HP-35S Calculator Program   Closure   1B

Traverse Closure with Area Calculation and Co-ordinates and Proportional Misclosure

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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		
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		
A017	0 **i** 1		(Key in as 0, then **i**, then 1, press ENTER.)
A018	×		
A019	RCL+ N		
A020	STO F		
A021	360		
A022	STO B		
A023	CLSTK		
A024	STO P		
A025	STO Q		
A026	STO M		
A027	STO T		
A028	XEQ V001		
A029	STO R		
A030	STO+ P		
A031	ARG		
A032	RCL P		
A033	ARG		
A034	–		
A035	SIN		
A036	STO S		
A037	RCL R		
A038	ABS		

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A039	STO+ T	
A040	STO× S	
A041	RCL P	
A042	ABS	
A043	STO× S	
A044	RCL S	
A045	2	
A046	÷	
A047	STO+ Q	
A048	1	
A049	STO+ M	
A050	RCL C	
A051	x = 0?	
A052	GTO A074	
A053	RCL P	
A054	RCL+ F	
A055	XEQ X001	
A056	RCL M	
A057	RCL Q	
A058	ABS	
A059	R↓	
A060	STOP	
A061	RCL T	
A062	RCL P	
A063	ABS	
A064	÷	
A065	RCL P	
A066	ARG	
A067	x < 0?	
A068	RCL+ B	
A069	→HMS	
A070	RCL P	
A071	ABS	
A072	STOP	
A073	GTO A028	
A074	RCL Q	
A075	ABS	
A076	RCL P	
A077	ARG	
A078	x < 0?	
A079	RCL+ B	
A080	→HMS	
A081	RCL P	
A082	ABS	
A083	RCL M	
A084	STOP	
A085	GTO A028	

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Traverse Closure, Area Calc., Co-ordinates & Prop.Misc.

This version of the program is designed to completely hide the complex number work that the calculator performs to compute the traverse. All values entered and returned are presented in much the same manner as with the HP-33S calculator.

Notes

(1)   Set the calculator into DEGREES mode (press MODE 1) before starting.

(2)   This is a general traverse closure program that computes the azimuth and distance, plus area, to each point around the traverse, together with co-ordinates, if desired. It also computes the misclosure of a closed traverse.

(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 format. Program V is one of the HP-35s Utilities programs (Utility 3).

(4)   This program uses the X program as a sub-routine for co-ordinate return from the internal format., so program X must be in the calculator as program X (or the XEQ X001 at line A053 changed to reflect the label change). The X program allows co-ordinates to be returned from the internal processing format of the calculator. Program X is one of the HP-35s Utilities programs (Utility 4).

(5)   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.

(6)   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 Easting co-ordinate of the point in line 1.

Stack Register	Contents
T	Area of the traverse thus far
Z	Northing co-ordinate of current point
Y	Easting co-ordinate of current point
X	Number of sides entered

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. The user can also continue without viewing the stack.

When the user presses R/S, the calculator takes the line 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). The calculator also includes the proportional misclosure in the Z register of the stack.

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Stack Register	Contents
T	
Z	Proportional Misclosure (Representative Fraction)
Y	Azimuth from start to current point (in D.MMSSss)
X	Distance from start to current point

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).

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 (or the line from the start to the current forward point) are needed, press RCL P, then XEQ X ENTER. The Easting component of the misclosure (ΔE) will be displayed in the X register (line 2), while the Northing component (ΔN) will be displayed in the Y register (line 1).

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

(7)   Azimuths are entered and displayed by themselves in HP notation, i.e., DDD.MMSSss.

(8)   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.

(9)   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.

(10) The program calculates the proportional misclosure (representative fraction) of the traverse, and displays it in the stack. It only does this of the Co-ordinates

option is selected If you don't want to run the Co-ordinates option, but still want the proportional misclosure, do the following. When you have completed processing the traverse, press: RCL T   RCL P   **ABS**   ÷

The denominator will show in the display. If the proportional misclosure is 1 in *X*, then *X* will be displayed.

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.

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	=	0.0228
DN	=	–0.0022
Misclosure Length	=	0.0229
Misclosure Bearing	=	95° 24' 15"
Area	=	6,378.4660
Proportional Misclosure	=	1 in 14,537.95

Note that the value presented for the proportional misclosure will be 14,537.95

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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.

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.

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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.

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, then XEQ X ENTER brings the misclosure to the display in rectangular form. The Northing component of the misclosure (ΔN) is in the Y register (line 1) and is –0.0022, while the Easting component of the misclosure (ΔE) is in the X register (line 2) and is 0.0228.

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: 508.6325   (Easting co-ordinate of current forward point)
                        1.0000   (number of sides entered)

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

                        0.0000   (area thus far)
                        1,071.4806   (Northing co-ordinate 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)

(Note that the proportional misclosure at this time will be meaningless, so we don't need to roll down to it.)

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.

Display shows: 602.9971   (Easting co-ordinate of current forward point)
                        2.0000   (number of sides entered)

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

                        3,542.3468   (area thus far)
                        1,032.1575   (Northing co-ordinate of current forward point)

Press R/S.

Display shows: 72.3939   (Azimuth for current forward point from starting point)
                        107.9004   (Distance from starting point to current forward point)

(Note that the proportional misclosure at this time will be meaningless, so we don't need to roll down to it.)

(Note that the proportional misclosure at this time will be meaningless, so we don't need to roll down to it.)

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: | 600.1310 | (Easting co-ordinate of current forward point) |
| | 3.0000 | (number of sides entered) |

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

| | 4,984.4807 | (area thus far) |
| | 1,003.2593 | (Northing co-ordinate of current forward point) |

Press R/S.

| Display shows: | 88.0808 | (Azimuth for current forward point from starting point) |
| | 100.1841 | (Distance from starting point to current forward point) |

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: | 599.4012 | (Easting co-ordinate of current forward point) |
| | 4.0000 | (number of sides entered) |

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

| | 6,378.6396 | (area thus far) |
| | 975.3888 | (Northing co-ordinate of current forward point) |

Press R/S.

| Display shows: | 103.5423 | (Azimuth for current forward point from starting point) |
| | 102.4027 | (Distance from starting point to current forward point) |

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.

| Display shows: | 500.0228 | (Easting co-ordinate of current forward point) |
| | 5.0000 | (number of sides entered) |

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

| | 6,378.4660 | (area thus far) |
| | 999.9978 | (Northing co-ordinate of current forward point) |

Press R/S.

| Display shows: | 95.2415 | (Azimuth for current forward point from starting point) |
| | 0.0229 | (Distance from starting point to current forward point) |

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Press the R↓ key, and the display becomes:

Display shows: 14,537.9488   (Proportional Misclosure 1 in *X*, where *X* is displayed)
                        95.2415   (Azimuth for current forward point from starting point)

Press RCL P, then XEQ X ENTER to bring the misclosure onto the stack in rectangular mode. The misclosure in Northings (latitude, ΔN) will be displayed in the Y register (line 1) as –0.0022. The misclosure in Eastings (departure, ΔE) will be displayed in the X register (line 2) and is 0.0228.

Storage Registers Used

A   Used by the V program for the entered azimuth.

B   Stores 360 for azimuth correction.

C   Test for displaying co-ordinates: 1 = YES; 0 = NO.

D   Used by the V program for the entered distance.

E   Easting co-ordinates of the starting point.

F   Co-ordinates of starting point, as a complex number.

I   Used by the V and X programs to address the additional storage registers.

M   The number of sides entered.

N   The Northing co-ordinate of the starting point.

P   Current position of forward point, as a complex number.

Q   Current area.

R   Last side entered, as a complex number.

S   Temporary storage for area calculation.

T   Proportional Misclosure value 1 in *X*, where *X* is stored.

Statistical Registers: not used.

Other registers: 10, 11 and 12 used by the V program; 10 used by the X program.

Labels Used

Label **A**   Length = 289   Checksum = A19C

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.

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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 routines 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.

The program labeled X, which takes a complex number and converts it to the rectangular components, is called for co-ordinate presentation in this program. It uses storage register I for indirect addressing, which uses register 10.

Label **V**   Length =   128   Checksum = 39FE

Label **X**   Length =   53   Checksum = C46D