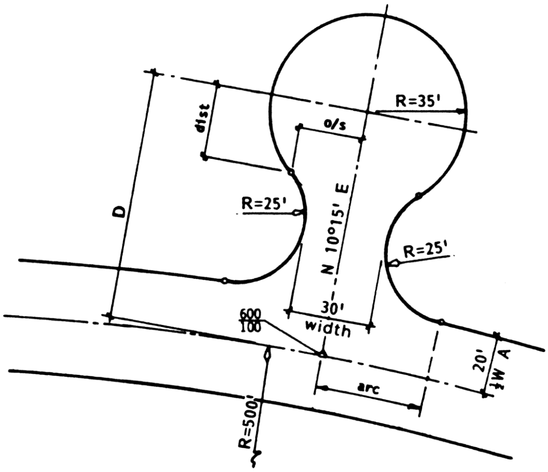
output:

```
D = 89.721

CENTER:
N= 504.6957
E= 410.4016
DELTA =
 276° 22' 45.7"
L =168.736

RETURNS:
DIST = 24.667
O/S = 24.831

N= 462.4099
E= 452.9682

DELTA =
 138° 11' 22.9"
L = 60.297
T = 65.451
CH = 46.709

N= 542.3003
E= 457.1551
```

The bulb shown above is similar to the first one, with the exception that it occurs on a curved street. In this case, on the outside of the curve.

The only difference in input will be that three radii are input instead of two. The main street alignment radius (in this case, 500) is input first.

The keystrokes are as shown to the right.



keystrokes: [XEQ]

[ALPHA] [B] [B] [ALPHA]

display: **360.0000**

keystroke: [A]

prompt: **CURVE?**

keystrokes:

[Y] [R/S]

prompt: **OUTSIDE?**

keystrokes:

[Y] [R/S]

prompt: **RADII?**

keystrokes:

[5] [0] [0] [ENTER↑]

[2] [5] [ENTER↑]

[3] [5] [R/S]

prompt: **1/2W A?**

keystrokes:

[2] [0] [R/S]

prompt: **WIDTH?**

keystrokes:

[3] [0] [R/S]

output:

```
D = 88.251
ARC = 36.730

CENTER:
N= 686.8431
E= 115.7038
DELTA =
 276° 22' 45.7"
L =168.736

RETURNS:
DIST = 21.519
O/S = 27.603

N= 649.9532
E= 68.3843

DELTA =
 133° 58' 50.5"
L = 58.460
T = 58.869
CH = 46.022

N= 635.7177
E= 147.1075
```

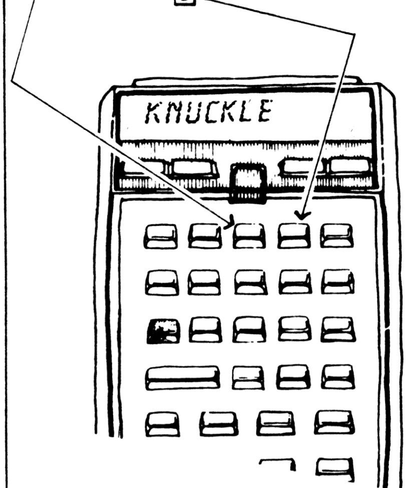
Knuckles

A "knuckle" is sometimes added at the angle-point intersection of two streets in order to get a better lot pattern without actually building in a full cul-de-sac. As with anything else, different designers use different types of solutions. This routine solves for all of the needed data for the type where the return radii are equal, and the central angle of the main area is 180°.

The offset distance (**D**) from the main alignment intersection varies with the angle of intersection and the proportions of the main and return radii. If it occurs outside the angle point, it will be a positive number, if inside, negative. The main line tangent length (**T**) is the distance along the main alignment tangents which will be at a centerline point opposite the BC or EC of the returns.

keystroke [C] to begin the prompt sequence if you do not need coordinate output

if coordinate output is wanted input the coordinates of the intersection point and stroke [D]



An additional feature of this routine is that it also designs a curve to fit the opposite side of the street (opposite the same tangent points).

This allows layout by turning 90's at the tangent points to set the BC or EC offsets and radius points directly. Because of the type of knuckle, all of the radii and the PRC points are on a straight line.

It is also convenient for layout that, with the instrument at the main alignment intersection, the angle to turn to the center radius point is equal to the central angle of the returns when the point is on the inside (D is negative), or 180° minus the return central angle when it falls outside the intersection (D is positive).

Because this program uses so many of the same program steps as are needed in solving for the bulbs, the two programs have been combined. The basic moves are the same, with the exception that we use the [C] and [D] keys to begin the prompt sequence.

After keystroking [XEQ] [ALPHA] [B] [B] [ALPHA], and execution halts, you may either continue by stroking [C] or input the coordinates of the intersection and stroke [D] if you want coordinate output. Either key will begin the prompt sequence. The complete keystroke procedures are on page 20.

Initialize the program by keystroking [XEQ] [ALPHA] [B] [B] [ALPHA] . The program will clear the registers and reset the flag status, and then halt.

After the calculator has halted you may choose whether or not you want to have the coordinates calculated. The routine is fully prompted, and the following are the keystroke procedures:

1		If coordinates are to be calculated, input the N-coordinate value of the intersection of the streets and stroke	[ENTER↑]
2		Input the E-coordinate value for the streets' intersection and stroke	[D]
	or	If coordinates are not wanted, stroke	[C]

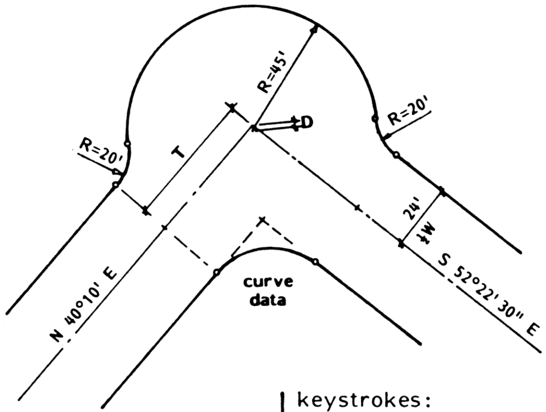
The prompts for the remainder of the input are the same regardless of which option was chosen. Bearing input should be in a **clockwise** direction.

3	**BRG=?**	Input the bearing of the first street	[R/S]
4	**QD=?**	Input the quadrant code	[R/S]
5	**BRG=?**	Input the bearing of the second street	[R/S]
6	**QD=?**	Input the quadrant code	[R/S]
7	**RADII?**	Input the radius of the return	[ENTER↑]
		Input the center radius of the cul-de-sac	[R/S]
8	**1/2W?**	Input the half-width of the street	[R/S]

Output is automatic and will first print out the tangent distance (**T**) along the main tangent, followed by the distance from the streets' intersection to the center of the knuckle (**D**). If coordinate output was selected, the coordinates for the radius points will also be output.

As a first keystroke example, we will use the knuckle shown on the opposite page. Assume that the coordinates of the intersection are N=500 and E=500, and we will have it output the coordinates. If a printer is not attached, continue stroking [R/S] to obtain the output.

Knuckles



keystrokes: [XEQ]

[ALPHA] [B] [B] [ALPHA]

display: **360.0000**

keystrokes:

[5] [0] [0] [ENTER↑]

[5] [0] [0] [D]

prompt: **BRG=?**

keystrokes:

[4] [0] [.] [1] [R/S]

prompt: **QD=?**

keystrokes:

[1] [R/S]

prompt: **BRG=?**

keystrokes:

[5] [2] [.] [2] [2] [3] [R/S]

prompt: **QD=?**

keystrokes:

[2] [R/S]

prompt: **RADII?**

keystrokes:

[2] [0] [ENTER↑]

[4] [5] [R/S]

prompt: **1/2W?**

keystrokes:

[2] [4] [R/S]

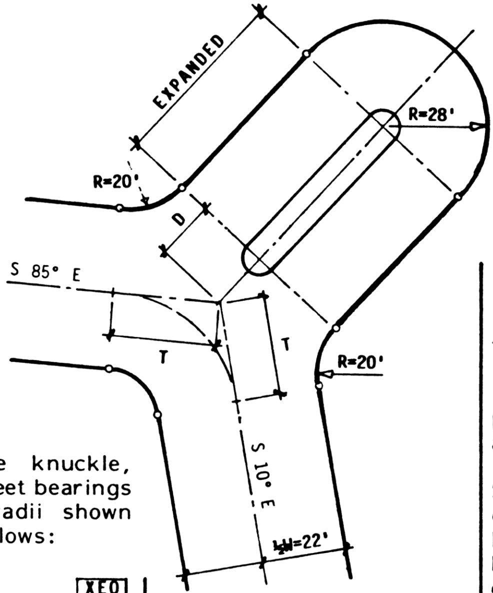
output:

```
T = 47.861
D = -1.289

CENTER:
N= 498.7186
E= 500.1370
DELTA =
 180° 0' 0.0"
L =141.372

RETURNS:
N= 491.8067
E= 435.5056

DELTA =
 46° 16' 15.0"
L = 16.152
T = 8.545
CH = 15.716

N= 505.6304
E= 564.7685

OPPOSITE:
R = 26.0325
DELTA =
 87° 27' 30.0"
L = 39.737
T = 24.903
CH = 35.990
```

If we had stroked [C] without input of the coordinates, the output would be as shown below.

```
T = 47.8608
D = -1.289

CENTER:
DELTA =
 180° 0' 0.0"
L =141.372

RETURNS:
DELTA =
 46° 16' 15.0"
L = 16.152
T = 8.545
CH = 15.716

OPPOSITE:
R = 26.033
DELTA =
 87° 27' 30.0"
L = 39.737
T = 24.903
CH = 35.990
```

The knuckle routine of this program may also be used for designing a cul-de-sac of the type shown on the next page by adding a distance to **D** which expands the knuckle and creates a cul-de-sac.



OPPOSITE:
R = 14.849
DELTA =
75° 0' 0.0"
L = 19.437
T = 11.394
CH = 18.079

Calculate the knuckle, using the street bearings and curve radii shown above, as follows:

keystrokes: [XEQ]
[ALPHA] [B] [B] [ALPHA]
display: **360.0000**
keystroke: [C]
prompt: **BRG=?**
keystrokes:
[8] [5] [R/S]
prompt: **QD=?**
keystrokes:
[2] [R/S]
prompt: **BRG=?**
keystrokes:
[1] [0] [R/S]
prompt: **QD=?**
keystrokes:
[2] [R/S]

prompt: **RADII?**
keystrokes:
[2] [0] [ENTER↑]
[2] [8] [R/S]
prompt: **1/2W?**
keystrokes:
[2] [2] [R/S]
output:
T = 28.2749
D = 16.108

CENTER:
DELTA =
180° 0' 0.0"
L =87.965

RETURNS:
DELTA =
52° 30' 0.0"
L = 18.326
T = 9.863
CH = 17.692

The angle is turned to the center point and **D** is set in the normal way (to become the radius point of the island nose at the centerline).

Set another point at the desired distance from **D**. This point becomes both the radius point of the cul-de-sac and the radius point of the other end of the island.

If the opposite radius which is calculated by the program is not long enough to meet minimum local ordinances, in this case 14.85', it can be recalculated with a new radius, or the return radii can be increased in length. Using 25' as the return radius would give:

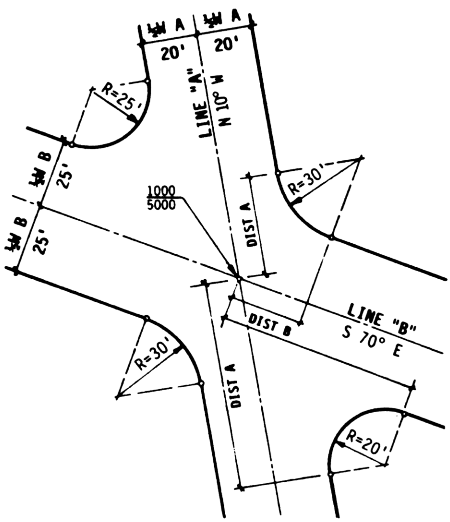
OPPOSITE:
R = 18.062
DELTA =
75° 0' 0.0"
L = 23.643
T = 13.859
CH = 21.991

Intersection - Both Straight

This program can be used on those many occasions when the field crew is to stake out an intersection, but the site plan or subdivision map doesn't give all of the necessary information, or can be used to generate quick solutions when designing the intersection.

In its simplest form, it calculates the distance along centerline to be opposite the E.C. or B.C. of the returns. If desired, the coordinates of the return points and the radius points may be generated, either for plotting or for radial layout from known coordinate points.

A third option, using this program is direct radial layout of offset points to the curb returns from an instrument setup at the intersection. The angles and distances to the offset hubs are output, and the maximum spacing of the offset points around the curve, as well as the offset distance, can be pre-selected to meet the needs of the contractor.



The intersection shown to the left will be used for the examples which follow.

The required information is the bearing of the centerline of each street, the street widths, and the radii at the curb returns. In order to avoid confusion with the output, the line which runs most nearly north-south is designated as line A, and the street running most nearly east-west as line B.

When input, the line A quadrant code should be given in the northerly direction, and the line B quadrant code in the easterly direction. The solutions will begin with the northeasterly return and go clockwise around the intersection.

The output "Dist A" and "Dist B" allow quick calculation of the station at the E.C. and B.C. of the returns and, of course, the offset from centerline is already known.

When used for radial layout of the intersection, the program calculates the angle right to the solution point backsighting northerly along line A.

For easy access to this program, it has been designated as "NN". With the calculator sized at 035, Initialize the program by keystroking [XEQ] [ALPHA] [N] [N] [ALPHA]. All of the routines used are guided by prompts, and the first of these appears as

1	**LAYOUT?**	If the calculated solutions are to include radial stakeout of the returns, answer [Y] [R/S], and the additional prompts (marked *) will appear. If layout is not desired, answer [N] [R/S] and go to step number 4.
2	**OFFSET DIST?***	Input the distance by which you wish to offset the stakes to be set [R/S]
3	**MAX SPG?***	At this point you can select the maximum spacing which you want to have between the offset hubs, in order to assure that the construction of the return is a curve instead of a series of chords. Input the maximum distance between points at the curb line [R/S]
4	**SHOW COORDS?**	If the coordinates of the solution points are required, answer [Y] [R/S]. If this option is selected, the coordinates of the radius point will also be calculated. When the option for LAYOUT has already been selected, the coordinates which are output at the B.C. and E.C. will be those of the **offset hub** location. If layout has not been selected, the coordinates output are the actual E.C. and B.C. locations. When the answer to this prompt is yes, the additional prompt (marked **) for beginning coordinates will appear. If the coordinates are not required, answer [N] [R/S] and proceed at step 6.
5	**INTER-X N↑E****	Input the N-coordinate of the intersection point [ENTER↑] Input the E-coordinate of the intersection point [R/S]
6	**BRG=?**	Input the bearing of line A [R/S]
7	**QD=?**	Input the quadrant code for line A, using the **northerly** direction of the bearing [R/S]

8 **BRG?** Input the bearing for line B [R/S]

9 **QD=?** Input the quadrant code for the line B bearing, using the **easterly** direction [R/S]

10 **1/2W A?** Input the half-width of street A [R/S]

11 **1/2W B?** Input the half-width of street B [R/S]

12 **R?** Input the radius of the first return, beginning in the upper right-hand (northeasterly) corner of the intersection [R/S]

Output will be the solutions requested for the return. If a printer is not attached, continue stroking [R/S] after each output until the solution for this quadrant has been completed. At this point the program will again prompt **R?**.

Return to step 12 for solution of the next return, working clockwise around the intersection.

To begin with an easy example of the keystroke procedures, use the illustrated intersection to calculate solutions without layout or coordinates, as follows:

keystrokes: [XEQ]
[ALPHA] [N] [N] [ALPHA]
prompt: **LAYOUT?**
keystrokes:
[N] [R/S]
prompt: **SHOW COORDS?**
keystrokes:
[N] [R/S]
prompt: **BRG=?**
keystrokes:
[1] [0] [R/S]
prompt: **QD=?**
keystrokes:
[4] [R/S]

prompt: **BRG=?**
keystrokes:
[7] [0] [R/S]
prompt: **QD=?**
keystrokes:
[2] [R/S]
prompt: **1/2W A?**
keystrokes:
[2] [0] [R/S]
prompt: **1/2W B?**
keystrokes:
[2] [5] [R/S]

prompt: **R?**
keystrokes:
[3] [0] [R/S]
output:

```
R = 30.0000
DELTA =
 60° 0' 0.0"
L = 31.416
T = 17.321
CH = 30.000

DIST A = 34.641
DIST B = 25.981
```

The distances may be added or subtracted to the station at the intersection to obtain the station at the return points.

prompt: R?	prompt: R?	prompt: R?
keystrokes:	keystrokes:	keystrokes:
[2] [0] [R/S]	[3] [0] [R/S]	[2] [5] [R/S]
output: R = 20.0000 DELTA = 120° 0' 0.0" L = 41.888 T = 34.641 CH = 34.641 DIST A = 75.056 DIST B = 72.169	output: R = 30.0000 DELTA = 60° 0' 0.0" L = 31.416 T = 17.321 CH = 30.000 DIST A = 34.641 DIST B = 25.981	output: R = 25.0000 DELTA = 120° 0' 0.0" L = 52.360 T = 43.301 CH = 43.301 DIST A = 83.716 DIST B = 80.829

Using the same keystrokes, but with an answer of [Y] [R/S] to the coordinate prompt, the coordinates would have been input as [1] [0] [0] [0] [ENTER↑], [5] [0] [0] [0] [R/S], and the outputs would appear as shown to the right.

The coordinates shown after distances A and B are the coordinates of the return points, at the half-width distance from and opposite the centerline distance point.

The radius point is also output, as a design aid.

R = 30.0000 DELTA = 60° 0' 0.0" L = 31.416 T = 17.321 CH = 30.000	R = 20.0000 DELTA = 120° 0' 0.0" L = 41.888 T = 34.641 CH = 34.641	R = 30.0000 DELTA = 60° 0' 0.0" L = 31.416 T = 17.321 CH = 30.000	R = 25.0000 DELTA = 120° 0' 0.0" L = 52.360 T = 43.301 CH = 43.301
DIST A = 34.641 N= 1,037.5877 E= 5,013.6803	DIST A = 75.056 N= 929.5577 E= 5,032.7294	DIST A = 34.641 N= 962.4123 E= 4,986.3192	DIST A = 83.716 N= 1,078.9710 E= 4,965.7668
RADIUS POINT: N= 1,042.7972 E= 5,043.2250	RADIUS POINT: N= 933.0307 E= 5,052.4256	RADIUS POINT: N= 957.2028 E= 4,956.7750	RADIUS POINT: N= 1,074.6298 E= 4,941.1466
DIST B = 25.981 N= 1,014.6064 E= 5,032.9644	DIST B = 72.169 N= 951.8245 E= 5,059.2660	DIST B = 25.981 N= 985.3936 E= 4,967.0356	DIST B = 80.829 N= 1,051.1375 E= 4,932.5961

Next, as an example of the **layout mode** of this program, we can work the same example, assuming that we are setting the instrument up at the intersection of the centerlines of the two streets, and sighting northerly along line A. We will further assume that we want to set our offset stakes at an offset of 3 feet to the face of the curb, and that we do not want more than 16 feet between the points around the curve.

keystrokes: [XEQ]	prompt: OFFSET DIST?	keystrokes:
[ALPHA] [N] [N] [ALPHA]	keystrokes:	[1] [6] [R/S]
prompt: LAYOUT?	[3] [R/S]	prompt: SHOW COORDS?
keystrokes:	prompt: MAX SPG?	keystrokes:
[Y] [R/S]		[N] [R/S]

prompt: **BRG=?**

keystrokes:

[1] [0] [R/S]

prompt: **QD=?**

keystrokes:

[4] [R/S]

prompt: **BRG=?**

keystrokes:

[7] [0] [R/S]

prompt: **QD=?**

keystrokes:

[2] [R/S]

prompt: **1/2W A?**

keystrokes:

[2] [0] [R/S]

prompt: **1/2W B?**

keystrokes:

[2] [5] [R/S]

prompt: **R?**

keystrokes:

[3] [0] [R/S]

output:

```
R = 30.0000
DELTA =
 60° 0' 0.0"
L = 31.416
T = 17.321
CH = 30.000

DIST A = 34.641
HD = 41.581
∡RT=
 23° 34' 56.2"

RADIUS POINT:
HD = 60.828
∡RT=
 45° 17' 6.0"

1/2
HD = 33.992
∡RT=
 41° 32' 28.9"

DIST B = 25.981
HD = 38.197
∡RT=
 62° 51' 27.9"
```

prompt: **R?**

keystrokes:

[2] [0] [R/S]

output:

```
R = 20.0000
DELTA =
 120° 0' 0.0"
L = 41.888
T = 34.641
CH = 34.641

DIST A = 75.056
HD = 78.501
∡RT=
 152° 57' 46.3"

RADIUS POINT:
HD = 85.049
∡RT=
 141° 56' 42.4"

1/3
HD = 69.571
∡RT=
 147° 11' 4.6"

2/3
HD = 69.087
∡RT=
 137° 34' 16.9"

DIST B = 72.169
HD = 77.410
∡RT=
 131° 12' 18.8"
```

prompt: **R?**

keystrokes:

[3] [0] [R/S]

output:

```
R = 30.0000
DELTA =
 60° 0' 0.0"
L = 31.416
T = 17.321
CH = 30.000

DIST A = 34.641
HD = 41.581
∡RT=
 203° 34' 56.2"

RADIUS POINT:
HD = 60.828
∡RT=
 225° 17' 6.0"

1/2
HD = 55.009
∡RT=
 198° 56' 18.0"

DIST B = 25.981
HD = 38.197
∡RT=
 242° 51' 27.9"
```

prompt: **R?**

keystrokes:

[2] [5] [R/S]

output:

```
R = 25.0000
DELTA =
 120° 0' 0.0"
L = 52.360
T = 43.301
CH = 43.301

DIST A = 83.716
HD = 86.818
∡RT=
 334° 38' 15.5"
```

```
RADIUS POINT:
HD = 95.044
∠RT=
 321° 44' 25.8"

1/4
HD = 98.206
∠RT=
 334° 40' 46.8"

2/4
HD = 108.247
∠RT=
 331° 41' 37.2"

3/4
HD = 114.895
∠RT=
 326° 56' 31.3"

DIST B = 80.829
HD = 85.541
∠RT=
 309° 6' 23.8"
```

It may be noted that, for the last radius, the mid-point was labled as "2/4" instead of 1/2.

Similar output will occur as 2/8, 4/8, 6/8, etc. because it was felt that the user would rather not have to punch in all of the extra steps which would be needed, just to reduce the fractional output to least common denominator.

Answering YES to both the **LAYOUT?** and the **SHOW COORDS?** prompts would result in output as shown below. This type of output is convenient if the layout calculations are done at the same time as the design data is calculated, since it does not require additional work to obtain the field layout information at a later date. A partial printout is shown as an example of the output.

```
R = 30.0000
DELTA =
 60° 0' 0.0"
L = 31.416
T = 17.321
CH = 30.000

DIST A = 34.641
N= 1,038.1086
E= 5,016.6352

HD = 41.581
∠RT=
 23° 34' 56.2"

RADIUS POINT:
N= 1,042.7972
E= 5,043.2250

HD = 60.828
∠RT=
 45° 17' 6.0"

1/2
N= 1,025.4419
E= 5,022.5418

HD = 33.992
∠RT=
 41° 32' 28.9"

DIST B = 25.981
N= 1,017.4254
E= 5,033.9905
```

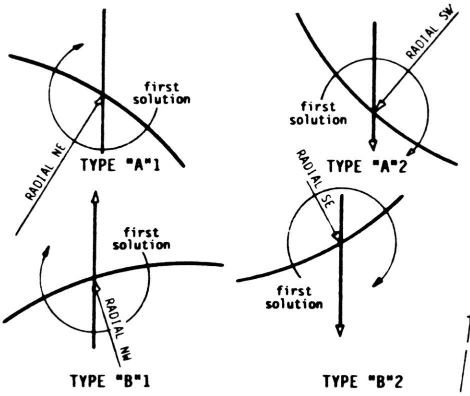
```
HD = 38.197
∠RT=
 62° 51' 27.9"

R = 20.0000
DELTA =
 120° 0' 0.0"
L = 41.888
T = 34.641
CH = 34.641

DIST A = 75.056
N= 930.0786
E= 5,035.6838

HD = 78.501
∠RT=
 152° 57' 46.3"

RADIUS POINT:
N= 933.0307
E= 5,052.4256

HD = 85.049
∠RT=
 141° 56' 42.4"

1/3
N= 941.5307
E= 5,037.7031

HD = 69.571
∠RT=
 147° 11' 4.6"
```

When working in both **layout** and **coordinate output** modes, it should be remembered that coordinates of the offset points are output, rather than those of the return and curve points.

Intersection - One Curved

This program is similar to the previous one, with the exception that it calculates the intersection when one of the streets is straight and the other is curved.

The required information is the bearing of the centerline of the straight street, the radial bearing, **to** the point of intersection, and radius of the curved street, the street widths, and the radii at the curb returns.



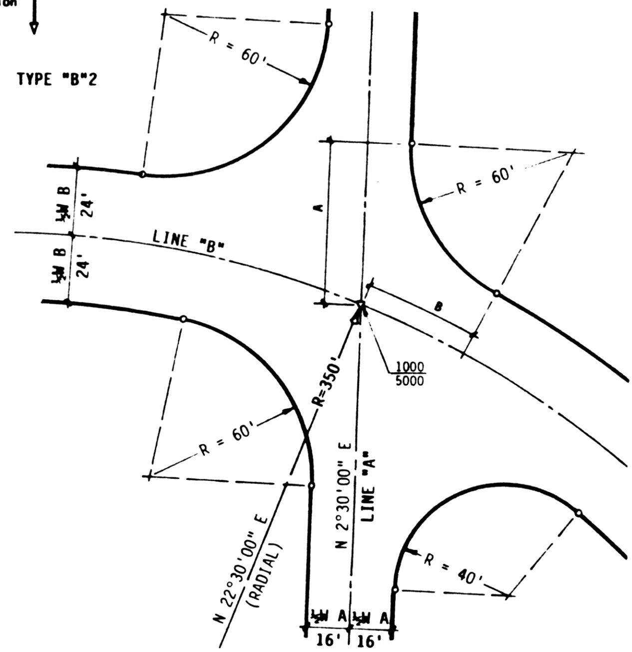
Select type A if the radial bearing is northeast or southwest, and Type B when the radial bearing is northwest or southeast.

When input, the line A quadrant code should be given in the northerly or southerly direction which matches the northerly or southerly direction of the radial bearing of B, when the line B quadrant code is given as radial **to** the point of intersection.

The solutions begin with the return to the right of the line A direction, and go clockwise around the intersection.

The output distance, "A" and the arc, "B" allow calculation of the stations of the E.C. and B.C. points.

The intersection shown to the right will be used as the example, and is a type A1 intersection. All of the basic information is the same as in the last progam, with the exception of the radial instead of the tangent bearing being used for the curved street.



This program has been designated as "NO". With the calculator sized at 035, Initialize the program by keystroking [XEQ] [ALPHA] [N] [O] [ALPHA]. The calculator will clear and pause with a display of 0.0000.

1		Keystroke either [A] or [B] , to correspond with the type of intersection.	[A] or [B]
2	**LAYOUT?**	If the calculated solutions are to include radial stakeout of the returns, answer [Y] [R/S] and the additional prompts (marked *) will appear. If layout is not desired, answer [N] [R/S] and go to step number 5	
3	**OFFSET DIST?***	Input the offset distance for the hubs	[R/S]
4	**MAX SPG?***	Input the maximum spacing which you want between the curve points on the returns	[R/S]
5	**SHOW COORDS?**	If the coordinates of the solution points are required, answer [Y] [R/S]. If this option is selected, the coordinates of the radius point will also be calculated. When the answer to this prompt is yes, the additional prompt (marked **) for beginning coordinates will appear. If the coordinates are not required, answer [N] [R/S] and proceed at step 7	
6	**INTER-X N↑E****	Input the N-coordinate of the intersection point	[ENTER↑]
		Input the E-coordinate of the intersection point	[R/S]
7	**BRG=?**	Input the bearing of line A	[R/S]
8	**QD=?**	Input the quadrant code for line A that corresponds to the northerly or southerly direction of the radial bearing	[R/S]
9	**BRG=?**	Input the radial bearing of street B	[R/S]
10	**QD=?**	Input the quadrant code for the radial bearing of street B in the direction **to** the intersection	[R/S]

11 **R?** Input the radius of the centerline of street B [R/S]

12 **1/2W A?** Input the half-width of street A [R/S]

13 **1/2W B?** Input the half-width of street B [R/S]

14 **R?** Input the radius of the first return, beginning in the quadrant indicated for the type of intersection being calculated [R/S]

Output will be the solutions requested for the return. If a printer is not attached, continue stroking [R/S] after each output until the solution for this quadrant has been completed. At this point the program will again prompt **R?**.

Return to step 14 for solution of the next return, working clockwise around the intersection.

To begin with an easy example of the keystroke procedures, use the illustrated intersection to calculate solutions without layout or coordinates, as follows:

keystrokes: [XEQ]

[ALPHA] [N] [O] [ALPHA]

display: 0.0000

[A] prompt: **LAYOUT?**

keystrokes:

[N] [R/S]

prompt: **SHOW COORDS?**

keystrokes:

[N] [R/S]

prompt: **BRG=?**

keystrokes:

[2] [.] [3] [R/S]

prompt: **QD=?**

keystrokes:

[1] [R/S]

prompt: **BRG=?**

keystrokes:

[2] [2] [.] [3] [R/S]

prompt: **QD=?**

keystrokes:

[1] [R/S]

prompt: **R?**

keystrokes:

[3] [5] [0] [R/S]

prompt: **1/2W A?**

keystrokes:

[1] [6] [R/S]

prompt: **1/2W B?**

keystrokes:

[2] [4] [R/S]

prompt: **R?**

keystrokes:

[6] [0] [R/S]

output:

```
A = 58.477
R = 60.000
DELTA =
 63° 11' 46.1"
L = 66.179
T = 36.909
CH = 62.875
B = 41.563
```

The stations of the E.C. and B.C. may be found using DIST A and ARC B.

Add or subtract from the centerline intersections, depending on the direction of the stationing.

prompt: **R?**

keystrokes:

[4] [0] [R/S]

output:

A = 103.231
R = 40.000
DELTA =
127° 54' 19.6"
L = 89.295
T = 81.841
CH = 71.875
B = 109.378

prompt: **R?**

keystrokes:

[6] [0] [R/S]

output:

A = 66.508
R = 60.000
DELTA =
80° 32' 33.8"
L = 84.344
T = 50.832
CH = 77.569
B = 64.402

prompt: **R?**

keystrokes:

[6] [0] [R/S]

output:

A = 102.901
R = 60.000
DELTA =
95° 46' 47.7"
L = 100.300
T = 66.380
CH = 89.023
B = 86.866

A = 58.477	A = 103.231	A = 66.508	A = 102.901
N= 1,057.7230	N= 896.1692	N= 934.2534	N= 1,103.5011
E= 5,018.5355	E= 5,011.4819	E= 4,981.1142	E= 4,988.5037
RAD. POINT:	RAD. POINT:	RAD. POINT:	RAD. POINT:
N= 1,055.1059	N= 894.4245	N= 936.8706	N= 1,106.1183
E= 5,078.4784	E= 5,051.4438	E= 4,921.1713	E= 4,928.5608
R = 60.000	R = 40.000	R = 60.000	R = 60.000
DELTA =	DELTA =	DELTA =	DELTA =
63° 11' 46.1"	127° 54' 19.6"	80° 32' 33.8"	95° 46' 47.7"
L = 66.179	L = 89.295	L = 84.344	L = 100.300
T = 36.909	T = 81.841	T = 50.832	T = 66.380
CH = 62.875	CH = 71.875	CH = 77.569	CH = 89.023
B = 41.563	B = 109.378	B = 64.402	B = 86.866
N= 1,002.7837	N= 924.8835	N= 995.5687	N= 1,046.7437
E= 5,049.1119	E= 5,077.3715	E= 4,933.6022	E= 4,919.9203

Using the same keystrokes, but with an answer of [Y] [R/S] to the coordinate prompt, the coordinates would have been input as [1] [0] [0] [0] [ENTER↑], [5] [0] [0] [0] [R/S], and the outputs would appear as shown to the left.

The coordinates shown after distances A and B are the coordinates of the return points, at the half-width distance from and opposite the centerline distance point.

The radius point is also output, as a design aid.

Next, as an example of the **layout mode** of this program, we can work the same example, assuming that we are setting the instrument up at the intersection of the centerlines of the two streets, and sighting along line A in the direction that was input at steps 7 and 8. We will further assume that we want to set our offset stakes at an offset of 3 feet to the face of the curb, and that we do not want more than 25 feet between the stakes around the curve.

keystrokes: [XEQ]

[ALPHA] [N] [O] [ALPHA]

display: 0.000

keystrokes:

[A]

prompt: **LAYOUT?**

keystrokes:

[Y] [R/S]

prompt: **OFFSET DIST?**

keystrokes:

[3] [R/S]

prompt: **MAX SPG?**

keystrokes:

[2] [5] [R/S]

prompt: SHOW COORDS?
keystrokes:
[N] [R/S]
prompt: BRG=?
keystrokes:
[2] [·] [3] [R/S]
prompt: QD=?
keystrokes:
[1] [R/S]
prompt: BRG=?
keystrokes:
[2] [2] [·] [3] [R/S]
prompt: QD=?
keystrokes:
[1] [R/S]
prompt: R?
keystrokes:
[3] [5] [0] [R/S]
prompt: 1/2 A?
keystrokes:
[1] [6] [R/S]
prompt: 1/2 B?
keystrokes:
[2] [4] [R/S]
prompt: R?
keystrokes:
[6] [0] [R/S]
output:
A = 58.477
HD = 61.486
∡RT=
17° 59' 59.4"

RAD. POINT:
HD = 95.893
∡RT=
52° 25' 27.4"

R = 60.000
DELTA =
63° 11' 46.1"
L = 66.179
T = 36.909
CH = 62.875

1/3
HD = 44.310
∡RT=
30° 58' 53.0"

2/3
HD = 39.335
∡RT=
59° 1' 57.7"

B = 41.563
HD = 50.868
∡RT=
81° 24' 22.8"

prompt: R?
keystrokes:
[4] [0] [R/S]
output:
A = 103.231
HD = 104.965
∡RT=
169° 34' 16.5"

RAD. POINT:
HD = 117.442
∡RT=
151° 31' 17.0"

R = 40.000
DELTA =
127° 54' 19.6"
L = 89.295
T = 81.841
CH = 71.875

1/4
HD = 87.184
∡RT=
163° 36' 3.6"

2/4
HD = 80.491
∡RT=
150° 24' 14.5"

3/4
HD = 89.395
∡RT=
137° 59' 44.5"

B = 109.378
HD = 108.075
∡RT=
133° 14' 24.0"

prompt: R?
keystrokes:
[6] [0] [R/S]
output:
A = 66.508
HD = 69.169
∡RT=
195° 56' 37.0"

RAD. POINT:
HD = 100.992
∡RT=
228° 48' 38.7"

R = 60.000
DELTA =
80° 32' 33.8"
L = 84.344
T = 50.832
CH = 77.569

1/4
HD = 51.998
∡RT=
205° 37' 11.2"

2/4
HD = 44.008
∡RT=
227° 37' 18.7"

3/4
HD = 50.762
∡RT=
250° 30' 7.5"

B = 64.402
HD = 67.423
∡RT=
261° 13' 39.8"

prompt: R?

keystrokes:

[6] [0] [R/S]

output:

A = 102.901
HD = 104.641
∡RT=
349° 32' 18.8"

RAD. POINT:
HD = 127.924
∡RT=
323° 33' 5.2"

R = 60.000
DELTA =
95° 46' 47.7"
L = 100.300
T = 66.380
CH = 89.023

1/4
HD = 83.272
∡RT=
343° 19' 0.8"

2/4
HD = 71.424
∡RT=
328° 4' 0.8"

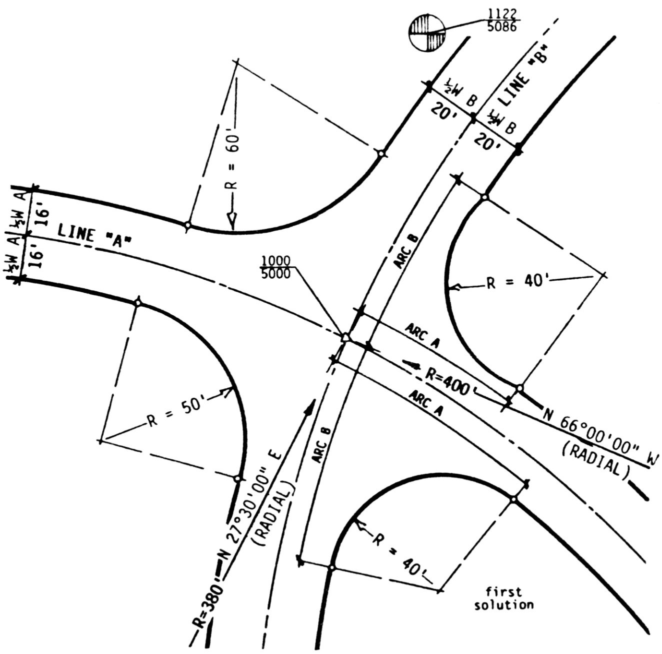
3/4
HD = 75.937
∡RT=
309° 55' 52.8"

B = 86.866
HD = 93.889
∡RT=
299° 28' 13.9"

Intersection - Both Curved

The solution of the returns on an intersection where both of the streets are curved has some slightly different prompts. The main difference is in the **layout** routine. Because neither of the streets is on a tangent, it is necessary to input the backsight coordinates.

When we come to the layout example, we will assume a known point with the coordinates N=1122/E=5086 as a backsight, but any convenient known point may be used.



Both of the bearings are the radial bearings **to** the intersection point. Line A should be clockwise and line B counter-clockwise of the return which is inside both curves.

The first solution will be the return which is on the inside of both curves. Go clockwise for the other solutions.

In the intersection shown to the left, line A has a radius of 380' and a radial bearing of N 27°30' E. Line B has a radial bearing of N 66° W, with a radius of 400'.

The street half-widths are as shown, as are the return radii. The centerline arc distances opposite the E.C. and B.C. points of the returns are output so that the stations may be calculated. As in the previous programs, there are options for calculating the arcs and curve data, the coordinates of the points or doing a complete layout of the intersection at any selected offset and spacing for the stakes.

Keystroke procedures and detailed examples are on the following pages. Even though the program prompts for all of the necessary input, it's handy to have a sketch of the intersection while working with it, in order to input the proper radius dimensions as the solutions are generated.

This program has been designated as "CC". Size the calculator at 045 prior to running it, and initialize the program by keystroking [XEQ] [ALPHA] [C] [C] [ALPHA]. the routines used are guided by prompts, and the first of these is:

1 **LAYOUT?**

If the calculated solutions are to include radial stakeout of the returns, answer [Y] [R/S] and the additional prompts (marked *) will appear. If layout is not desired, answer [N] [R/S] and go to step number 4

2 **OFFSET DIST?***

Input the distance by which you wish to offset the stakes to be set [R/S]

3 **MAX SPG?***

At this point you can select the maximum spacing which you want between the layout points. Input the maximum distance between points [R/S]

4 **SHOW COORDS?**

If the coordinates of the solution points are required, answer [Y] [R/S]. If this option is selected, the coordinates of the radius point will also be calculated.

When the option for LAYOUT has already been selected, the coordinates which are output at the B.C. and E.C. will be those of the **offset hub** location. If layout has not been selected, the coordinates output are the actual E.C. and B.C. locations.

When the answer to this prompt is yes, the additional prompt (marked **) for beginning coordinates will appear.

If the coordinates are not required, answer [N] [R/S] and proceed at step 7

5 **INTER-X N↑E****

Input the N-coordinate of the intersection point [ENTER↑]

Input the E-coordinate of the intersection point [R/S]

6 **BACKSITE?***

Any point with known coordinates may be used. Input the N-coordinate of the backsight point [ENTER↑]

Input the E-coordinate of the backsight point [R/S]

7 **A-LINE R=?** Input the centerline radius of street "A" line. In selecting which line to designate as "A" and which to designate as "B", the line to be used as "A" will be the one with a radial bearing to the intersection **clockwise** from the return which is inside both curves. [R/S]

8 **BRG=?** Input the bearing of line A. [R/S]

9 **QD=?** Input the quadrant code for the line A bearing, using the direction **toward** the intersection [R/S]

10 **1/2W A?** Input the half-width of street A [R/S]

11 **B-LINE R=?** Input the centerline radius of street B [R/S]

12 **BRG=?** Input the bearing for line B [R/S]

13 **QD=?** Input the quadrant code for the line B bearing, using the direction **toward** the intersection [R/S]

14 **1/2W B?** Input the half-width of street B [R/S]

15 **R?** Input the radius of the first return, beginning with the return which is inside both curves [R/S]

Output will be the solutions requested for the return. If a printer is not attached, continue stroking [R/S] after each output until the solution for this quadrant has been completed. At this point the program will again prompt **R?**.

Return to step 15 for solution of the next return, working clockwise around the intersection.

This program, like the last two, assumes that the coordinates of the basic curve data are already known (such as the coordinates of the intersection. In the two previous programs sighting down the tangent and using assumed coordinates will work, but for this program it is necessary to use real values for the intersection and backsight points in order to prevent rotation of the intersection layout.

We will begin with the keystrokes for an example run without the layout option, and do the first three returns. All of the keystrokes for solving the intersection are the same when the layout option is used, except that the additional prompts are answered with known information. Start with the calculator sized at 045, then

keystrokes: [XEQ]

[ALPHA] [C] [C] [ALPHA]

prompt: LAYOUT?

keystrokes:

[N] [R/S]

prompt: SHOW COORDS?

keystrokes:

[Y] [R/S]

prompt: INTER-X N↑E

keystrokes:

[1] [0] [0] [0] [ENTER↑]

[5] [0] [0] [0] [R/S]

prompt: A-LINE R=?

keystrokes:

[3] [8] [0] [R/S]

prompt: BRG=?

keystrokes:

[2] [7] [.] [3] [R/S]

prompt: QD=?

keystrokes:

[1] [R/S]

prompt: 1/2W A?

keystrokes:

[1] [6] [R/S]

prompt: B-LINE R=?

keystrokes:

[4] [0] [0] [R/S]

prompt: BRG=?

keystrokes:

[6] [6] [R/S]

prompt: QD=?

keystrokes:

[4] [R/S]

prompt: 1/2W B?

keystrokes:

[2] [0] [R/S]

prompt: R?

keystrokes:

[4] [0] [R/S]

output:

ARC A = 83.849
N= 919.2400
E= 4,994.3566

RADIUS POINT:
N= 910.6153
E= 5,033.4157

R = 40.000
DELTA =
117° 41' 27.0"
L = 82.164
T = 66.166
CH = 68.462

ARC B = 80.622
N= 941.1930
E= 5,059.2034

prompt: R?

keystrokes:

[5] [0] [R/S]

output:

ARC A = 74.002
N= 950.7452
E= 4,961.0280

RADIUS POINT:
N= 964.2499
E= 4,912.8863

R = 50.000
DELTA =
89° 19' 40.1"
L = 77.953
T = 49.417
CH = 70.295

ARC B = 58.155
N= 1,012.2298
E= 4,926.9549

prompt: R?

keystrokes:

[6] [0] [R/S]

output:

ARC A = 65.876
N= 1,065.1239
E= 5,012.5745

RADIUS POINT:
N= 1,097.6694
E= 4,962.1682

R = 60.000
DELTA =
74° 43' 6.3"
L = 78.245
T = 45.806
CH = 72.817

ARC B = 61.777
N= 1,040.4676
E= 4,944.0586

Intersection - Both Curved

Now, for the example using the layout routine, a backsight point must be selected. In the example illustration the known point used as a backsight is shown as having coordinates of N1122/E5086, and is convenient for backsighting. With a maximum spacing required at 20 feet and the hubs offset 3 feet, we use the keystrokes shown below.

Begin with the calculator sized at 045 and stroke [XEQ] [ALPHA] [C] [C] [ALPHA] to initiate the routine, and follow the prompts

prompt: LAYOUT?
keystrokes:
[Y] [R/S]

prompt: OFFSET DIST?
keystrokes:
[3] [R/S]

prompt: MAX SPG?
keystrokes:
[2] [0] [R/S]

prompt: SHOW COORDS?
keystrokes:
[N] [R/S]

prompt: INTER-X N↑E
keystrokes:
[1] [0] [0] [0] [ENTER↑]
[5] [0] [0] [0] [R/S]

prompt: BACKSITE?
keystrokes:
[1] [1] [2] [2] [ENTER↑]
[5] [0] [8] [6] [R/S]

prompt: A-LINE R=?
keystrokes:
[3] [8] [0] [R/S]

prompt: BRG=?
keystrokes:
[2] [7] [•] [3] [R/S]

prompt: QD=?
keystrokes:
[1] [R/S]

prompt: 1/2W A?
keystrokes:
[1] [6] [R/S]

prompt: B-LINE R=?
keystrokes:
[4] [0] [0] [R/S]

prompt: BRG=?
keystrokes:
[6] [6] [R/S]

prompt: QD=?
keystrokes:
[4] [R/S]

prompt: 1/2W B?
keystrokes:
[2] [0] [R/S]

prompt: R?
keystrokes:
[4] [0] [R/S]

output:

ARC A = 83.849

HD = 81.452
∡RT=
146° 43' 43.5"

RADIUS POINT:

HD = 95.427
∡RT=
124° 19' 17.4"

R = 40.000
DELTA =
117° 41' 27.0"
L = 82.164
T = 66.166
CH = 68.462

1/5
HD = 69.593
∡RT=
105° 36' 54.3"

2/5
HD = 60.089
∡RT=
116° 1' 5.1"

3/5
HD = 59.333
∡RT=
130° 31' 19.4"

4/5
HD = 67.731
∡RT=
141° 52' 32.4"

ARC B = 80.6220
HD = 83.744
∡RT=
101° 40' 23.0"

prompt: **R?**

keystrokes:

[5] [0] [R/S]

output:

ARC A = 74.002

HD = 64.025
∡RT=
185° 38' 57.4"

RADIUS POINT:
HD = 94.164
∡RT=
212° 30' 24.5"

R = 50.000
DELTA =
89° 19' 40.1"
L = 77.953
T = 49.417
CH = 70.295

1/4
HD = 57.752
∡RT=
235° 45' 19.2"

2/4
HD = 47.797
∡RT=
219° 4' 35.0"

3/4
HD = 50.523
∡RT=
197° 58' 22.0"

ARC B = 58.1550
HD = 74.479
∡RT=
242° 1' 55.3"

prompt: **R?**

keystrokes:

[6] [0] [R/S]

output:

ARC A = 65.876

HD = 67.504
∡RT=
333° 23' 5.5"

RADIUS POINT:
HD = 104.740
∡RT=
303° 38' 44.4"

R = 60.000
DELTA =
74° 43' 6.3"
L = 78.245
T = 45.806
CH = 72.817

1/4
HD = 54.805
∡RT=
282° 44' 38.9"

2/4
HD = 47.777
∡RT=
301° 59' 49.6"

3/4
HD = 53.096
∡RT=
322° 15' 37.0"

ARC B = 61.7769
HD = 70.045
∡RT=
273° 1' 52.9"

prompt: **R?**

keystrokes:

[4] [0] [R/S]

output:

ARC A = 52.775

HD = 59.601
∡RT=
15° 31' 6.5"

RADIUS POINT:
HD = 79.540
∡RT=
41° 40' 54.6"

R = 40.000
DELTA =
86° 39' 43.3"
L = 60.502
T = 37.735
CH = 54.897

1/3
HD = 44.154
∡RT=
52° 8' 46.9"

2/3
HD = 45.257
∡RT=
28° 21' 38.0"

ARC B = 56.6842
HD = 57.278
∡RT=
66° 58' 25.4"

Program Listings

The following pages contain the program steps which must be keyed into the calculator in order for the programs to function properly. Since this book has been written with the intention of providing help in the calculations needed for surveying, it is important that the programs provide correct answers when used.

For those users who have card readers, **D'Zign** provides a card-programming service. We will program your cards for you and return them in a labeled card holder which can be inserted directly into the book. The cost for the service is $8.50, and you provide the blank cards.

To take advantage of this option, send 20 blank magnetic cards and your check for $8.50 to **D'Zign land survey & development**, P.O. Box 1370, Pacifica, CA 94044.

KEYING IN A PROGRAM

1. Before beginning to key the program steps into the calculator, keystroke [shift] [GTO] [·] [·] to prepare the calculator for the new program. Set the calculator to **program mode** by pressing the [PRGM] key.

2. Labels are marked with a diamond (♦) in the program listings, as a visual aid. When keying in the program ignore the diamond, and key in **LBL** by keystroking [shift] [LBL] (the STO button), followed by either the label number or [ALPHA] the label name [ALPHA] .

3. Symbols or characters shown with quote marks indicate that they are **alpha** characters, and must be input as program steps in **alpha mode.**

4. Functions which do not appear on the keyboard may be keyed into the program by stroking [ALPHA], spelling out the function, and again stroking [ALPHA]. Some of the functions, such as **FC?01** must be input partly in alpha. Stroke [ALPHA] [F] [C] [?] ; again stroke [ALPHA], and the display will prompt **FC?_ _,** at which time you stroke the **01**. The character * in the listing is the [X] (multiply) button, and the character printed as / is the divide button.

UTILITY PROGRAMS

These are programs which are used as sub-routines by the other programs. For the main programs to function properly these sub-routines must also be in program memory. They are divided into two groups, one called UTILITIES, and the other UTILITIES 2.

Those shown on the opposite page are the same as used in the book "**HP-41CV/CX Surveying Field Solutions**", and do not need to be input again if previously input for use with programs from that book. Additionally, they do not have to be input if the calculator contains the **D'Zign** "COGO 41" module.

"**AZ**" need not be input if the calculator contains the HEWLETT-PACKARD Surveying Pac. This program changes bearing input to north azimuth for storage and use in the various calculations.

"**DMS**" must be in the calculator memory if the calculator is used with a printer attached. It is not necessary when no printer is used. Other than input by use of a card reader, this routine **cannot be put into memory unless a printer is attached while programming.**

If you do not already have these programs, and want them, when sending for the card programming service, include one extra card with your order. The extra card will also contain "**STA**", a handy subroutine which changes the number in the x-register to stationing (XX+XX.xxx) form. The extra card will be programmed with your set at no extra charge.

The following pages contain the programs of the UTILITIES 2 set. The program listings for each of the main programs will tell you which are used each time, but most all of them are used by all of the main programs. UTILITIES 2 contains 529 bytes of programming which would otherwise have to be typed in as part of each program. This sub-routine group occupies 77 registers of program memory.

All of these may also be used with other programs which you write yourself. "**CURD**", for instance, calculates the curve data (store the radius in 17 and the central angle in 21 and have your program contain the step XEQ "CURD") and "**CLR**" may be used at the start of any program to reset the flag status and clear the registers.

Another that you may find use for in your own programming is "**RI**", which performs the radial inverses. Store your instrument position northing in register 05, the easting in 06, and have the north azimuth to the backsight in register 01. If your program includes the step XEQ "RI", it will automatically perform the inverse and output the horizontal distance and angle right to any point whose N-coordinate is in the Y-register and E-coordinate is in the X-register.

```
01♦LBL "AZ"
02 "BRG=?"
03 PROMPT
04 "QD=?"
05 PROMPT
06 X<>Y
07 HR
08 X<>Y
09 ENTER↑
10 ENTER↑
11 2
12 /
13 INT
14 PI
15 R-D
16 *
17 X<>Y
18 LASTX
19 *
20 COS
21 R↑
22 *
23 -
24 FS? 10
25 RTN
26 HMS
27 RTN
```

```
01♦LBL "DMS"
02 STO 23
03 RDN
04 STO 24
05 RDN
06 STO 25
07 RDN
08 STO 26
09 RDN
10 ENTER↑
11 INT
12 CF 29
13 FIX 0
14 ACX
15 -
16 100
17 *
18 ABS
19 STO 22
20 3
21 SKPCOL
22 6
23 ACCOL
24 9
25 ACCOL
26 ACCOL
27 6
28 ACCOL
29 2
30 SKPCOL
31 RCL 22
32 INT
33 ACX
34 39
35 ACCHR
36 RCL 22
37 FRC
38 100
39 *
40 FIX 1
41 ACX
42 34
43 ACCHR
44 PRBUF
45 RCL 26
46 RCL 25
47 RCL 24
48 RCL 23
49 FIX 4
50 SF 29
51 RTN
52 END
```

```
01♦LBL "SORT"
02 XEQ 01
03 "LAYOUT?"        is layout wanted?
04 XEQ 02
05 X=Y?
06 XEQ 23
07 XEQ 01
08 "SHOW COORDS?"   are coordinates
09 XEQ 02           wanted?
10 X=Y?
11 XEQ 22
12 RTN
13♦LBL 01           set for alpha response
14 "Y"
15 ASTO X
16 AON
17 RTN
18♦LBL 02           accept alpha response
19 PROMPT
20 ASTO Y
21 AOFF
22 RTN
23♦LBL 22
24 SF 06
25 SF 02
26 "INTER-X N↑E"
27 PROMPT           prompt for input of
28 STO 06           center coordinates
29 RDN
30 STO 05
31 RTN
32♦LBL 23
33 SF 02
34 SF 03
35 "OFFSET DIST?"
36 PROMPT           prompts for desired
37 STO 02           hub offset distance
38 "MAX SPG?"
39 PROMPT           prompts for spacing
40 STO 32           between layout points
41 RTN
42♦LBL "BA"
```

```
43 RCL 37        radius 'a'
44 RCL 38        return radius 'b'
45 RCL 03        base distance
46 +
47 +
48 2
49 /
50 STO 10
51 X↑2
52 LASTX
53 RCL 38        return radius 'b'
54 *
55 -
56 RCL 37
57 RCL 03
58 *
59 /
60 SQRT
61 ACOS
62 2
63 *
64 STO 39        ancle 'C'
65 SIN
66 RCL 37        radius 'a'
67 STO 28
68 RCL 10
69 X↑2
70 LASTX
71 RCL 37
72 *
73 -
74 RCL 38        radius 'b'
75 /
76 RCL 03        base distance
77 /
78 SQRT
79 ACOS
80 2
81 *
82 STO 40        angle 'B'
83 SF 01
84 RTN
85♦LBL "SET"
86 RCL 27        denominator
87 RCL 34
88 X=Y?
89 RTN
90 RCL 31        return base azimuth
91 RCL 33        curve portion angle
92 RCL 27
93 *
94 FS? 07
95 CHS
96 -
97 CLA
98 FIX 0
99 CF 29
100 ARCL 27      numerator
101 "⊢/"
102 ARCL 34      denominator
103 AVIEW
104 SF 29
105 RCL 17       return radius
106 RCL 02       hub offset constant
107 -
108 P-R
109 RCL 07       radius point N-coord
110 +
111 X<>Y
112 RCL 08       radius point E-coord
```

```
113 +
114 CLA
115 FIX 4
116 XEQ "RI"
117 1
118 ST+ 27
119 GTO "SET"
120 RTN
121♦LBL "CURD"
122 HMS
123 "DELTA ="
124 AVIEW
125 FIX 4
126 CLA
127 ARCL X
128 FC? 55
129 AVIEW
130 FS? 55
131 XEQ "DMS"     output as DD°MM'SS"
132 RCL 17
133 RCL 21
134 D-R
135 *
136 STO 30        curve length
137 RCL 21        curve central angle
138 2
139 /
140 TAN
141 RCL 17
142 *
143 FIX 3
144 "L = "
145 ARCL Y
146 AVIEW         output length
147 "T = "
148 ARCL X
149 AVIEW         output tangent dist
150 RCL 21
151 2
152 /
153 SIN
154 RCL 17
155 *
156 2
157 *
158 "CH = "
159 ARCL X
160 AVIEW         output chord length
161 RTN
162♦LBL "DIV"
163 RCL 17
164 X=0?
165 RTN
166 1
167 STO 27
168 RCL 09
169 180
170 +
171 STO 31        return base azimuth
172 RCL 30        curve arc length
173 RCL 32        maximum spacing
174 /
175 .46
176 +
177 FIX 0
178 RND
179 STO 34        denominator
180 FIX 4
181 RCL 21
182 STO 30        curve portion length
```

```
183 X<>Y
184 /
185 STO 33
186 RTN
187♦LBL "RI"
188 FS? 06
189 XEQ"98"       output coordinates
190 FS? 06
191 ADV
192 RCL 06        instrument E-coord
193 -
194 X<>Y
195 RCL 05        instrument N-coord
196 -
197 R-P
198 FIX 3
199 "HD = "
200 ARCL X
201 AVIEW         distance to hub being
202 CLX           set (offset hub)
203 X<>Y
204 X<0?
205 360
206 +
207 STO 11
208 ENTER↑
209 ENTER↑        calculate angle right
210 90            to the offset hub
211 /
212 1
213 +
214 INT
215 STO 12
216 2
217 /
218 INT
219 180
220 *
221 -
222 ABS
223 HMS
224 FIX 4
225 RCL 12
226 RCL 11
227 RCL 01
228 -
229 ENTER↑
230 CLX
231 X<>Y
232 X<0?
233 360
234 +
235 HMS
236 "∡RT="
237 FC? 55
238 ARCL X
239 AVIEW         output angle right if
240 FS? 55        no printer attached
241 XEQ "DMS"     output as DD°MM'SS"
242 ADV           when the printer is
243 RTN           attached
244♦LBL "98"
245 FIX 4
246 "N= "
247 ARCL Y
248 AVIEW
249 "E= "
250 ARCL X
251 AVIEW
252 RTN
```

```
253♦LBL "CLR"
254 CLRG
255 SF 21
256 SF 27
257 CF 00
258 CF 01
259 CF 02
260 CF 03
261 CF 04
262 CF 05
263 CF 06
264 CF 07
265 CF 08
266 CF 09
267 CF 10
268 RTN
```

Cul-de-Sac

CD occupies 79 registers of program memory and should be used with the calculator sized at least to 045. The program contains 550 bytes of programming, and can be stored on 5 tracks of magnetic cards.

Subroutines used with this program are "**SORT**", "**SET**", "**CURD**", "**DIV**", "**98**", "**CLR**" and "**RI**", all of which are contained in the UTILITIES 2 series of program steps. "**AZ**" and "**DMS**" are also used with this program. "**AZ**" is contained in the Hewlett-Packard Surveying Pac, and both are in the D'Zign "COGO 41" module. It is not necessary to have "**DMS**" in program memory unless the calculator is being used with a printer attached.

```
01♦LBL "CD"
02 XEQ "CLR"     clear registers & set
03 SF 00         flag status
04 SF 07
05 360
06 STO 00
07 XEQ "SORT"    prompt subroutine
08 FS? 03
09 XEQ 21        prompt for backsight
10 FS? 02        coordinates (layout)
11 XEQ 16        prompt routine, input
12 FS? 02        when coordinates or
13 XEQ 22        layout are wanted
14 "RADII?"
15 PROMPT
16 STO 15
17 RDN
18 STO 04
19 RDN
20 STO 14
21 STO 17
22 "WIDTH?"
23 PROMPT
24 2
25 /
26 STO 16        store outer and inner
27 STO 18        values for ½ width of
                 street
28 "OFFSET?"
29 PROMPT        prompt for offset from
30 STO 10        centerline of street
31♦LBL 02        calculate distance and
32 RCL 14        offset to return point
33 RCL 04
34 +
35 STO 37
36 RCL 14
37 RCL 16
38 +
39 RCL 10
40 FS? 07
```

```
41 CHS
42 -
43 X<>Y
44 /
45 ASIN
46 ST- 00
47 FC? 07
48 CHS
49 STO 19
50 FC? 07
51 XEQ 12
52 RCL 19
53 RCL 04
54 X<>Y
55 COS
56 *
57 ABS
58 FIX 3
59 "DIST 1="     output PRC distance
60 ARCL X
61 AVIEW
62 RCL 04
63 RCL 19
64 SIN
65 *
66 ABS
67 RCL 10
68 FS? 07
69 CHS
70 +
71 "O/S 1="      output offset at PRC
72 ARCL X
73 AVIEW
74 FC? 06
75 ADV
76 RCL 19
77 RCL 20
78 +
79 STO 09
80 XEQ 15
81 RCL 14
82 STO 17
83 "R = "        output return radius
84 ARCL X
85 AVIEW
86 90
87 RCL 19
88 FC? 07
89 CHS
90 -
91 STO 21
92 XEQ "CURD"    calculate curve data
93 ADV
94 RCL 19
95 FS? 03        layout wanted?
96 XEQ "DIV"     divide curve
97 FS? 03
98 XEQ "SET"     calculate arc points
99 FS? 02        and set for layout
100 XEQ 18
101 RCL 37
102 RCL 19
103 COS
104 *
105 ABS
106 RCL 16
107 FIX 3
108 "DIST 2="
109 ARCL Y
110 AVIEW         output distance to BC
```

```
111 "O/S 2="
112 ARCL X
113 AVIEW          output offset at BC
114 ADV
115 FC? 07
116 RTN
117 RCL 15         reset for solution of
118 STO 14         second return curve
119 STO 17
120 RCL 18
121 STO 16
122 CF 07
123 XEQ 02
124 RTN
125♦LBL 12         calculate curve data
126 ADV            for central radius of
127 "R = "         the cul-de-sac
128 ARCL 04
129 AVIEW          radius output
130 RCL 00
131 HMS
132 "DELTA ="
133 AVIEW
134 CLA
135 ARCL X
136 FC? 55
137 AVIEW          central angle output
138 FS? 55         when printer is not
139 XEQ "DMS"      attached
                   with printer attached
140 RCL 04
141 RCL 00
142 D-R
143 *
144 FIX 3
145 "L ="
146 ARCL X
147 AVIEW          output curve length
148 FS? 03
149 XEQ 11
150 ADV
151 ADV
152 RTN
153♦LBL 11
154 ENTER↑
155 RCL 32
156 /
157 RCL 02
158 RCL 04
159 +
160 RCL 04
161 /
162 *
163 /
164 FIX 2
165 "    <"
166 ARCL X         output chord value to
167 "├>"           use for double-chain
168 AVIEW          layout in central area
                   of the cul-de-sac
169 RTN
170♦LBL 18
171 RCL 43
172 RCL 21
173 FC? 07
174 CHS
175 +
176 XEQ 19
177 RTN
178♦LBL 50         output of coordinates
179 FS? 03
180 RTN
```

```
181 XEQ "98"        coordinate subroutine
182 ADV
183 RTN
184♦LBL 15
185 RCL 09
186 RCL 37
187 P-R
188 RCL 05
189 +
190 STO 07          return radius N-coord
191 X<>Y
192 RCL 06
193 +
194 STO 08          return radius E-coord
195 FS? 02
196 XEQ 17          adjust azimuth value
197 "RADIUS POINT:"
198 FS? 02          coordinates or layout?
199 AVIEW           output
200 RCL 07
201 RCL 08
202 FS? 06          coordinates wanted?
203 XEQ 50          output of coordinates
204 FS? 03          is layout wanted?
205 XEQ "RI"        calculate angle and
206 RTN             distance to new point
207♦LBL 17
208 ADV
209 RCL 09
210 180
211 +
212 STO 43
213♦LBL 19
214 RCL 17
215 FS? 03
216 RCL 02          hub offset distance
217 FS? 03
218 -
219 P-R
220 RCL 07
221 +
222 X<>Y
223 RCL 08
224 +
225 FS? 06          coordinates wanted?
226 XEQ 50          output the coordinates
227 FS? 03
228 XEQ "RI"        calculate angle and
229 RTN             distance to new point
230♦LBL 01
231 RCL 01
232 RCL 19
233 +
234 RCL 04
235 FS? 03
236 RCL 02
237 FS? 03
238 +
239 P-R
240 RCL 05
241 +
242 X<>Y
243 RCL 06
244 +
245 RTN
246♦LBL 16
247 FS? 06
248 RTN
249 "INTER-X N↑E"   this prompt will
250 PROMPT          appear when either of
                    the coordinates or the
                    layout options wanted
```

```
251 STO 06
252 RDN
253 STO 05
254 RTN
255♦LBL 21
256 "BACKSITE?"   Prompt appears when
257 PROMPT        layout is wanted
258 XEQ 23
259 STO 01
260 RTN
261♦LBL 22
262 SF 10
263 XEQ "AZ"      the input bearing and
264 180           quadrant code stored
265 +             as reverse azimuth
266 STO 20
267 CF 10
268 RTN
269♦LBL 23        set backsight azimuth
270 RCL 06
271 -
272 X<>Y
273 RCL 05
274 -
275 R-P
276 CLX
277 X<>Y
278 X<0?
279 360
280 +
281 RTN
282 END
```

Curved Cul-de-Sac

CDC occupies 95 registers of program memory and should be used with the calculator sized at least to 045. The program contains 669 bytes of programming, and can be stored on 6 tracks of magnetic cards.

Subroutines used with this program are "**SORT**", "**BA**", "**SET**", "**CURD**", "**DIV**", "**CLR**", "**98**" and "**RI**", all of which are contained in the UTILITIES 2 series of program steps. In addition to these, both "**AZ**" and "**DMS**" are used. These are the programs contained in the UTILITIES programs at the beginning of the program listings, and are the same utilities group used with the programs in the book "**HP-41CV/CX Surveying Field Solutions**".

It is not necessary to have "**DMS**" in program memory unless the calculator is being used with a printer attached, and it is not necessary to include the subroutine "**AZ**" in program memory if the calculator contains either the Hewlett-Packard Surveying Pac, or the D'Zign COGO 41 module.

```
01♦LBL "CDC"
02 XEQ "CLR"      clear registers & set
03 SF 04          flag status
04 SF 07
05 XEQ "SORT"     prompt routine sets
06 FS? 02         flag status for output
07 XEQ 06
08 FS? 03         radial inverse if set
09 XEQ 03
10 FS? 02
11 XEQ 02
12 "RADII?"
13 PROMPT
14 STO 15         ending return radius
15 RDN
16 STO 04         main radius
17 RDN
18 STO 14         beginning return rad.
19 RDN
20 X<0?
21 SF 05
22 FS? 05
23 CHS
24 STO 38         alignment radius
25 "WIDTH?"
26 PROMPT
27 2
28 /
29 STO 16         store outer and inner
30 STO 18         values for half-width
31 "OFFSET?"      centerline offset dist.
32 PROMPT
33 FS? 05
34 CHS
35 ST+ 16         modify half-width
36 CHS
37 ST+ 18         modify half-width
38 ST+ 38         modify the alignment
39 STO 36         radius
40 RCL 14
```

```
41 RCL 04
42 +
43 STO 37
44 RCL 38
45 RCL 16
46 RCL 14
47 +
48 +
49 STO 03
50 XEQ "BA"        calculate angles
51 RCL 40
52 RCL 39
53 +
54 ST+ 00
55 "R = "
56 ARCL 14
57 AVIEW           first return radius
58 RCL 14
59 STO 17
60 RCL 39
61 XEQ 01          output curve data for
62♦LBL 13         first return
63 RCL 38
64 RCL 18
65 RCL 15
66 +
67 -
68 STO 03
69 RCL 15
70 RCL 04
71 +
72 STO 37
73 XEQ "BA"        calculate angles
74 180
75 ST+ 00
76 X<>Y
77 RCL 39          angle
78 +
79 -
80 ST+ 00
81 FC? 00
82 XEQ 12          calculate curve data
83 "R = "          for central curve
84 ARCL 15
85 AVIEW           begin output return
86 RCL 15          number two
87 STO 17
88 180
89 RCL 39
90 -
91♦LBL 01
92 STO 21
93 X=0?
94 SF 08
95 FC? 08
96 XEQ "CURD"      calculate curve data
97 XEQ 10
98 FS? 02
99 XEQ 04
100 FS? 08
101 CF 04
102 FS?C 08
103 RTN
104 FS? 03         layout wanted?
105 XEQ "DIV"      divide curve length
106 FS? 03
107 XEQ "SET"      calculate radial layout
108 FS? 02
109 XEQ 08
110 XEQ 14
```

```
111 RTN
112♦LBL 06
113 FS? 06
114 RTN
115 "INTER-X N↑E"
116 PROMPT         prompt appears when
117 STO 06         either coordinate or
118 RDN            layout is selected as
119 STO 05         output. Stores setup
                   point coordinates
120 RTN
121♦LBL 04
122 RCL 09
123 RCL 20
124 +
125 STO 09
126 RCL 37
127 FS? 05         is main curve to the
128 CHS            left?
129 P-R
130 RCL 05
131 +
132 STO 07         return radius N-coord
133 X<>Y
134 FS? 05         is the main curve to
135 CHS            the left?
136 RCL 06
137 +
138 STO 08         return radius E-coord
139 FS? 02
140 XEQ 07         backsight azimuth
141 FS? 08
142 RTN
143 "RADIUS POINT:"
144 FS? 02         coordinates or layout?
145 AVIEW
146 RCL 07
147 RCL 08
148 FS? 06
149 XEQ 05         output coordinates
150 FS? 03
151 XEQ "RI"       radial inverse to set
152 RTN            curve points
153♦LBL 14
154 RCL 40
155 D-R
156 RCL 38
157 RCL 36
158 -
159 *
160 FIX 3
161 FC? 02
162 ADV
163 "ARC 2= "
164 ARCL X
165 AVIEW
166 RCL 36
167 ST+ 16
168 ST- 18
169 "O/S 2= "
170 FS? 04         which side?
171 ARCL 16
172 FC? 04
173 ARCL 18
174 AVIEW
175 RCL 36
176 ST- 16
177 ST+ 18
178 CF 04
179 FIX 4
180 ADV
```

```
181 RTN
182♦LBL 12          output curve data for
183 "R = "          main portion
184 ARCL 04
185 AVIEW
186 RCL 00
187 HMS
188 "DELTA ="
189 AVIEW
190 CLA
191 ARCL X
192 FC? 55
193 AVIEW
194 FS? 55
195 XEQ "DMS"
196 RCL 04
197 RCL 00
198 D-R
199 *
200 FIX 3
201 "L = "
202 ARCL X
203 AVIEW
204 FS? 03
205 XEQ 11          calculate offset chord
206 ADV
207 ADV
208 CF 07
209 RTN
210♦LBL 11          determines the chord
211 ENTER↑          at the offset line for
212 RCL 32          double-taping of main
213 /               portion of cul-de-sac
214 RCL 02
215 RCL 04
```

```
216 +
217 RCL 04
218 /
219 *
220 /
221 FIX 2
222 "   <"
223 ARCL X
224 "├>"
225 AVIEW           output chord distance
226 RTN
227♦LBL 05
228 FS? 03
229 RTN
230 XEQ "98"        output coordinates
231 ADV
232 RTN
233♦LBL 03
234 "BACKSITE?"
235 PROMPT          prompt for input of
236 XEQ 23          backsight coordinates
237 STO 01
238 RTN
239♦LBL 02
240 "RADIUS N↑E"
241 PROMPT          prompt for input of
242 XEQ 23          alignment radius point
243 STO 20          coordinates
244 RTN
245♦LBL 23
246 RCL 06
247 -
248 X<>Y
249 RCL 05
250 -
```

```
251 R-P
252 CLX
253 X<>Y
254 X<0?
255 360
256 +
257 RTN
258•LBL 10
259 ADV
260 180
261 RCL 40
262 RCL 39
263 +
264 -
265 STO 09
266 RCL 04
267 P-R
268 CHS
269 RCL 38
270 +
271 STO 28
272 /
273 ATAN
274 STO 29
275 D-R
276 RCL 38
277 *
278 RCL 28
279 RCL 29
280 COS
281 /
282 RCL 38
283 -
284 FIX 3
285 ABS
```

calculates the offset and arc distances at the return PRC (steps 258–260)

```
286 "ARC 1= "
287 X<>Y
288 RCL 38
289 RCL 36
290 -
291 RCL 38
292 /
293 *
294 X<>Y
295 ARCL Y
296 AVIEW
297 RCL 36
298 FS? 04
299 CHS
300 -
301 "O/S 1= "
302 ARCL X
303 AVIEW
304 FIX 4
305 RTN
306•LBL 07
307 ADV
308 RCL 09
309 180
310 FS? 05
311 CHS
312 +
313 STO 43
314•LBL 09
315 RCL 17
316 FS? 03
317 RCL 02
318 FS? 03
319 -
320 P-R
```

output arc length to return point (steps 286–287)

output offset distance to return point (steps 303–304)

moves to next curve (step 306)

calculates coordinates from return's radius point coordinates (steps 314–316)

```
321 FS? 05
322 CHS
323 RCL 07
324 +
325 X<>Y
326 RCL 08
327 +
328 XEQ 05        output coordinates
329 FS? 03
330 XEQ "RI"      radial inverse to set
                  point
331 RTN
332♦LBL 08
333 RCL 43
334 RCL 21
335 FC? 07
336 CHS
337 +
338 XEQ 09
339 RTN
340 .END.
```

Bulbs & Knuckles

BB occupies 90 registers of program memory and should be used with the calculator sized at least to 045. The program contains 627 bytes of programming, and can be stored on 6 tracks of magnetic cards.

Subroutines used with this program are "**CURD**", "**CLR**" and "**98**", all of which are contained in the UTILITIES 2 series of program steps. In addition to these, both "**AZ**" and "**DMS**" are used.

It is not necessary to have "**DMS**" in program memory unless the calculator is being used with a printer attached, and it is not necessary to include the subroutine "**AZ**" in program memory if the calculator contains either the Hewlett-Packard Surveying Pac, or the D'Zign COGO 41 module.

```
01♦LBL "BB"
02 XEQ "CLR"    clear registers & flag
03 90           status
04 STO 21
05 360
06 STO 00
07 SF 07
08 SF 10
09 RTN
10♦LBL B        bulb solution with the
11 STO 06       coordinates output
12 RDN
13 STO 05
14 SF 06
15 XEQ "AZ"     bearing to azimuth
16 STO 10
17♦LBL A        bulb solution without
18 SF 09        coordinates
19 XEQ 06
20 X=Y?
21 SF 01
22 FS? 01
23 XEQ 06
24 X=Y?
25 SF 04
26 "RADII?"
27 PROMPT       input radii
28 STO 04       main radius stored
29 RDN
30 STO 17       return radius stored
31 FS? 01
32 RDN
33 FS? 01
34 STO 03
35 "1/2W A?"
36 PROMPT       one-half of the street
37 STO 36       width
38 "WIDTH?"     throat width of the
39 PROMPT       cul-de-sac
40 2
```

41 /	
42 STO 16	
43 RCL 17	
44 +	
45 FS? 01	
46 GTO 03	calculate if on curve
47 RCL 17	
48 RCL 04	
49 +	
50 STO 37	
51 /	
52 ASIN	
53 STO 14	
54 CHS	
55 90	
56 +	
57 ST+ 21	add to central angle storage of return
58 RCL 14	
59 2	
60 *	
61 ST- 00	calculate central angle of main bulb section
62 RCL 14	
63 COS	
64 RCL 37	
65 *	
66 RCL 17	
67 RCL 36	
68 +	
69 +	
70♦LBL 00	straight and curve return point
71 FIX 3	
72 STO 15	
73 "D = "	
74 ARCL X	
75 AVIEW	tangent distance to be at centerline of bulb
76 FS? 01	
77 XEQ 01	calculate arc if curve
78 ADV	
79 "CENTER:"	
80 AVIEW	
81 FS? 06	
82 XEQ 02	calculate coordinates at center point
83 RCL 04	
84 RCL 00	
85 HMS	
86 FIX 4	
87 "DELTA ="	
88 AVIEW	
89 ARCL X	
90 FC? 55	
91 AVIEW	
92 FS? 55	
93 XEQ "DMS"	output in form D°M'S" if printer is attached
94 D-R	
95 *	
96 FIX 3	
97 "L ="	
98 ARCL X	
99 AVIEW	length of arc for main curve
100 ADV	
101 "RETURNS:"	
102 AVIEW	
103 XEQ 05	
104 RCL 04	
105 P-R	
106 ABS	
107 FIX 3	
108 "DIST = "	distance to point on centerline at PRC's
109 ARCL X	
110 FC? 08	

```
111 AVIEW
112 X<>Y
113 ABS
114 "O/S = "          offset to PRC's from
115 ARCL X            centerline
116 FC? 08
117 AVIEW
118 FC? 08
119 ADV
120 FS? 06
121 XEQ 04            calculate radius point
122 FS? 06            of return curve
123 ADV
124 RCL 21
125 XEQ "CURD"        calculate and output
126 FS? 06            curve data for return
127 ADV
128 CF 07
129 FS? 06
130 XEQ 04
131 FS? 06
132 ADV
133 FS? 08
134 XEQ 07
135 RTN
136♦LBL 03           calculate if on curve
137 RCL 03
138 RCL 36
139 RCL 17
140 +
141 FS? 04            outside curve?
142 CHS
143 -
144 RCL 17
145 RCL 16
146 +
147 X<>Y
148 /
149 STO 11
150 ASIN
151 STO 12
152 FS? 04            on curve?
153 CHS
154 ST+ 21            add to return delta
155 RCL 27
156 RCL 17
157 RCL 16
158 +
159 RCL 17
160 RCL 04
161 +
162 STO 37
163 /
164 ASIN
165 STO 14
166 CHS
167 90
168 +
169 ST+ 21
170 RCL 14
171 2
172 *
173 ST- 00            subtract from central
174 180               delta angle
175 RCL 14
176 FC? 04
177 -
178 RCL 12
179 +
180 SIN
```

```
181 RCL 37
182 *
183 RCL 11
184 /
185 RCL 03
186 -
187 ABS
188 XEQ 00
189 RTN
190♦LBL D          knuckle solution with
                  coordinates
191 SF 06
192 STO 06
193 RDN
194 STO 05
195♦LBL C          solve knuckle without
                  coordinates
196 SF 08
197 180
198 STO 00
199 90
200 STO 14
201 XEQ "AZ"
202 STO 09
203 XEQ "AZ"
204 STO 18
205 RCL 09
206 RCL 18
207 -
208 ABS
209 2
210 /
211 STO 02
212 90
213 X<>Y
214 -
215 STO 21          central angle, return
216 "RADII?"
217 PROMPT          input of radii
218 STO 04          center radius
219 RDN
220 STO 17          return radius
221 "1/2W?"
222 PROMPT          half-width of street
223 STO 16
224 RCL 09
225 90
226 RCL 02
227 -
228 -
229 STO 10
230 RCL 04
231 RCL 17
232 +
233 RCL 02
234 SIN
235 /
236 STO 19
237 RCL 17
238 RCL 16
239 +
240 -
241 RCL 02
242 TAN
243 *
244 "T = "
245 ARCL X          output tangent dist.
246 AVIEW
247 RCL 04
248 RCL 17
249 +
250 RCL 02
```

```
251 TAN
252 /
253 RCL 19
254 RCL 16
255 -
256 RCL 17
257 -
258 RCL 02
259 COS
260 /
261 -
262 XEQ 00          output return point
263 RTN
264♦LBL 01
265 RCL 12
266 D-R
267 RCL 03
268 *
269 "ARC = "        output arc length
270 ARCL X
271 AVIEW
272 RTN
273♦LBL 02         calculate coordinates
274 RCL 10          at center
275 RCL 15
276 P-R
277 ST+ 05
278 X<>Y
279 ST+ 06
280 RCL 05
281 RCL 06
282 XEQ "98"        output coordinates
283 RTN
284♦LBL 04         calc radius points of
285 XEQ 05          return curve
286 RCL 04
287 RCL 17
288 +
289 P-R
290 RCL 05
291 +
292 STO 07
293 X<>Y
294 RCL 06
295 +
296 STO 08
297 XEQ "98"        output coordinates
298 RTN
299♦LBL 05         set brg/az to radius
300 RCL 10          point of return
301 180
302 +
303 RCL 14
304 FS? 07
305 CHS
306 -
307 RTN
308♦LBL 06         prompt sequence for
309 "Y"             curved alignment
310 ASTO X
311 AON
312 FS? 09
313 "CURVE?"
314 FC? 09
315 "OUTSIDE?"
316 PROMPT
317 ASTO Y
318 AOFF
319 CF 09
320 RTN
```

```
321♦LBL 07      calculate curve data
322 RCL 19      opposite knuckle
323 RCL 16
324 2
325 *
326 -
327 RCL 17
328 -
329 STO 17
330 RCL 02
331 2
332 *
333 STO 21
334 ADV
335 "OPPOSITE:"
336 AVIEW
337 "R = "      output radius opposite
338 ARCL Y
339 AVIEW
340 XEQ "CURD"  calculate curve data
341 RTN
342 END
```

Intersection-Both Straight

NN occupies 94 registers of program memory and should be used with the calculator sized at least to 045. The program contains 656 bytes of programming, and can be stored on 6 tracks of magnetic cards.

Subroutines used with this program are "**SORT**", "**CURD**", "**CLR**", "**RI**" and "**98**", all of which are contained in the UTILITIES 2 series of program steps. In addition to these, both "**AZ**" and "**DMS**" are used.

It is not necessary to have "**DMS**" in program memory unless the calculator is being used with a printer attached, and it is not necessary to include the subroutine "**AZ**" in program memory if the calculator contains either the Hewlett-Packard Surveying Pac, or the D'Zign COGO 41 module.

```
01♦LBL "NN"
02 XEQ "CLR"    clear registers & set
03 SF 10        flag status
04 XEQ "SORT"   subroutine for prompt
05 XEQ "AZ"     sequence
06 STO 09
07 XEQ 04       set direction
08 1
09 X=Y?
10 SF 00
11 XEQ "AZ"     bearing to azimuth
12 STO 10
13 90
14 -
15 XEQ 04       set direction
16 1
17 X=Y?
18 SF 01
19 RCL 09
20 RCL 10
21 -
22 ENTER↑
23 180
24 X<=Y?
25 XEQ 01       rotate by 180°
26 X<>Y
27 X<0?
28 XEQ 00       rotate by 180°
29 X<0?
30 XEQ 00
31 STO 03
32 XEQ 02
33 ADV
34♦LBL 08       calc subroutine
35 "R?"
36 PROMPT
37 STO 17
38 RCL 03
39 FS? 07
40 XEQ 13       subtract from 180°
```

```
41 STO 21
42 XEQ 03          curve data setup
43 XEQ 09          sorts direction, match
44 FIX 3           to flag setting
45 RCL 19
46 ABS
47 "DIST A = "
48 ARCL X
49 AVIEW           output first distance
50 FIX 4
51 FS? 02
52 XEQ 05          calculate coordinates
53 FS? 02
54 XEQ 07          calculate radius point
55 FS? 03          for return
56 XEQ 10
57♦LBL 25          insert for return
58 FIX 3
59 RCL 20
60 ABS
61 "DIST B = "
62 ARCL X          output distance #2
63 AVIEW
64 FIX 4
65 FS? 02
66 XEQ 06          calculate coordinates
67 FS? 09
68 STOP
69 FS? 08
70 GTO 11
71 FS? 07
72 GTO 14          redo flag status
73 SF 00
74 SF 05
75 SF 07
76 GTO 08
77 RTN
78♦LBL 09
79 RCL 09
80 FS? 07
81 XEQ 00          delta less than 0°?
82 90
83 FS? 07
84 CHS
85 FS? 08
86 CHS
87 +
88 RCL 16
89 FS? 09
90 CHS
91 P-R
92 RCL 10
93 90
94 FS? 07
95 CHS
96 FS? 08
97 CHS
98 -
99 RCL 18
100 P-R
101 X<>Y
102 RDN
103 X<>Y
104 -
105 RDN
106 X<>Y
107 -
108 R↑
109 X<>Y
110 STO 22
```

```
111 X<>Y
112 STO 23
113 RCL 10
114 SIN
115 *
116 X<>Y
117 RCL 10
118 COS
119 *
120 +
121 RCL 03
122 SIN
123 /
124 STO 19          distance, quads 1 & 3
125 RCL 22
126 RCL 23
127 FS? 09
128 CHS
129 RCL 09
130 SIN
131 *
132 X<>Y
133 FS? 09
134 CHS
135 RCL 09
136 COS
137 *
138 +
139 RCL 03
140 SIN
141 /
142 FS? 09
143 CHS
144 STO 20          distance quads 2 & 4
145 RCL 17
146 RCL 21
147 2
148 /
149 TAN
150 *
151 FS? 07
152 CHS
153 FS? 08
154 CHS
155 ST+ 19
156 FS? 07
157 CHS
158 FS? 09
159 CHS
160 ST+ 20
161 RTN
162♦LBL 10          calculate return delta
163 1
164 STO 27
165 RCL 09
166 90
167 FS? 08
168 CHS
169 FS? 09
170 CHS
171 -
172 STO 31
173 RCL 30
174 RCL 32
175 /
176 .46
177 +
178 FIX 0
179 RND
180 STO 34
```

```
181 FIX 4
182 RCL 21
183 STO 30
184 X<>Y
185 /
186 STO 33
187♦LBL 12          loop/stop
188 RCL 27
189 RCL 34
190 X=Y?
191 GTO 25          insert for return
192 XEQ 19
193 RTN
194♦LBL 19          curve loop
195 RCL 31
196 RCL 33
197 RCL 27
198 *
199 FS? 07
200 CHS
201 FS? 08
202 CHS
203 -
204 CLA
205 FIX 0
206 CF 29
207 ARCL 27
208 "⊢/"
209 ARCL 34
210 AVIEW           output fractional label
211 SF 29
212 RCL 17
213 RCL 02
214 -
215 P-R
216 RCL 07
217 +
218 X<>Y
219 RCL 08
220 +
221 CLA
222 FIX 4
223 XEQ "RI"        radial inverse to set
224 1               point
225 ST+ 27
226 GTO 12
227 RTN
228♦LBL 11          change from zone 3 to
229 CF 00           zone 4
230 CF 08
231 CF 07
232 CF 05
233 SF 09
234 180
235 RCL 03
236 -
237 STO 03
238 STO 21
239 GTO 08
240 RTN             modify delta
241♦LBL 13
242 180
243 X<>Y
244 -
245 RTN
246♦LBL 14          reset flag status
247 CF 07
248 SF 08
249 SF 04
250 SF 01
```

```
251 GTO 08
252 RTN
253♦LBL 01
254 -
255 ENTER↑
256 RTN
257♦LBL 00
258 180
259 FS? 07
260 CHS
261 +
262 RTN
263♦LBL 02          prompt sequence
264 "1/2W A?"
265 PROMPT
266 STO 16
267 "1/2W B"
268 PROMPT
269 STO 18
270 RTN
271♦LBL 03
272 ADV
273 "R = "
274 ARCL 17         output return radius
275 AVIEW
276 RCL 21
277 XEQ "CURD"      calculate and output
278 ADV             curve data
279 RTN
280♦LBL 04          set azimuth direction
281 90
282 /
283 INT
284 1
285 +
286 2
287 /
288 INT
289 RTN
290♦LBL 05          calculate coordinates
291 RCL 09
292 RCL 16
293 FS? 03
294 XEQ 24
295 FS? 08
296 CHS
297 FS? 09
298 CHS
299 RCL 19
300 R-P
301 RDN
302 +
303 R↑
304 P-R
305 RCL 05
306 +
307 X<>Y
308 RCL 06
309 +
310 FC? 03
311 XEQ "98"        output coordinates
312 FC? 03
313 ADV
314 FS? 03
315 XEQ "RI"        radial inverse to set
316 RTN             point
317♦LBL 24
318 RCL 02
319 +
320 RTN
```

```
321♦LBL 07
322 RCL 09
323 RCL 17
324 RCL 16
325 +
326 FS? 08
327 CHS
328 FS? 09
329 CHS
330 RCL 19
331 R-P
332 RDN
333 +
334 R↑
335 P-R
336 RCL 05
337 +
338 STO 07
339 X<>Y
340 RCL 06
341 +
342 STO 08
343 "RADIUS POINT:"
344 FS? 02
345 AVIEW          label output
346 FC? 03
347 XEQ "98"       output coordinates
348 FC? 03
349 ADV
350 FS? 03
351 XEQ "RI"       radial inverse to set
352 RTN            point
353♦LBL 06         calculate coordinates
354 RCL 10
355 RCL 18
356 FS? 03
357 XEQ 24
358 FS? 08
359 CHS
360 RCL 20
361 R-P
362 RDN
363 FS? 07
364 CHS
365 -
366 R↑
367 P-R
368 RCL 05
369 +
370 X<>Y
371 RCL 06
372 +
373 FC? 03
374 XEQ "98"       output coordinates
375 FC? 03
376 ADV
377 FS? 03
378 XEQ "RI"       radial inverse to set
379 RTN            point
380 END
```

Intersection-One Curved

NO occupies 64 registers of program memory and should be used with the calculator sized at least to 045. The program contains 448 bytes of programming, and can be stored on 4 tracks of magnetic cards.

Subroutines used with this program are "**SORT**", "**CURD**", "**CLR**", "**RI**", "**DIV**", "**SET**" and "**98**", all of which are contained in the UTILITIES 2 series of program steps. In addition to these, both "**AZ**" and "**DMS**" are used.

It is not necessary to have "**DMS**" in program memory unless the calculator is being used with a printer attached, and it is not necessary to include the subroutine "**AZ**" in program memory if the calculator contains either the Hewlett-Packard Surveying Pac, or the D'Zign COGO 41 module.

```
01♦LBL "NO"
02 XEQ "CLR"     clear registers & set
03 SF 10         flag status
04 CLX
05 RTN
06♦LBL B         type B intersection
07 SF 01
08 SF 04
09♦LBL A         type A intersection
10 XEQ "SORT"    prompt sequence
11 XEQ "AZ"      bearing to azimuth
12 STO 01
13 XEQ "AZ"      bearing to azimuth
14 STO 10
15 "R?"          start prompts
16 PROMPT
17 STO 04
18♦LBL 02
19 "1/2W A?"
20 PROMPT
21 STO 16
22 "1/2W B?"
23 PROMPT
24 STO 18
25 "R?"
26 PROMPT
27 STO 17
28 RCL 10
29 RCL 01
30 -
31 FS? 04
32 XEQ 03        calculate return curve
33 STO 00        data
34♦LBL 00
35 ENTER↑
36 SIN
37 RCL 04
38 *
39 STO 03
40 RCL 17
41 RCL 16
42 +
43 FS? 08
44 CHS
```

```
45 FS? 04
46 CHS
47 +
48 RCL 17          return radius
49 RCL 18
50 +
51 FS? 08
52 CHS
53 FS? 07
54 CHS
55 RCL 04
56 +
57 /
58 ASIN
59 STO 14
60 X<>Y
61 FS? 04
62 X<>Y
63 FS? 08
64 X<>Y
65 FS? 07
66 X<>Y
67 -
68 STO 15          angle factor
69 RCL 14
70 COS
71 RCL 04
72 RCL 17          return radius
73 FS? 08
74 CHS
75 FS? 07
76 CHS
77 +
78 RCL 18          width
79 FS? 08
80 CHS
81 FS? 07
82 CHS
83 +
84 *
85 FS? 07
86 CHS
87 RCL 00
88 COS
89 FS? 01
90 CHS
91 RCL 04
92 CHS
93 FS? 07
94 CHS
95 FS? 04
96 CHS
97 *
98 +
99 FS? 07
100 CHS
101 STO 19         distance, line A
102 ABS
103 ADV
104 FIX 3
105 "A = "
106 ARCL X
107 AVIEW          output distance A
108 XEQ 07         calculate coordinates
109♦LBL 05         at radius point
110 RCL 15
111 FS? 07
112 CHS
113 D-R
114 RCL 04
```

```
115 *
116 FS? 08
117 CHS
118 STO 20
119 ABS
120 FIX 3
121 "B = "
122 ARCL X
123 AVIEW          output distance B
124 FIX 4
125 RCL 09
126 180
127 +
128 RCL 21
129 FS? 07
130 CHS
131 -
132 RCL 17
133 FS? 02
134 RCL 02
135 FS? 02
136 -
137 P-R
138 RCL 07
139 +
140 X<>Y
141 RCL 08
142 +
143 FS? 06
144 XEQ 04         output coordinates if
145 FS? 03         wanted
146 XEQ "RI"       radial inverse to set
147 FS? 07         point
148 GTO 01
149 SF 07
150 "R?"
151 PROMPT         input next radius
152 STO 17
153 RCL 00
154 GTO 00
155 RTN
156♦LBL 03        calculate return curve
157 360
158 X<>Y
159 -
160 360
161 X<>Y
162 X>Y?
163 -
164 X<0?
165 CHS
166 RTN
167♦LBL 01        reset flag status
168 SF 00
169 CF 07
170 SF 08
171 "R?"
172 PROMPT         input next radius
173 STO 17
174 RCL 00
175 GTO 00
176 RTN
177♦LBL 07        calculate coordinates
178 RCL 01         at radius point
179 RCL 19
180 P-R
181 RCL 05
182 +
183 STO 07
184 X<>Y
```

```
185 RCL 06
186 +
187 STO 08
188 RCL 01
189 90
190 FS? 08
191 CHS
192 +
193 STO 09
194 RCL 16
195 FS? 02
196 RCL 02
197 FS? 02
198 +
199 P-R
200 ST+ 07
201 X<>Y
202 ST+ 08
203 RCL 07
204 RCL 08
205 FS? 06
206 XEQ 04          output coordinates
207 FS? 03
208 XEQ "RI"        radial inverse to set
209 RCL 09          point
210 RCL 17
211 FS? 02
212 RCL 02
213 FS? 02
214 -
215 P-R
216 ST+ 07
217 X<>Y
218 ST+ 08
219 RCL 07
220 RCL 08
221 "RAD. POINT:"
222 FS? 02
223 AVIEW           label output
224 FS? 06
225 XEQ 04          output coordinates
226 FS? 03
227 XEQ "RI"        radial inverse to set
228 FIX 3           point
229 "R = "
230 ARCL 17
231 AVIEW           output current radius
232 90
233 RCL 14
234 CHS
235 FS? 07
236 CHS
237 FS? 04
238 CHS
239 +
240 STO 21
241 XEQ "CURD"      calculate and output
242 ADV             curve data
243 FS? 03
244 XEQ "DIV"       divide curve per max
245 FS? 03          spacing requirements
246 XEQ "SET"       calculate curve points
247 GTO 05
248 RTN
249♦LBL 04
250 FS? 03
251 RTN
252 XEQ "98"        output coordinates
253 ADV
254 RTN
```

Intersection - Both Curved

CC occupies 92 registers of program memory and should be used with the calculator sized at least to 045. The program contains 641 bytes of programming, and can be stored on 6 tracks of magnetic cards.

Subroutines used with this program are "**SORT**", "**CURD**", "**CLR**", "**RI**", "**DIV**", "**SET**" and "**98**", all of which are contained in the UTILITIES 2 series of program steps. In addition to these, both "**AZ**" and "**DMS**" are used.

It is not necessary to have "**DMS**" in program memory unless the calculator is being used with a printer attached, and it is not necessary to include the subroutine "**AZ**" in program memory if the calculator contains either the Hewlett-Packard Surveying Pac, or the D'Zign COGO 41 module.

```
01♦LBL "CC"
02 XEQ "CLR"     clear registers & set
03 SF 10         flag status
04 XEQ "SORT"    prompt sequence
05 FS? 03
06 XEQ 11
07 FS? 03
08 XEQ 10
09 "A LINE R=?"
10 PROMPT        begin added prompts
11 STO 37
12 XEQ "AZ"      bearing to azimuth
13 STO 35
14 "1/2W A?"
15 PROMPT
16 STO 16
17 "B LINE R=?"
18 PROMPT
19 STO 38
20 XEQ "AZ"      bearing to azimuth
21 STO 36        radial azimuth, line B
22 CF 10
23 RCL 35        radial azimuth line A
24 X<>Y
25 -
26 360
27 X<>Y
28 X<0?
29 +
30 STO 00
31 "1/2W B?"
32 PROMPT
33 STO 18
34 RCL 00        delta
35 RCL 38        radius, line B
36 P-R
37 RCL 37        radius, line A
38 -
39 R-P
40 STO 03        base distance
```

```
41 CLX
42 RCL 37
43 RCL 38
44 RCL 03
45 +
46 +
47 2
48 /
49 STO 10
50 X↑2
51 LASTX
52 RCL 38          radius, line B
53 *
54 -
55 RCL 37
56 RCL 03
57 *
58 /
59 SQRT
60 ACOS
61 2
62 *
63 STO 39          calculated angle
64 SIN
65 RCL 37
66 STO 28
67 RCL 10
68 X↑2
69 LASTX
70 RCL 37
71 *
72 -
73 RCL 38
74 /
75 RCL 03
76 /
77 SQRT
78 ACOS
79 2
80 *
81 STO 40          calculated angle
82 SF 01
83♦LBL 00         begin solutions
84 FS? 04
85 SF 07
86 FS? 09
87 SF 07
88 "R?"
89 PROMPT
90 STO 17
91 RCL 16
92 +
93 FS? 01
94 CHS
95 FS? 04
96 CHS
97 RCL 37
98 +
99 STO 10
100 RCL 17
101 RCL 18
102 +
103 FS? 01
104 CHS
105 FS? 09
106 CHS
107 RCL 38
108 +
109 STO 28
110 RCL 03
```

```
+
+
2
/
STO 42        temporary storage reg
X↑2
LASTX
RCL 28        base side two
*
-
RCL 10        base side one
RCL 03        base distance
*
/
SQRT
ACOS
2
*
STO 29        calculated angle
SIN
RCL 10
RCL 42
X↑2
LASTX
RCL 10
*
-
RCL 28
/
RCL 03
/
SQRT
ACOS
2
*
STO 41        third angle
180
X<>Y
RCL 29
+
FS? 01
-
FS? 08
-
STO 21        central angle of the
RCL 39        return
RCL 29
FS? 04
X<>Y
FS? 08
X<>Y
-
D-R
RCL 37        radius, line A
*
FIX 3
ADV
ADV
"ARC A = "
ARCL X
AVIEW         output arc distance
FC? 02
ADV
FS? 02
XEQ 01        set coordinates
FS? 02
XEQ 02        output radius point if
FIX 3         coordinates or layout
"R = "        are wanted
ARCL 17
```

```
181 AVIEW          output return radius
182 RCL 21
183 XEQ "CURD"     calculate curve data
184 ADV
185 FS? 03
186 XEQ "DIV"      divide curve per max
187 FS? 03         spacing instruction
188 XEQ "SET"      set coordinates at the
189 RCL 40         curve points
190 RCL 41
191 FS? 08
192 X<>Y
193 FS? 09
194 X<>Y
195 -
196 D-R
197 RCL 38
198 *
199 FIX 3
200 "ARC B = "
201 ARCL X
202 AVIEW          output line B arc dist
203 FS? 02
204 XEQ 03
205 FS?C 08
206 SF 09
207 FS?C 04
208 SF 08
209 FS?C 01
210 SF 04
211 CF 07
212 GTO 00
213 RTN
214♦LBL 11         additional prompts if
215 FS? 06         layout or coord. mode
216 RTN
217 "INTER-X N↑E"
218 PROMPT         input coordinates at
219 STO 06         intersection
220 RDN
221 STO 05
222 RTN
223♦LBL 12         azimuth rotation
224 180
225 -
226 STO 09
227 180
228 +
229 RTN
230♦LBL 01         calculate coordinates
231 180            at return radius point
232 RCL 35
233 +
234 RCL 37
235 P-R
236 RCL 05
237 +
238 STO 07
239 X<>Y
240 RCL 06
241 +
242 STO 08
243 RCL 35
244 RCL 39
245 RCL 29
246 -
247 +
248 FS? 01
249 XEQ 12         rotate
250 FS? 04
```

```
251 XEQ 12        rotate
252 FS? 08
253 STO 09
254 FS? 09
255 STO 09        reset azimuth
256 RCL 17        return radius
257 RCL 16        half-width A
258 +
259 FS? 01
260 CHS
261 FS? 04
262 CHS
263 RCL 37        radius, line A
264 +
265 P-R
266 ST+ 07
267 X<>Y
268 ST+ 08
269 RCL 36
270 RCL 40
271 RCL 41
272 -
273 -
274 RCL 17
275 FS? 03
276 XEQ 09        modify radius by o/s
277 FS? 04
278 CHS
279 FS? 08
280 CHS
281 P-R           calculate coordinates
282 RCL 07
283 +
284 X<>Y
285 RCL 08
286 +
287 FC? 03
288 XEQ "98"      output coordinates
289 ADV
290 FS? 03
291 XEQ "RI"      radial inverse to set
292 RTN           points
293♦LBL 02        output coordinates
294 "RADIUS POINT:"
295 FS? 02
296 AVIEW
297 RCL 07
298 RCL 08
299 FC? 03
300 XEQ "98"      output coordinates
301 FS? 06
302 ADV
303 FS? 03
304 XEQ "RI"      radial inverse to set
305 RTN           point
306♦LBL 03
307 RCL 35
308 RCL 39
309 RCL 29
310 -
311 +
312 RCL 17
313 FS? 03
314 XEQ 09        modify radius by o/s
315 FS? 08
316 CHS
317 FS? 09
318 CHS
319 P-R
320 RCL 07
```

```
321 +
322 X<>Y
323 RCL 08
324 +
325 FC? 03
326 XEQ "98"        output of coordinates
327 FS? 03
328 XEQ "RI"        radial inverse to set
329 RTN             point
330♦LBL 09
331 RCL 02
332 -
333 RTN
334♦LBL 10         prompt (layout mode)
335 "BACKSITE?"
336 PROMPT
337 RCL 06
338 -
339 X<>Y
340 RCL 05
341 -
342 R-P
343 CLX
344 X<>Y
345 X<0?
346 360
347 +
348 STO 01          backsight azimuth
349 RTN
350 END
```

A

We often are asked, "How do you store coordinates by point number without X-function in a 41?" There are a number of ways this can be done, but this little routine is one of the easiest.

PIN (point in) assigns the next consecutive number in the counter register to any coordinate pair when the N-coord is in the Y register and the E-coord is in X. **POUT** (point out) replaces the coordinate pair into the Y and X registers for whatever point number is in the X register when executed.

These two routines (©1983, Ted J. Kerber), combined with short programs that tap the subroutines of the HP SURVEYING PAC, give you a complete traverse and inverse package. It may also be extended into storage of three-dimensional coordinates by using similar steps to store the Z register, and have the elevation of the point reside there.

The number of points you can store by this method is only limited by the total number of available registers (it requires two registers per point number), and this is dictated by how many registers you have to use up with the other routines.

In the example listings, with the calculator sized at 120, we're storing N-coordinates in registers 20 thru 69, and E-coordinates in registers 70 thru 119 (a total of 49 points), with register 17 used as the counter. Begin with 0 in register 17.

You can custom fit the routine to your own needs by varying step 19 (first E register), steps 26 and 38 (first N register) and step 43 (difference between registers). Data cards can be used to input or dump the coordinates for later use. You can recall and use the coordinates without having to look at them by adding a PRINT/DON'T PRINT flag in front of the "AVIEW" steps.

```
01♦LBL "PIN"
02 RCL 17
03 1
04 +
05 FIX 0
06 CF 29
07 CLA
08 ARCL X
09 AVIEW
10 STO 17
11 FIX 4
12 CLA
13 ARCL Z
14 AVIEW
15 CLA
16 ARCL Y
17 AVIEW
18 ADV
19 70
20 +
21 STO 19
22 RDN
23 STO IND 19
24 CLX
25 RCL 17
26 20
27 +
28 STO 19
29 RDN
30 STO IND 19
31 RTN
32♦LBL "POUT"
33 FIX 0
34 CLA
35 ARCL X
36 AVIEW
37 FIX 4
38 20
39 +
40 STO 19
41 RCL IND 19
42 X<>Y
43 50
44 +
45 STO 19
46 RDN
47 RCL IND 19
48 CLA
49 ARCL Y
50 AVIEW
51 CLA
52 ARCL X
53 AVIEW
54 ADV
55 RTN
56 END
```

notes

$21.00

ISBN 0-9616846-2-3