


**Traverse Closure with Area Calculation and Co-ordinates**

Programmer: Dr. Bill Hazelton

Date: October, 2007.

Line	Instruction	Display	User Instructions
A001	LBL A		Press XEQ A ENTER
A002	CLSTK		
A003	SF 10		
A004	USE COORDS	USE COORDS	(Key in using EQN RCL U, RCL S, etc.)
A005	PSE		
A006	INPUT C	C?	
A007	RCL C		(Key in using EQN RCL E, RCL N, etc.)
A008	x = 0?		
A009	GTO A021		
A010	ENTER N0	ENTER N0	(Key in using EQN RCL E, RCL N, etc.)
A011	PSE		
A012	INPUT N	N?	
A013	ENTER E0	ENTER E0	(Key in using EQN RCL E, RCL N, etc.)
A014	PSE		
A015	INPUT E	E?	
A016	RCL E		(Key in as 0, then i, then 1, press ENTER.)
A017	0 i 1		
A018	×		
A019	RCL+ N		
A020	STO F		
A021	360		
A022	STO B		
A023	CLSTK		
A024	STO P		
A025	STO Q		
A026	STO M		
A027	XEQ V001		
A028	STO R		
A029	STO+ P		
A030	ARG		
A031	RCL P		
A032	ARG		
A033	-		
A034	SIN		
A035	STO S		
A036	RCL R		
A037	ABS		
A038	STO× S		
A039	RCL P		

**Traverse Closure with Area Calculation and Co-ordinates**

A040	ABS	
A041	STO× S	
A042	RCL S	
A043	2	
A044	÷	
A045	STO+ Q	
A046	1	
A047	STO+ M	
A048	RCL C	
A049	x = 0?	
A050	GTO A067	
A051	RCL Q	
A052	ABS	
A053	RCL P	
A054	RCL+ F	
A055	RCL M	
A056	x i y	(Key in as  DISPLAY, then select 9xy)
A057	STOP	
A058	RCL P	
A059	ARG	
A060	x < 0?	
A061	RCL+ B	
A062	→HMS	
A063	RCL P	
A064	ABS	
A065	STOP	
A066	GTO A027	
A067	RCL Q	
A068	ABS	
A069	RCL P	
A070	ARG	
A071	x < 0?	
A072	RCL+ B	
A073	→HMS	
A074	RCL P	
A075	ABS	
A076	RCL M	
A077	STOP	
A078	GTO A027	

**Notes**

- (1) Set the calculator into DEGREES mode (press MODE 1) before starting.
- (2) This is a general traverse closure program that computes vector and area to each point around the traverse, together with co-ordinates, if desired. It also computes the misclosure of a closed traverse.


**Traverse Closure with Area Calculation and Co-ordinates**

- (3) This program uses the V program as a sub-routine for data entry, so Program V must be in the calculator as program V (or the XEQ V001 at line A027 changed to reflect the changed label. The V program allows entry of azimuths in D.MMSS format (HP notation) and distances, while converting them to the internal complex number format. Program V is one of the HP-35s Utilities programs (Utility 3).
- (4) The program allows the user to choose if the co-ordinates of each point are to be calculated. The user is prompted with USE COORDS briefly, followed by the C? prompt. If co-ordinates are desired, key in 1, if not, key in 0, then press R/S to continue.
- (5) After each side (azimuth and distance) has been entered, the calculator produces the following output.
  - A. If the user has selected to use co-ordinates, the calculator has the following data on the stack. It will stop and display this information, with the number of sides entered in the display in line 2, and the co-ordinates of the point in line 1.

Stack Register	Contents
T	
Z	Area of the traverse thus far
Y	Co-ordinate vector of current point (as a complex number)
X	Number of sides entered

The complex numbers will be displayed in rectangular form, with the Northing first, followed by the letter i, then the Easting. All this will be displayed as a single line of data.

The user can scroll through the stack, using the R↓ key, and can perform any other operation of interest to the data on the stack. This information is stored in memory registers for use later in the program, so the stack may be changed and worked with as needed.

To show the co-ordinates and the vector to the current point in polar form, change the display (use  DISPLAY  $10r\theta\alpha$ ). The complex numbers will be displayed as  $r \theta a$ , where r is the distance and a is the angle in decimal degrees.

When the user presses R/S, the calculator takes the vector to the current forward point from the starting point, and converts it into the distance (which is placed in line 2, the X register) and the azimuth in degrees, minutes and seconds (HP notation) in line 1 of the display (the Y register).

When the user presses R/S again, the calculator prompts for the azimuth of the next side to be entered. The azimuth should be entered in HP notation (DDD.MMSSss).

**Traverse Closure with Area Calculation and Co-ordinates**

- B. If the user has selected not to show co-ordinates, the calculator has the following data on the stack. It will stop and display this information, with the number of sides entered in line 2 of the display (the X register) and the distance of the misclosure or the line connecting the starting point to the current point, in line 1 of the display (Y register).

Stack Register	Contents
T	Area of the traverse thus far
Z	Azimuth of the line from the start to current point (in HP notation)
Y	Distance of the line from the start to the current point
X	Number of sides entered

By pressing the R↓ key, the user can see the azimuth in register Z of the stack. Pressing R↓ again will show the area to the current point.

If the rectangular components of the misclosure are needed, press RCL P and make sure the display is in  $x iy$  mode (change it using  $\leftarrow$  DISPLAY  $9xiy$ ). The misclosure will be displayed as  $\Delta N \ i \ \Delta E$ .

When the user presses R/S again, the calculator prompts for the azimuth of the next side.

- (6) Azimuths are entered and displayed by themselves in HP notation, i.e., DDD.MMSSss. If the azimuth is part of a complex number in  $r \theta$  a form, the azimuth (on the right, after the  $\theta$ ) will be in decimal degrees.
- (7) This program forms the basis of the two missing distances (2MD) program. Enter the known sides using this program to begin the 2MD computation process.
- (8) In order to display the prompts, this program sets Flag 10. However, the program never ends, because it is up to the user to decide when to stop and move control elsewhere. So the program never clears Flag 10. If you require Flag 10 to be clear, in order to process equations, you must do this manually.

**Theory**

The traverse closure programs works by converting the entered azimuths (in DDD.MMSS, or HP, notation) and distances into complex numbers (which act as 2-D vectors), which are then added to compute the location of points around the traverse. The area is computed by triangles developed by each new side of the traverse and the line from the starting point to the current forward point, and is updated with each new side. So the area is that of the polygon formed by the traverse entered thus far and the line from the start to the current point. This allows areas to be incremented for lot splitting calculations.

The azimuth and distance of the line from the start to the current point is also placed on the stack after each line. This allows a connecting line to be computed easily between two points. The final azimuth and distance is the traverse misclosure and the area is that of the traverse.

If the user chooses, the co-ordinates of the starting point may be entered, and if this choice is made, the calculator displays the co-ordinates of each point, in addition to the other information. The co-ordinates are displayed as a complex number, in the form Northing  $i$  Easting.

**Traverse Closure with Area Calculation and Co-ordinates**

An arbitrary azimuth is satisfactory. Plane surveying assumptions apply. The program uses no error checking on entered data.

**Sample Computation**

Bearing	Distance
6° 53' 10"	72.00
112° 37' 20"	102.23
185° 39' 50"	29.04
181° 30' 00"	27.88
283° 54' 30"	102.38

**Final Results**

DE	=	0.023
DN	=	-0.002
Misclosure Length	=	0.023
Misclosure Bearing	=	95° 24' 15"
Area	=	6,378.4660

**Stepping through the Calculation**

**A. Without Co-ordinates**

Press XEQ A ENTER

Calculator prompts with USE COORDS, the C?

Key in 0, then press R/S.

*Side 1*

Calculator prompts with A? for azimuth of side.

Key in 6.5310, press R/S.

Calculator prompts with D? for distance of side.

Key in 72.00, press R/S.

Display shows:	72.0000	(distance from start)
	1.0000	(number of sides entered)

Press the R↓ key twice, and the display becomes:

	0.0000	(area thus far)
	6.5310	(azimuth from start in HP notation (D.MMSS))

Press R/S.

*Side 2*

Calculator prompts with A? for azimuth of side.

**Traverse Closure with Area Calculation and Co-ordinates**

Key in 112.372, press R/S.

Calculator prompts with D? for distance of side.

Key in 102.23, press R/S.

Display shows:            107.9004            (distance from start)  
                                 2.0000            (number of sides entered)

Press the R↓ key twice, and the display becomes:

                                 3,542.3468            (area thus far)  
                                 72.3939            (azimuth from start in HP notation (D.MMSS))

Press R/S.

*Side 3*

Calculator prompts with A? for azimuth of side.

Key in 185.395, press R/S.

Calculator prompts with D? for distance of side.

Key in 29.04, press R/S.

Display shows:            100.1841            (distance from start)  
                                 3.0000            (number of sides entered)

Press the R↓ key twice, and the display becomes:

                                 4,984.4807            (area thus far)  
                                 88.0808            (azimuth from start in HP notation (D.MMSS))

Press R/S.

*Side 4*

Calculator prompts with A? for azimuth of side.

Key in 181.3, press R/S.

Calculator prompts with D? for distance of side.

Key in 27.88, press R/S.

Display shows:            102.4027            (distance from start)  
                                 4.0000            (number of sides entered)

Press the R↓ key twice, and the display becomes:

                                 6378.6396            (area thus far)  
                                 103.5423            (azimuth from start in HP notation (D.MMSS))

Press R/S.

*Side 5*

Calculator prompts with A? for azimuth of side.

Key in 283.543, press R/S.

Calculator prompts with D? for distance of side.


Key in 102.38, press R/S.

**Traverse Closure with Area Calculation and Co-ordinates**

Display shows:           0.0229           (distance from start, also linear misclosure)  
                               5.0000           (number of sides entered)

Press the R↓ key twice, and the display becomes:

                              6378.4660       (area thus far)  
                               95.2415        (azimuth from start, also azimuth of misclosure)

Pressing RCL P brings the misclosure vector to the X register as a complex number. It will be displayed in rectangular form as  $-0.0022 i 0.0228$ , in which case the misclosure component in the north-south direction is  $-0.0022$ , while that in the east-west direction is  $0.0228$ . If the calculator is in  $r\theta\alpha$  display mode, the display will show  $0.0229 \theta 95.4041$ . Convert this by using  DISPLAY  $\theta xiy$ .

**B. Using Co-ordinates**

Press XEQ A ENTER

Calculator prompts with USE COORDS briefly, then C?

Key in 1, then press R/S.

Calculator prompts ENTER N0 briefly, then N?

Key in 1000.000, press R/S.

Calculator prompts ENTER E0 briefly, then E?

Key in 500.000, press R/S.

*Side 1*

Calculator prompts with A? for azimuth of side.

Key in 6.5310, press R/S.

Calculator prompts with D? for distance of side.

Key in 72.00, press R/S.

Display shows:           1,071.4806 *i* 508.6325           (Co-ordinates of current forward point)  
                               1.0000                           (number of sides entered)

Press the R↓ key, and the display becomes:

                              0.0000                           (area thus far)  
                               1,071.4806 *i* 508.6325       (Co-ordinates of current forward point)

Press R/S.

Display shows:           6.5310           (Azimuth for current forward point from starting point)  
                               72.0000        (Distance from starting point to current forward point)

Press R/S.

*Side 2*

Calculator prompts with A? for azimuth of side.

Key in 112.372, press R/S.

Calculator prompts with D? for distance of side.

Key in 102.23, press R/S.







**Traverse Closure with Area Calculation and Co-ordinates****Labels Used**

Label A          Length = 268          Checksum = CED9

Use the length (LN=) and Checksum (CK=) values to check if program was entered correctly. Use the sample computation to check proper operation after entry.

**Routines Called**

The program labeled V, which takes an azimuth in degrees, minutes and seconds (in HP notation), and a distance, and converts them to a complex number for processing in the calculator. This routine uses storage location A and D, but copies out and replaces the contents of these storage locations in order to preserve them. It also uses storage register I for indirect addressing, which uses registers 10, 11 and 12.

Label V          Length = 128          Checksum = 39FE