

# the HP 35s calculator

## A Field Surveyor's Companion

### Part 3—Traverse

*“But no longer to light candles to see the sun by, let me come to my business, which is to speak something concerning the following book; and if you ask, why I write a book of this nature, since we have so many very good ones already in our own language? I answer, because I cannot find in those books, many things, of great consequence, to be understood by the Surveyor. I have seen young men, in America, often nonplus’d so, that their books would not help them forward, particularly in Carolina, about laying out lands, when a*

*certain quantity of acres has been given to be laid out five or six times as broad as long. This I know is to be taught by a mathematician; yet to such as have no more of this learning, than to know how to measure a field, it seems a difficult question: and to what book already printed of Surveying shall they repair to, to be resolved?”*

*—John Love, Geodaesia: The Art of Surveying and Measuring of Land Made Easie circa 1688 A.D.*

John Love's observations distinguish the Professional Surveyor in America from the singular technical act of measurement. Love identifies the natural cause for professional development and through his work he championed that cause on the American Continent. Rather than entrusting his profession to European Academia he asserted his own undivided professional discretion towards the development of others and openly apportioned his knowledge. Love truly recognized that the Art of Surveying cannot be wholly conveyed from the confined walls of any Institution. I have found that Love's presentation in 1688 is archetypical of the following references sitting on my bookshelf: Davies 1870 *Elements of Surveying and Leveling*; the 1913 *I.C.S. Civil Engineer's Handbook*; Davis, Foote, and Rayner's 1928 *Surveying*; Bouchard and Moffit's 1969 *Surveying Fifth Edition*; and Wolf and Ghilani's 2006 *Elementary Surveying*. *Geodaesia* is relevant 326 years later because it shares a true professional understanding of Land Surveying. Imbibing that knowledge recorded in *Geodaesia* is more binding to professional development than any Pavlovian memorization exercise

associated with software keystrokes. It is in this light that our beloved HP calculator becomes a positive augmentation to our individual professional knowledge.

#### This Month's Programs

Traverse is a “point and direction” style program. Traverse azimuth entry is based on a 360° north oriented zero circle accepted in decimal degrees. I have included an option to key in p.o.b. coordinates or recall point coordinate values from storage.

T001	LBL T
T002	SF 10
T003	<b>EQN</b> “AZIMUTH TRAVERSE”
T004	FIX 0
T005	SF 10
T006	<b>EQN</b> “0=INP 1=RLC”
T007	x=0?
T008	GTO T011
T009	XEQ J001
T010	GTO T025
T011	FIX 2
T012	INPUT N
T013	INPUT E

T014	RCL E
T015	RCL N
T016	XEQ P001
T017	x<->y
T018	XEQ C001
T019	FIX 0
T020	INPUT J
T021	x<->y
T022	STO(J)
T023	FIX 2
T024	VIEW(J)
T025	FIX 4
T026	INPUT A
T027	FIX 2
T028	INPUT D
T029	FIX 2
T030	RCL D
T031	RCL A
T032	XEQ C001
T033	XEQ A001
T034	STO C
T035	XEQ S001
T036	RTN

“I answer, because I cannot find in those books, many things, of great consequence, to be understood by the Surveyor.”

—John Love 1688

### Example Data and Running the Program

KEYSTROKE STEPS	RESULTANT DISPLAY	ACTION
<b>XEQ 9 ENTER</b>	Y-reg : X-reg : AZMTH TRAVERSE	Executes program {T} and displays program annunciator.
<b>R/S</b>	Y-reg : X-reg : 0=INP 1=RCL	Prompt for INPUT or POINT RECALL. (See below for POINT RECALL instructions in green)
<b>0 R/S</b>	Y-reg : N? X-reg : default value	Prompt for Northing.
5000 <b>R/S</b>	Y-reg : E? X-reg : default value	Enter Northing. Prompt for Easting automatically appears.
7000 <b>R/S</b>	“RUNNING” then Y-reg : J? X-reg : default value	Enter Easting. Prompt for point storage number automatically appears.
1 <b>R/S</b>	Y-reg : (1)= X-reg : 5,000.00 i 7,000.00	Enter point number for storage. Stored point is displayed as complex number.
<b>R/S</b>	Y-reg : A? X-reg : default value	Prompt for 360° North oriented Azimuth in decimal degrees.
180 <b>ENTER</b> 45.3030 <b>YLS 8</b> <b>{HMS→} -</b>	Y-reg : A? X-reg : 134.4917	This is an intermediate step demonstrating the ability to use the functioning stack during input. The input bearing is S 45°30'30" E. The active stack permits the user to freely convert quadrant bearings to 360° azimuth. S 45°30'30" E = 180-45.3030 converted to Decimal Degrees or 134.4917° (See ATB conversion table below). The user may also take the liberty of programming the HMS→ conversion by inserting the following lines T026 as follows: T026 INPUT A T027 RCL A T028 HMS→ T029 STO A T030 will be the old T027 FIX2 function as the lines advance after insertion.
<b>R/S</b>	Y-reg : D? X-reg : default value	Prompt for distance. Again the stack is functional. For example you could add up a series of lot distances along a block line to determine an overall
100 <b>R/S</b>	“RUNNING” then Y-reg : X-reg : STORE POINT	Prompt for point storage.
<b>R/S</b>	“RUNNING” then Y-reg : J? X-reg : default value	Prompt for point number.
2	Y-reg : J? X-reg : 2	Input desired point number.
<b>R/S</b>	Y-reg : (2)= X-reg : 4929.92 i 7,071.34	Stored point is displayed as complex number.
<b>R/S</b>	“RUNNING” then AZMTH TRAVERSE	Program returns to it's top for additional input.

## POINT RECALL INSTRUCTIONS

Use program H "Points" to store Point 1 with N:5000 E:7000, then run TRAVERSE through step 2 as listed above and continue with the listing below.

<b>R/S</b>	Y-reg : X-reg : 0=INP 1=RCL	Prompt for INPUT or POINT RECALL. (The program is initiated and run as shown above to this point)
1 <b>R/S</b>	Y-reg : X-reg : RCL POINT	Recall annunciator.
<b>R/S</b>	Y-reg : J? X-reg : default value	Prompt for point number input automatically appears.
1 <b>R/S</b>	Y-reg : (1)= X-reg : 5,000.00 i 7,000.00	Enter point number for recall. Recall point is displayed as complex number.
<b>R/S</b>	Y-reg : A? X-reg : default value	Prompt for 360° North oriented Azimuth in decimal degrees. (The program continues as above from this point)

## Azimuth to Bearing Conversion Table

QUADRANT BEARING	ARITHMETIC Remember to convert to decimal degrees <b>YLS 8</b>	AZIMUTH Converted to decimal degrees <b>YLS 8</b>
N 45°00'00" E	NONE	45.0000
S 45°00'00" E	180°-THE BEARING IN DECIMAL DEGREES	135.0000
S 45°00'00" W	180°+THE BEARING IN DECIMAL DEGREES	225.0000
N 45°00'00" W	360°-THE BEARING IN DECIMAL DEGREES	315.0000

## This Month We Have a Bonus Equation!

**RMD((450-REGX),360)**

Add this equation to your EQN library. It converts azimuth values from the Argand Plane into a 360° North based system. The Argand Plane is HP's angular reference plane in which zero is east and the angles progress either left (counterclockwise, positive, north) or right (clockwise, negative, south) of the latitudinal axis to 180°. This is apparent when complex coordinates are both negative (The southwest quadrant to us rope stretchers, right?) and the argument function (or a polar display conversion) yields a modulus (azimuth) for example of -135°. Simply run this equation with the argument of the Argand value (-135°) in the X-reg. The result being 225°. There's a similar function in Excel named MOD. It follows this form:

**=MOD(450-the Argand value,360)**

So far we have a pair of tools to create, store and review coordinates. Traverse should be somewhat self-explanatory to most folks familiar with COGO. Anyone that



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desires a sample data and/or any additional instructions should not hesitate to contact me. In the next installment I will present an inverse program. Hopefully the information presented herein is clear and genuinely explanatory. Please do not hesitate to send any comments, concerns, questions, or criticism to [rls43185@gmail.com](mailto:rls43185@gmail.com). ■

**Jason Foose** is the County Surveyor of Mohave County Arizona. He has been licensed since 11111010000 and believes there are 10 types of people in the world, those that understand binary and those who don't.

## Polecat of the Month

The Polecat of the Month Award goes to Mark Leasure, L.S. I. of GMS, INC. located in Colorado Springs, Co. Mark dug up a grub worm in line H016 of the "Points" listing located on page 15 of the September 2014 issue. The line should read

"H016 EQN N x 1i0 + E 1090".

My apologies to the readers and staff for my oversight and as well as my undying gratitude to Mark Leasure. Thanks for the catch and a toast to our polecat of the month as he dons his orange vest to swim in the melee of traffic that the locals refer to as I-25!