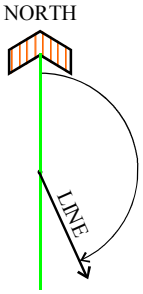
We're going to pretty much walk you through putting in each of the programs in this book, but if you don't bother reading the User's Guide that came with your calculator past the "how to insert the batteries" and "turning the calculator on" parts, at **least look** through chapters 13 and 14 to get somewhat familiar with what we're doing here. The first program we want to input is the same one we gave you a glimpse of on page 1, Label A. It performs azimuth-to-bearing calculations for you.

input your first program-subroutine

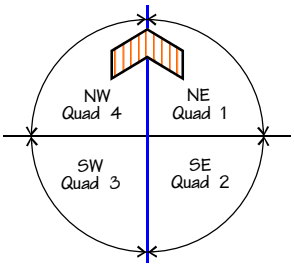
This is the first program you will input, and it will be used both as a stand-alone program *and* as a subroutine to several other programs later. All of these programs work in **RPN and Degree mode**. Make sure that you are in the proper mode before beginning by stroking [MODE] [5] [MODE] [1]. Start at Program Top by stroking [GTO] [·] [·] and then [↱] [R/S] the program steps in the order shown. The step numbers and instructions should look like the ones shown.

In step A002, [↰] [^] takes you to the flags menu and [1] selects Set Flag. Stroking [·] will automatically insert a 1, and stroking [0] completes the line. Input for step A003 was explained on page 1.

In step A009, the ARG menu is accessed by stroking [↰] [TAN]. IP is the sixth item in the menu, but instead of scrolling down to select it, just stroke [6].



Directions by Azimuths



Directions by Bearings

In the U.S. azimuths are defined as the angle to the right from north, and range from 0° to 360° and bearings are defined by their quadrant, from 0° to 90°.

A001	LBL A	[↱] [XEQ] [A]
A002	SF 10	[↰] [^] [1] [·] [0]
A003	AZIMUTH	[EQN] *Then stroke* [RCL] *before each alpha input*
A004	HMS→	[↰] [8]
A005	ENTER	[ENTER]
A006	ENTER	[ENTER]
A007	90	[9] [0]
A008	÷	[÷]
A009	IP	[↰] [TAN] [6]
A010	1	[1]
A011	+	[+]
A012	STO Q	[↱] [RCL] [Q]
A013	R↓	[R↓]
A014	ENTER	[ENTER]
A015	SIN	[SIN]
A016	ASIN	[↱] [SIN]
A017	ABS	[↱] [+/−]
A018	→HMS	[↱] [8]
A019	STO B	[↱] [RCL] [B]
A020	RCL Q	[RCL] [Q]
A021	RTN	[↰] [XEQ]

Angles are measured right (quad 1) or left (quad 4) of North when in quadrant 1 or 4, or right (quad 3) and left (quad 2) from 180° in 2 and 3. When an angle in quadrant 1 (NE) exceeds 90° it automatically becomes quadrant 2 and must be subtracted from 180° to be correct. **Mistakes happen more often in doing angle, or azimuth to bearing calculations than in any other type of calculation!**

PROGRAM: AZIMUTH TO BEARING/QUADRANT CODE

PROMPT	INSTRUCTIONS	KEYSTROKES	OUTPUT
		[XEQ] [A] [ENTER]	
AZIMUTH 0.0000	Input the Azimuth (D.ms)	[R/S]	BEARING (D.ms) QUAD CODE

ALL of the programs in this manual, use Degrees, Minutes and Seconds (DMS) for input and output. The second most common error in doing angle or bearing calculations is forgetting to change to or from degrees to decimal (or back) during keyboard calculations. We've reduced your chance of minor errors already.

With the program completed, try the example below.

EXAMPLE: CHANGE THE AZIMUTH, 125°23'16", TO BEARING AND QUADRANT CODE

PROMPT	INSTRUCTIONS	KEYSTROKES	OUTPUT
		XEQ A ENTER	
AZIMUTH	Input the Azimuth (D.	1 2 5 · 2 3 1 6 R/S	54.3644 (D.ms) 2.0000

If it didn't give the correct answer there's something wrong with the program. You can do this with several examples and assume that the program is correctly input, or there is an easier (and more accurate) way to check the program steps.

Each program has a specific size, measured by it's length, and a checksum. **There is a complete chart on page 14P of the length (LN value) and checksum* (CK) to check your programs against**. The chart also indicates which registers and flags have been used within the program. Stroke ↰ ∨ 2 to open the list of programs.

At this point you should see LBL A LN=73 stroke ↰ and hold down ENTER to show CK=17B0 LN=73

*In the earliest release of the HP35s calculators the checksums are not always the same in different calculators. For this book we will give the LN and checksum numbers, but you should **not** rely on the checksums to agree.

input your second program-subroutine

We've put in one program so far, and checked (or edited) it until it has the correct LN number, so this one should program faster. It has two prompts, the first for the bearing (has to be between 0° and 90°), the second for the quadrant code (see illustration on page 2).

Input the program. When you are finished, check it by stroking ↰ ∨ 2 to open the list of programs, scroll to LBL B. You should have:

LBL B
LN=166

If you got the right number, you're done, but

B001 LBL B	↱ XEQ B
B002 SF 10	↰ ^ 1 · 0
B003 BEARING	EQN *Then stroke* RCL *before each alpha input*
B004 STO B	↱ RCL B
B005 QUAD CODE	EQN *Then stroke* RCL *before each alpha input*
B006 STO Q	↱ RCL Q
B007 x<>y	x⇄y
B008 HMS→	↰ 8
B009 x<>y	x⇄y
B010 ENTER	ENTER
B011 ENTER	ENTER
B012 2	2
B013 ÷	÷
B014 IP	↰ TAN 6
B015 π	↰ COS
B016 →HMS	↱ 8
B017 x	×
B018 x<>y	x⇄y
B019 LASTx	↱ ENTER
B020 x	×
B021 COS	COS
B022 R↑	↱ R↓
B023 x	×
B024 -	−
B025 →HMS	↱ 8
B026 RTN	↰ XEQ

If you didn't get the right LN, the problem is in one of the steps. Check for an extra line or a missing line first. Stroke [GTO] [A] [ENTER], then enter program mode (stroke [↱] [R/S]) and scroll through the program. You will be working on the program line that is in the X-register (the bottom one); it is an extra step and you can delete it by back-clearing it with the [←] key.

If you are missing a step, put the step that is supposed to be proceeding it in the X-register then type in the new step. When you're finished, do NOT forget to leave program mode by stroking [C], then try the program again.

PROGRAM: BEARING/QUADRANT CODE TO AZIMUTH

PROMPT	INSTRUCTIONS	KEYSTROKES	OUTPUT
		[XEQ] [B] [ENTER]	
BEARING:	Input the Bearing (D.ms)	[R/S]	
QUAD CODE:	Input the Quadrant Code	[R/S]	AZIMUTH (D.ms)

EXAMPLE: CHANGE THE BEARING, N 25°23'16" W, TO AN AZIMUTH		[XEQ] [B] [ENTER]	
PROMPT	**INSTRUCTIONS**	**KEYSTROKES**	**OUTPUT**
BEARING:	Input the Bearing (D.ms)	[2] [5] [·] [2] [3] [1] [6] [R/S]	
QUAD CODE:	Input the Quadrant Code	[4] [R/S]	334.3644

You will have noted that the response to a prompt in this calculator does not require that you ENTER the input. You stroke the [R/S] key instead, to tell the program that input is complete and the program should continue.

While that example (above) answer is still in the X-register, try this; stroke [XEQ] [A] [0] [0] [4]. That should turn your last answer back into a bearing/quad. The HP35s calculator allows us to execute a particular program step anywhere in program memory as long as we know the *address* of that step. What we've done is the same conversion you typed in as LBL A, but bypassed the prompt and it ran automatically. This is how it will be used as a sub-routine in later programs.

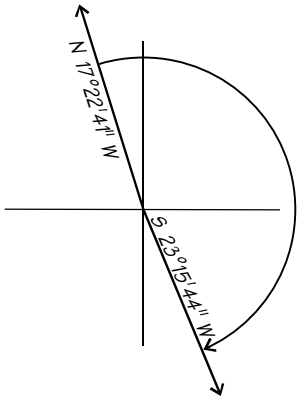
input your third program-subroutine

We'll add the short program (right) to our collection (it adds and subtracts in D.ms). This one is different from the first two. In those, you executed the programs and they prompted for input. In this one, you input the numbers first and then execute the program. There are no prompts

D001 LBL D	[↱] [XEQ] [D]
D002 x<>y	[x⇄y]
D003 HMS→	[↰] [8]
D004 x<>y	[x⇄y]
D005 HMS→	[↰] [8]
D006 x<>y	[x⇄y]
D007 +	[+]
D008 →HMS	[↱] [8]
D009 RTN	[↰] [XEQ]

INSTRUCTIONS	KEYSTROKES	OUTPUT
Input the 1st angle or azimuth (D.ms)	[ENTER]	
Input the 2nd angle or azimuth (D.ms) (to subtract, first stroke [+/-])	[XEQ] [D] [ENTER]	DIFFERENCE OR SUM

Start at the top of program memory by stroking [GTO] [·] [·] and then [↱] [R/S] to begin input. You should end up with LN=27, as shown in the chart on page 14P.



There are several ways to work this example, for instance you could change both bearings to azimuths and subtract them . . . but that is the angle from S 23°15'44" E to N 17°22'41" W, so you would have to subtract that answer from 360°. You could change the SE bearing to an azimuth and add the NW bearing angle to it.

This is essentially what we do in the solution below, but rather than run the bearing/quad to azimuth program, we just subtract the bearing value from 180° and come out with the same result (with less keystrokes and a better chance to actually look at the problem before we complicate it).

EXAMPLE: WHAT IS THE ANGLE BETWEEN N 17°22'41" W AND S 23°15'44" E?	[XEQ] [B] [ENTER]	
INSTRUCTIONS	**KEYSTROKES**	**OUTPUT**
Get the angle between North and S 23°15'44" E	[1] [8] [0] [ENTER]	
	[2] [3] [·] [1] [5] [4] [4] [+/−] [XEQ] [D] [ENTER]	156.4416
Add the other angle	[1] [7] [·] [2] [2] [4] [1] [XEQ] [D] [ENTER]	174.0657

Now we'll start on the 'workbook' part of this book. You're going to do part of the exercises either longhand or with the calculator, but you want to remember that the calculator functions for adding and subtracting work in decimal degrees, not D.ms, and pay attention to bringing them back to D.ms after the calculation as well as changing them before input. The same thing applies to the trigonometric functions.

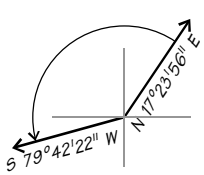
To change D.ms to decimal stroke [◁] [8] to change decimal to D.ms stroke [▷] [8]. When you use the programs, none of this is necessary because it's done for you and you only work in D.ms.

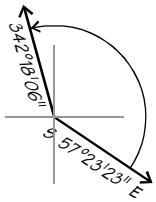
Exercise 1 *(do the first two longhand, then complete the exercise with the programs)*

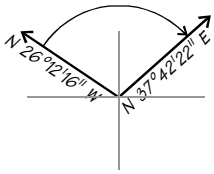
The answer key for the exercises is in the back of the book, beginning on page 14P

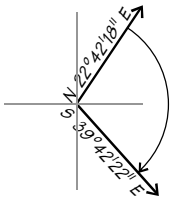
1. Add the angles, 28°15'34", 102°52'41", and 16°16'08" *ans:* _____
2. Subtract 28°15'34 from 102°52'41", then add 16°16'08" *ans:* _____
3. Add the angle, 102°52'41", to a bearing of N 62°45'23" W *ans:* _____
4. Subtract 98°15'59" from a bearing of N 01°14'17" E *ans:* _____

Exercise 2 *(do #s 1, 2, 5 and 6 longhand, then complete the exercise with the programs)* Calculate the angles indicated









1. *ans:* _____ 2. *ans:* _____ 3. *ans:* _____ 4. *ans:* _____