

HP-35s Calculator Program

Radiations 1

Calculate a Radiation from Two Offsets

Programmer: Dr. Bill Hazelton

Date: March, 2008.

Line	Instruction	Display	User Instructions
O001	LBL O		LBL O
O002	CLSTK		CLEAR 5
O003	FS? 10		FLAGS 3 .0
O004	GTO O008		
O005	SF 1		FLAGS 1 1
O006	SF 10		FLAGS 1 .0
O007	GTO O009		
O008	CF 1		FLAGS 2 1
O009	RAD FM OFFSETS		(Key in using EQN RCL R, RCL A, etc.)
O010	PSE		PSE
O011	ENTER RIGHT AZ		(Key in using EQN RCL E, RCL N, etc.)
O012	PSE		PSE
O013	INPUT R	R?	INPUT R
O014	RCL R		
O015	HMS→		HMS→
O016	STO A		STO A
O017	ENTER LEFT AZ		(Key in using EQN RCL E, RCL N, etc.)
O018	PSE		PSE
O019	INPUT L	L?	INPUT L
O020	RCL A		
O021	RCL L		
O022	HMS→		HMS→
O023	-		
O024	STO E		STO E
O025	ENTER RIGHT OS		(Key in using EQN RCL E, RCL N, etc.)
O026	PSE		PSE
O027	INPUT R	R?	INPUT R
O028	ENTER LEFT OS		(Key in using EQN RCL E, RCL N, etc.)
O029	PSE		PSE
O030	INPUT L	L?	INPUT L
O031	RCL R		
O032	RCL E		
O033	SIN		
O034	×		
O035	RCL E		
O036	COS		
O037	RCL× R		
O038	RCL+ L		
O039	÷		

Radiation from Two Offsets

Line	Instruction	Display	User Instructions
O040	ATAN		 ATAN
O041	STO C		 STO C
O042	RCL A		
O043	$x <> y$		
O044	-		
O045	→HMS		 →HMS
O046	STO B		 STO B
O047	RADIATION AZ		(Key in using EQN RCL R, RCL A, etc.)
O048	PSE		 PSE
O049	VIEW B		 VIEW B
O050	RCL R		
O051	RCL C		
O052	SIN		
O053	÷		
O054	STO D		 STO D
O055	RAD LENGTH		(Key in using EQN RCL R, RCL A, etc.)
O056	PSE		 PSE
O057	VIEW D		 VIEW D
O058	PROGRAM END		(Key in using EQN RCL P, RCL R, etc.)
O059	PSE		 PSE
O060	FS? 1		 FLAGS 3 1
O060	CF 10		 FLAGS 2 .0
O060	RTN		 RTN

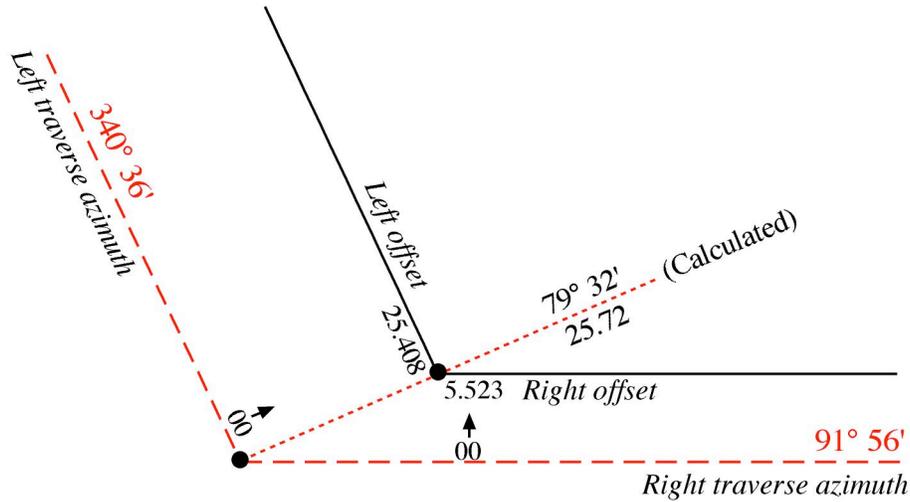
Notes

- (1) This program allows a radiation (azimuth and distance) to an object to be computed from two offsets measured from two lines of known azimuth to the object.
- (2) The two lines from which the offsets are measured do not have to be orthogonal. The closer they are to orthogonal, the better, but the program will work with any realistic set of measurements. It will also work across the 0° line, and with traverse lines in different quadrants.
- (3) The purpose of the program is to facilitate conversion of older survey data, in which corners were often located by pairs of offsets, to a form in which a radiation is employed. This will simplify calculations based on traverses and radiations, i.e., vectors.
- (4) Azimuths are entered and displayed in HP notation, i.e., DDD.MMSS, at all times.
- (5) Feet or meters (or any other linear units) can be used, provided their use is consistent.
- (6) The original code for this program was developed by Philip R. Price at the State Rivers and Water Supply Commission (SR&WSC) Survey Branch, Victoria, Australia, in November, 1976, for the HP-25 calculator. This program is an update and adaptation for the HP-35s, but is based on Phil Price's original solution and HP-25 implementation.

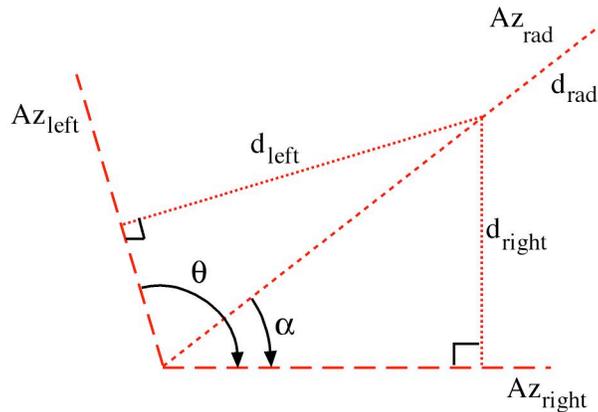
Radiation from Two Offsets

Theory

If an object, commonly a corner, is located by offsets, these can be converted to the equivalent radiation using the program. In the example below, the corner was located by two offsets, being 5.523 on the right and 25.408 on the left. The offsets are measured at right angles to their respective traverse lines, and are the distance between the object and the traverse line. The right traverse line has an azimuth of $91^{\circ} 56'$, while the left traverse line has an azimuth of $340^{\circ} 36'$. See the figure below:



Generalizing the diagram and giving it symbols, the general situation becomes as follows:



The angle θ is the difference between the two known azimuths, Az_{left} and Az_{right} . The offset from the right traverse line to the object is d_{right} , while the offset from the left traverse line to the object is d_{left} . Because the offsets are measured at right angles to the traverse lines, their azimuths are also known.

The angle α is the angle between the right traverse line and the radiation, and is determined using the following formula:

Radiation from Two Offsets

$$\alpha = \arctan\left(\frac{d_{\text{right}} \sin \theta}{d_{\text{left}} + d_{\text{right}} \cos \theta}\right)$$

Subtracting α from Az_{right} gives the azimuth of the radiation, Az_{rad} . The length of the radiation, d_{rad} , is derived using:

$$d_{\text{rad}} = \frac{d_{\text{right}}}{\sin \alpha}$$

Precision of Results

Note that the precision of the derived azimuth and distance is limited by the precision with which the offsets were measured, as well as the geometry of the offsets and radiation. The program provides the one solution given the data, but without redundant measurements the precision of the solution is unknown. It would be unwise to use azimuths for the radiation that are more precise than about one minute of arc. Experiment with changing the values of the offsets by small amounts that are consistent with their probable precision, as well as changing the azimuths by amounts consistent with their precision over the distances to the offsets, and see what happens to the azimuth and distance values for the radiation.

Sample Computations

1. Using the example given, where the right azimuth is $91^\circ 56'$, the left azimuth is $340^\circ 36'$, the right offset is 5.523 and the left offset is 25.408, the radiation has an azimuth of $79^\circ 32'$ and a distance of 25.72.
2. Using a right azimuth of $160^\circ 36'$ and a left azimuth of $91^\circ 56'$, a right offset of 13.272 and a left offset of 15.693, the radiation has an azimuth of $129^\circ 32'$ and a distance of 25.72.
3. Using a right azimuth of $268^\circ 35'$, a left azimuth of $195^\circ 12'$, a right offset of 11.782 and a left offset of 9.467, the radiation has an azimuth of $227^\circ 15'$ and a distance of 17.84.
4. Using a right azimuth of $340^\circ 36'$, a left azimuth of $271^\circ 56'$, a right offset of 11.57 and a left offset of 8.78, the radiation has an azimuth of $300^\circ 55'$ and a distance of 18.12.

Running the Program

With everything to hand, press XEQ O, then press ENTER.

The calculator briefly displays RAD FM OFFSETS, then briefly displays ENTER RIGHT AZ, then prompts R?

Key in the value of the azimuth of the right traverse line, in HP notation (DDD.MMSS). Press R/S.

The calculator briefly displays ENTER LEFT AZ, then prompts L?

Key in the value of the azimuth of the left traverse line, in HP notation (DDD.MMSS). Press R/S.

The calculator briefly displays ENTER RIGHT OS, then prompts R?

Radiation from Two Offsets

Key in the value of the right offset. Press R/S.

The calculator briefly displays ENTER LEFT OS, then prompts L?

Key in the value of the left offset. Press R/S.

The calculator briefly displays RADIATION AZ, then shows B= and the azimuth in HP notation (DDD.MMSS). Press R/S.

The calculator briefly displays RAD LENGTH, then shows D= and the length of the radiation.

Press R/S, the calculator briefly displays PROGRAM END, completes the program and resets Flag 10 to its state at the start of the program. The azimuth (in HP notation) and the distance of the radiation remain on the stack, in the Y and X locations, respectively.

To compute additional radiations from offset, press XEQ O, then press ENTER, and start the program again.

Storage Registers Used

- A** Azimuth of right traverse line (in decimal degrees)
- B** Azimuth of the radiation (in HP notation, DDD.MMSS)
- C** α , the angle between the right traverse line and the radiation (in decimal degrees)
- D** Length of the radiation
- E** θ , the angle between the traverse lines (in decimal degrees)
- L** Left traverse azimuth (in HP notation) or left offset (temporary storage)
- R** Right traverse azimuth (in HP notation) or right offset (temporary storage)

Labels Used

Label **O** Length = 287 Checksum = 55B5

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

Flags Used

Flags 1 and 10 are used by this program. Flag 10 is set for this program, so that equations can be shown as prompts. Flag 1 is used to record the setting of Flag 10 before the program begins. At the end of the program, Flag 10 is reset to its original value, based on the value in Flag 1.