Programmable TI 58/59

Marine Navigation

Quick Reference Guide

CONTENTS

CALCULATING NOTES

Low Battery Indication

If the display flashes erratically, fades out, gives incorrect results or is inconsistent in any way, recharge the battery. Calculator operation can be resumed after several minutes of recharging.

Algebraic Hierarchy

Operations and functions are performed automatically in following order.

1. Math Functions (x^2, cos, etc.)
2. Exponentiation (y^x) and Roots ($\sqrt[x]{y}$)
3. Multiplication, Division
4. Addition, Subtraction
5. Equals

Order applies to each set of parentheses. You can use up to 8 pending operations and 9 open parentheses, except where noted.

Flashing Display

A display flashing off and on indicates that an invalid key sequence has taken place or that the limits of the display have been exceeded. See Appendix B in *Personal Programming* for possible causes.

CONVERSIONS

Angle Formats

[2nd] [D.MS] — **DEGREES, MINUTES, SECONDS TO DECIMAL DEGREES** — Converts an angle measured in degrees, minutes and seconds to its decimal degrees equivalent. [INV] [2nd] [D.MS] reverses this conversion. Also used for time conversions. **Operates on display value only.** Submit 2 digits each for minutes and seconds. Entry and display format is DD.MMSSsss where DD is degrees, MM is minutes, SS is whole seconds and sss is fractional seconds.

Polar to Rectangular

R [x⇄t] θ [2nd] [P→R] → y; [x⇄t] → x

Rectangular to Polar

x [x⇄t] y [INV] [2nd] [P→R] → θ; [x⇄t] R

Only 4 pending operations are available for other uses when using D.MS or Polar/Rectangular conversions.

Angular Conversions

FROM \ TO	Degrees	Radians	Grads
Degrees		$\times \frac{\pi}{180}$	÷ 0.9
Radians	$\times \frac{180}{\pi}$		$\times \frac{200}{\pi}$
Grads	× 0.9	$\times \frac{\pi}{200}$	

STATISTICS

Initialize: [2nd] [Pgm] 1 [SBR] [CLR]
Data Entry: x_i [x⇄t] y_i [2nd] [Σ+]
Data Entry Removal: x_i [x⇄t] y_i [INV] [2nd] [Σ+]
Trendline Data Entry: x_1 [x⇄t], y_1 [2nd] [Σ+], y_2 [2nd] [Σ+], etc.
Trendline Point Removal: [x⇄t] [−] 1 [=] [x⇄t] y_i [INV] [2nd] [Σ+]

Calculations	Key Sequence
Mean of y-array then x-array	[2nd] [$\bar{x}$] [x⇄t]
Standard Deviation (N − 1 Weighting) of y-array then x-array (N Weighting) of y-array then x-array	 [INV] [2nd] [$\bar{x}$] [x⇄t] [INV] [2nd] [Op] 11 [$\sqrt{x}$] [x⇄t] [$\sqrt{x}$]
Variance (N Weighting) of y-array then x-array (N − 1 Weighting) of y-array then x-array	 [2nd] [Op] 11 [x⇄t] [2nd] [$\bar{x}$] [x^2] [x⇄t] [x^2]
Y-Intercept	[2nd] [Op] 12
Slope after y-intercept	[x⇄t]
Correlation Coefficient	[2nd] [Op] 13
y′ for new x	[2nd] [Op] 14
x′ for new y	[2nd] [Op] 15

SPECIAL CONTROL OPERATIONS

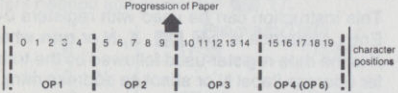
Each special control operation is called by pressing 2nd Op nn where **nn** is the 2-digit code assigned to each operation (short form addressing can be used here). These operations use up to 4 pending operations and 1 subroutine level.

Code nn	Function
00*	Initialize print register.
01*	Alphanumerics for far left quarter of print column.
02*	Alphanumerics for inside left quarter of print column.
03*	Alphanumerics for inside right quarter of print column.
04*	Alphanumerics for far right quarter of print column.
05*	Print the contents of the print register.
06*	Print last 4 characters of OP 04 with current display.
07*	Plot ⁑ in column 0-19 as specified by the display.
08*	List the labels currently used in program memory.
09	Bring specified library program into program memory.
10	Apply signum function to display register value.
11	Calculate variances.
12	Calculate slope and intercept.
13	Calculate correlation coefficient.
14	Calculate new y prime (y') for an x in the display.
15	Calculate new x prime (x') for a y in the display.
16	Display current partition of memory storage area.
17	Repartition memory storage area.
18	If no error condition exists in a program, set flag 7.
19	If an error condition exists in a program, set flag 7.
20-29	Increment a data register 0-9 by 1.
30-39	Decrement a data register 0-9 by 1.

*Designed specifically for use with optional PC-100A Print Cradle

ALPHANUMERIC PRINT CODES

The first seven control operations allow you to create and print out alphanumeric messages. Twenty characters can be printed on each line. They are assembled and stored in groups of 5 characters at a time as shown below.



Each printed character is represented by a two-digit, row-column address code according to the following table:

	0	1	2	3	4	5	6	7
0		0	1	2	3	4	5	6
1	7	8	9	A	B	C	D	E
2	-	F	G	H	I	J	K	L
3	M	N	O	P	Q	R	S	T
4	.	U	V	W	X	Y	Z	+
5	×	*	√	π	e	(	)	,
6	↑	%	¦	/	=	'	x	x̄
7	²	?	÷	!	Ⅱ	∆	Π	Σ

For instance, A is code 13 and + is code 47

PROGRAMMING NOTES

Labels

Any key on the keyboard can be used as a label except [2nd], [LRN], [Ins], [Del], [SST], [BST], [Ind] and the numbers 0-9.

DSZ

This instruction can be used with registers 0-9. Entry sequence is [2nd] [Dsz] **X, N** or **nnn** where X is the data register used followed by the transfer address (label N or absolute address nnn).

Flags

Ten flags are available (0-9). Entry sequence for setting, resetting or testing flags is the flag instruction, flag number, then transfer address (testing only).

MEMORY PARTITIONING

Memory area is partitioned in sets of 10 registers where each register can hold a data value or 8 program instructions. To check placement of current partition, press [2nd] [Op] **16.** To repartition, enter number of sets (N) of 10 data registers needed and press [2nd] [Op] **17.**

N	Program/Data TI-58	TI-59
N < 0 = N		
0	479/00	959/00
1	399/09	879/09
2	319/19	799/19
3	**239/29***	719/29
4	159/39	639/39
5	079/49	559/49
6	000/59	**479/59***
7	Flashing	399/69
8	Flashing	319/79
9	Flashing	239/89
10	Flashing	159/99
N > 10	Flashing	159/99

*Partition when calculator is turned on.

PROGRAM KEY CODES

Key Code	Key	Key Code	Key	Key Code	Key
00	0	39	cos	72*	STO Ind
↓	↓	40	Ind	73*	RCL Ind
09	9	42	STO	74*	SUM Ind
10	E'	43	RCL	75	−
11	A	44	SUM	76	Lbl
12	B	45	y^x	77	x≠t
13	C	47	CMs	78	Σ+
14	D	48	Exc	79	$\bar{x}$
15	E	49	Prd	80	Grad
16	A'	50	|x|	81	RST
17	B'	52	EE	83*	GTO Ind
18	C'	53	(	84*	Op Ind
19	D'	54	)	85	+
20	CLR	55	÷	86	St flg
22	INV	57	Eng	87	If flg
23	ln x	58	Fix	88	D.MS
24	CE	59	Int	89	π
25	CLR	60	Deg	90	Lst
27	INV	61	GTO	91	R/S
28	log	62*	Pgm Ind	92*	INV SBR
29	CP	63*	Exc Ind	93	.
30	tan	64*	Prd Ind	94	+/−
32	x:t	65	×	95	=
33	x^2	66	Pause	96	Write
34	$\sqrt{x}$	67	x=t	97	Dsz
35	1/x	68	Nop	98	Adv
36	Pgm	69	Op	99	Prt
37	P→R	70	Rad		
38	sin	71	SBR		

*Merged codes

RECORDING MAGNETIC CARDS (TI-59 Only)

Display When Write Pressed, Card Entered	Calculator Response
1, 2, 3, 4	Writes a card side with this number from the bank of this number (program and/or data) and records current partition on card.
−1, −2, −3, −4	Writes and protects card side with this number from the bank with this number. Also records current partition on card.
Any other number	Card is passed but not recorded. Rightmost two integer digits of display are flashed.

If the display is flashing any value when trying to read or record a card, the card is passed but not read or recorded and the rightmost two integers in the display are flashed.

The calculator should be in standard display format when reading or recording cards.

Only the integer portion of the display is recognized, i.e., 1.234 = 1.

READING MAGNETIC CARDS (TI-59 Only)

Display When Card Entered	Calculator Response
0	Reads information into bank number listed on card if current partition matches that on card. If partition incorrect, card is passed, but not read — display flashes card side passed.
1, 2, 3, 4	Expects card with this side number to be read — displays that side number. If another side is entered or if partition is incorrect, card is passed but not read — display flashes card side passed.
−1, −2, −3, −4	Forces side to be read into this bank number regardless of the partition or the number on the card. A protected program cannot be forced into any bank or alternate partition.
Any other number	Card is passed but not read — rightmost two integers in display flash.

LIBRARY USER INSTRUCTIONS

The remainder of this booklet contains the User Instructions for each program of the library.

REMOVING AND INSTALLING MODULES. The library module can easily be removed or replaced with another. It is a good idea to leave the module in place in the calculator except when replacing it with another module. Be sure to follow these instructions when you need to remove or replace a module.

CAUTION

Be sure to touch some metal object before handling a module to prevent possible damage by static electricity.

1. Turn the calculator OFF. Loading or unloading the module with the calculator ON may cause the keyboard or display to lock out. Also, shorting the contacts can damage the module or calculator.
2. Slide out the small panel covering the module compartment at the bottom of the back of the calculator.
3. Remove the module. You may turn the calculator over and let the module fall out into your hand.
4. Insert the module, notched end first with the labeled side up into the compartment. The module should slip into place effortlessly.
5. Replace the cover panel, securing the module against the contacts.

NAVIGATION LIBRARY DIAGNOSTIC NG-01

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
	Diagnostic/Module Check			
1a	Select Program		[2nd] [Pgm] 01	
1b	Run Diagnostic		[SBR] [=]	5.[1]
	or			
1c	Library Module Check		[SBR] [2nd] [R/S]	5.[2]
	Initialize Linear Regression			
2a	Select Program		[2nd] [Pgm] 01	
2b	Initialize Linear Regression		[SBR] [CLR]	0.

NOTES:
1. This output is obtained if the calculator is operating properly.
2. The number 5. indicates the Navigation Library.
3. The Navigation Library programs are numbered 1 through 30. Program number 0 is the calculator's program memory.

TIME-SPEED-DISTANCE WITH CURRENT SAILING NG-02

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 02	
2	Select degree mode.		[2nd] [Deg]	
	TIME-SPEED-DISTANCE			
3	Initialize.		[2nd] [A']	0.
4	Enter time interval and speed made good to calculate distance.	Δt (HH.MMSS) SMG (knots)	[B] [C] [D]	0. 0. Dist (nau. mi.)
	OR			
5	Enter time interval and distance to calculate SMG .	Δt (HH.MMSS) Dist (nau. mi.)	[B] [D] [C]	0. 0. SMG (knots)
	OR			
6	Enter distance and speed made good to calculate time.	Dist (nau. mi.) SMG (knots)	[D] [C] [B]	0. 0. Δt (HH.MMSS)
7	Display: time, SMG, Dist.		[B] [B] [C] [C] [D] [D]	Δt (HH.MMSS) SMG (knots) Dist (nau. mi.)

	PLANNING			
8	Initialize		[2nd] [A′]	0.
9	Enter ETD.	ETD (HH.MMSS)	[A]	ETD (HH.hh)
10	Enter speed to make good.	SMG (knots)	[C]	0.
11	Enter leg distance.	Dist (nau. mi.)	[D]	0.
12	Calculate ETA.		[E]	ETA (HH.MMSS)
13	Compute.		[2nd] [E′]	ETA
14a	Display total distance		[R/S]	tD (nau. mi.)
14b	and time (optional).		[R/S]	Δt (HH.MMSS)
15	Display leg time (optional).		[B] [B]	Δt_n (HH.MMSS)
	Return to step 10 for next leg.			
	OR			
16	Enter ETD.	ETD (HH.MMSS)	[A]	ETD (HH.hh)
17	Enter leg distance.	Dist (nau. mi.)	[D]	0.
18	Enter ATA and compute.	ATA (HH.MMSS)	[2nd] [E′]	ATA (HH.MMSS)
19a	Display total distance		[R/S]	tD (nau. mi.)
19b	and time (optional).		[R/S]	Δt (HH.MMSS)
20	Display leg time (optional).		[B] [B]	Δt_n (HH.MMSS)
21	Display SMG		[C] [C]	SMG (knots)
	Return to step 17 for next leg.			

	PLANNING WITH CURRENT SAILING			
	To find the speed and true course to steer through the water for a leg, insert the following between steps 10 and 11 (or 19 and 20).			
22a	Enter drift and	Dr (knots)	[2nd] [C′]	Prev. Dr (knots)
22b	set of current.	St (DDD.dd)	[2nd] [C′]	Prev. St (DDD.dd)
23a	Enter CMG to find true course to steer	CMG (DDD.dd)	[2nd] [D′]	C_t (DDD.dd)
23b	and required speed.		[R/S]	S (knots)

NOTES:

1. To correct an erroneous entry, simply reenter. Data not causing immediate computation may be entered in any order providing both parts of a step are performed in sequence.
2. Steps 22 and 23 may be performed any time after SMG has been entered or calculated.
3. If any value to be entered is zero, enter zero.

DISTANCE SHORT OF, BEYOND, OR TO HORIZON

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 03	
2	Select degree mode.		[2nd] [Deg]	
	Find D_h			
3	Enter eye height.	EYE (ft.)	[A]	EYE (ft)
4	Display D_h in nau. mi., in feet (optional).		[C] [R/S]	D_h (nau. mi.) D_h (ft.)
	Find D_v			
5	Enter eye height.	EYE (ft.)	[A]	EYE (ft.)
6	Enter object height.	H (ft.)	[2nd] [A′]	H (ft.)
7	Display D_v in nau. mi., in feet (optional).		[2nd] [C′]	D_v (nau. mi.) D_v (ft.)
	Find D_b			
8	Enter eye height.	EYE (ft.)	[A]	EYE (ft.)
9	Enter object height.	H (ft.)	[2nd] [A′]	H (ft.)
10	Enter sextant altitude above horizon.	Hs (DDMM.m)	[B]	Hs (DD.dd)
11	Enter index correction.	IC (M.m)	[2nd] [B′]	IC (.dd)

12	Display D_b in nau. mi., in feet (optional).		[D] [R/S]	D_b (nau. mi.) D_b (ft.)
	Find D_d			
13	Enter eye height.	EYE (ft.)	[A]	EYE (ft.)
14	Enter depression angle	Hs (DDMM.m)	[B]	Hs (DD.dd)
15	Enter index correction.	IC (M.m)	[2nd] [B′]	IC (.dd)
16	Display D_d in nau. mi., in feet (optional).		[2nd] [D′] [R/S]	D_d (nau. mi.) D_d (ft.)
	Find D.			
17	Enter object height.	H (ft.)	[2nd] [A′]	H (ft.)
18	Enter subtended angle.	Hs (DDMM.m)	[B]	Hs (DD.dd)
19	Enter index correction.	IC (M.m)	[2nd] [B′]	IC (.dd)
20	Display D in nau. mi., in feet (optional).		[E] [R/S]	D (nau. mi.) D (ft.)
	Find object height.			
21	Enter subtended angle	Hs (DDMM.m)	[B]	Hs (DD.dd)
22	Enter index correction.	IC (M.m)	[2nd] [B′]	IC (.dd)
23	Enter distance to object in feet and compute object height in feet.	D (ft.)	[2nd] [E′]	H (ft.)

VELOCITY NEEDED TO CHANGE RELATIVE POSITION NG-04

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 04	
2	Select degree mode.		[2nd] [Deg]	
3a	Enter speed of guide vessel and its true course.	S_g (knots)	[A]	Prev. S_g (knots)
3b		C_{tg} (DDD.dd)	[A]	Prev. C_{tg} (DDD.dd)
4a	Enter initial distance and bearing between vessels.	D_1 (nau. mi.)	[B]	Prev. D_1 (nau. mi.)
4b		B_1 (DDD.dd)	[B]	Prev. B_1 (DDD.dd)
5	IF B_1 IS RELATIVE convert to true bearing.		[2nd] [B′]	B_{t1} (DDD.dd)
6a	Enter desired distance and bearing between vessels	D_2 (nau. mi.)	[C]	Prev. D_2 (nau. mi.)
6b		B_2 (DDD.dd)	[C]	Prev. B_2 (DDD.dd)
7	IF B_2 IS RELATIVE convert to true bearing.		[2nd] [C′]	B_{t2} (DDD.dd)
8	Enter allowed time.	Δt (HH.MMSS)	[D]	Δt (HH.hh)
9	Compute required speed and true course of maneuvering vessel.		[E] [R/S]	S_m (knots) C_{tm} (DDD.dd)

NOTES:

1. The data for Steps 3, 4, and 6 may be entered or corrected by reentry in any order (part b must follow a). In making a correction, both parts of the step must be performed in sequence even if only one value was entered incorrectly.
2. If the value of any data is zero, enter zero.

VELOCITY, VMG, AND CURRENT VECTORS NG-05

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 05	
2	Select degree mode.		[2nd] [Deg]	
3	Enter magnetic variation (+W, −E).	V (DD.dd)	[2nd] [A′]	V (DD.dd)
	Find SMG and CMG			
4a	Enter vessel speed and	S (knots)	[A]	Prev. S (knots)
4b	magnetic course.	C_m (DDD.dd)	[A]	Prev. C_m (DDD.dd)
5a	Enter drift and	Dr (knots)	[B]	Prev. Dr (knots)
5b	set of current.	St (DDD.dd)	[B]	Prev. St (DDD.dd)
6	Compute.		[E]	0.
7a	Display SMG		[C]	SMG (knots)
7b	and CMG.		[R/S]	CMG (DDD.dd)
	Find drift and set.			
8a	Enter vessel speed and	S (knots)	[A]	Prev. S (knots)
8b	magnetic course.	C_m (DDD.dd)	[A]	Prev. C_m (DDD.dd)
9a	Enter speed and	SMG (knots)	[C]	Prev. SMG (knots)
9b	course made good.	CMG (DDD.dd)	[C]	Prev. CMG (DDD.dd)
10	Compute.		[E]	0.
11a	Display drift and		[B]	Dr (knots)
11b	set of current.		[R/S]	St (DDD.dd)
	Find speed and C_m.			
12a	Enter drift and	Dr (knots)	[B]	Prev. Dr (knots)
12b	set of current.	St (DDD.dd)	[B]	Prev. St (DDD.dd)
13a	Enter speed and	SMG (knots)	[C]	Prev. SMG (knots)
13b	course made good.	CMG (DDD.dd)	[C]	Prev. CMG (DDD.dd)
14	Compute.		[E]	0.
15a	Display speed and		[A]	S (knots)
15b	magnetic course.		[R/S]	C_m (DDD.dd)

NOTES:

1. Major data entry steps (i.e., 4 and 5, not 4a and 4b) may be performed in any order
2. Data may be corrected any time previous to computation by reentry; however, both parts of the step (a and b) must be performed in their proper sequence regardless of whether one or both of the entered values is to be changed.
3. Printer usage is optional.
4. If the value of any data is zero, enter zero.

COURSE TO STEER AND SMG (PLANNING) NG-06

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 06	
2	Select degree mode.		[2nd] [Deg]	
3	Enter magnetic variation (+W, −E).	V (DD.dd)	[2nd] [A′]	V (DD.dd)
4	Enter vessel speed.	S (knots)	[A]	S (knots)
5	Enter course to make good.	CMG (DDD.dd)	[B]	CMG (DDD.dd)
6a	Enter drift and	Dr (knots)	[C]	Prev. Dr (knots)
6b	set of current.	St (DDD.dd)	[C]	Prev. St (DDD.dd)
7a	Calculate magnetic course		[D]	C_m (DDD.dd)
7b	and correct to compass course if desired (De: +W, −E).	De (D.dd)	[R/S]	C_c (DDD.dd)
8	Compute resulting speed made good.		[E]	SMG (knots)
9	Enter distance to find cruise time.	Dist (nau. mi.)	[2nd] [D′]	Δt (HH.MMSS)
10	Enter starting time to find arrival time.	t_S (HH.MMSS)	[2nd] [E′]	ETA (HH.MMSS)

NOTES:

1. Data entries not causing immediate calculation may be entered in any order (6b must follow 6a).
2. Data may be corrected by reentering. If either Dr or St is incorrect, both must be reentered in the proper order. If [R/S] is pressed after entering a wrong value for De, press [D] and reenter; if not, press [CE] and reenter.
3. Enter time in GMT unless the starting and destination points are in the same time zone.
4. All time entries are based on the 24-hour clock.
5. Use of printing unit is optional.
6. If the value of any data is zero, enter zero.

DISTANCE OFF ONE OBJECT AND TIME OF NEAREST APPROACH NG-07

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 07	
2	Select degree mode.		[2nd] [Deg]	
3	Enter magnetic variation (+W, −E).	V (DD.dd)	[2nd] [A′]	V (DD.dd)
4a	Enter vessel speed	S (knots)	[A]	S (knots)
4b	and compass course.	C_c (DDD.dd)	[A]	C_c (DDD.dd)
4c	Enter magnetic deviation if desired (+W, −E).	De (D.dd)	[R/S]	De (D.dd)
5a	Enter drift and	Dr (knots)	[2nd] [B′]	Prev. Dr (knots)
5b	set of current.	St (DDD.dd)	[2nd] [B′]	Prev. St (DDD.dd)
6	Enter first relative bearing.	B_{r1} (DDD.dd)	[B]	Prev. B_{r1} (DDD.dd)
7	Enter first time.	t_1 (HH.MMSS)	[C]	t_1 − prev t_2
8	Enter second relative bearing.	B_{r2} (DDD.dd)	[B]	Prev. B_{r2} (DDD.dd)
9	Enter second time.	t_2 (HH.MMSS)	[C]	Δt (HH.hh)
10a	Compute distance made good between observations		[D]	DMG (nau. mi.)
10b	and distance off object at t_2.		[R/S]	D_2 (nau. mi.)
11	Display distance of nearest approach.		[2nd] [D′]	D_n (nau. mi.)

12a	Display time before nearest approach.		[E]	Δt_n (HH.MMSS)
12b	Display time of nearest approach.		[R/S]	t_n (HH.MMSS)

NOTES:

1. All time entries are based on the 24-hour clock.
2. All times entered should be in the same zone (or GMT).
3. If t_n is displayed as a negative value, add 24 to obtain the correct result. If $t_n \geq 24$, subtract 24.
4. In entering data, Step 8(9) must follow Step 6(7).
5. Data may be corrected by reentry; however, if either of B_{r1} or B_{r2} (or t_1 or t_2) is to be changed, both must be reentered in the proper sequence. Also, if De must be corrected, both S and C_c must be reentered as well.
6. If Δt_n is displayed as a negative value, then t_n has already been passed.

DMG, SMG, CMG FROM TWO OBJECTS NG-08

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 08	
2	Select degree mode.		[2nd] [Deg]	
3a	Enter magnetic variation (+W, −E).	V (DD.dd)	[2nd] [A′]	V (DD.dd)
3b	Enter magnetic deviation if desired (+W, −E).	De (D.dd)	[R/S]	De (D.dd)
4a	Enter distance and	D (nau. mi.)	[A]	Prev. D (nau. mi.)
4b	true course from object 1 to object 2.	B_t (DDD.dd)	[A]	Prev. B_t (DDD.dd)
5	Enter first bearing to object 1,	B_{c1} (DDD.dd)	[B]	Prev. B'_{t1} (DDD.dd)
6	to object 2.	B_{c2} (DDD.dd)	[2nd] [B′]	0.
7	Enter first time.	t_1 (HH.MMSS)	[C]	t_1 − prev. t_2
8a	Display first distance to object 1,		[D]	D_1 (nau. mi.)
8b	to object 2,		[R/S]	D_2 (nau. mi.)
9	Enter second bearing to object 1,	B'_{c1} (DDD.dd)	[B]	B_{t1} (DDD.dd)
10	to object 2.	B'_{c2} (DDD.dd)	[2nd] [B′]	0.
11	Enter second time to find time interval.	t_2 (HH.MMSS)	[C]	Δt (HH.hh)
12a	Display second distance to object 1,		[D]	D'_1 (nau. mi.)
12b	to object 2.		[R/S]	D'_2 (nau. mi.)
13	Compute distance made good between observations.		[E]	DMG (nau. mi.)
14a	Display speed and		[2nd] [E′]	SMG (knots)
14b	course made good.		[R/S]	CMG (DDD.dd)

NOTES:

1. All time entries should be based on the 24-hour clock and in the same time zone (or GMT).
2. If midnight falls between the two observations, add 24 to t_2 before entering.
3. In entering data, Step 3 must be performed first, Step 9(10) must follow Step 5(6).
4. Data may be corrected by reentry; however, both parts of a step (a and b) must be performed in sequence even if only one value is to be changed. This also applies to Steps 5 and 9 (6 and 10).
5. Steps 8 and 12 are optional.
6. If either bearing is 000°, enter 0.

COURSE MADE GOOD FROM THREE BEARINGS NG-09

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 09	
2	Select degree mode.		[2nd] [Deg]	
3a	Enter magnetic variation (+W, −E).	V (DD.dd)	[2nd] [A′]	V (DD.dd)
3b	Enter magnetic deviation if desired (+W, −E).	De (D.dd)	[R/S]	De (D.dd)
4	Enter first time.	t_1 (HH.MMSS)	[B]	t_1 (HH.hh)
5	Enter first compass bearing.	B_{c1} (DDD.dd)	[2nd] [B′]	B_{c1} (DDD.dd)
6	Enter second time.	t_2 (HH.MMSS)	[C]	t_2 (HH.hh)
7	Enter second compass bearing.	B_{c2} (DDD.dd)	[2nd] [C′]	B_{c2} (DDD.dd)
8	Enter third time.	t_3 (HH.MMSS)	[D]	t_3 (HH.hh)
9	Enter third compass bearing.	B_{c3} (DDD.dd)	[2nd] [D′]	B_{c3} (DDD.dd)
10	Compute true course made good.		[E]	CMG (DDD.dd)

NOTES:

1. Data may be entered or corrected in any order (3b must follow 3a).
2. If De is to be corrected, V must be reentered first.
3. All times are entered on a 24-hour basis and must be in the same time zone (or GMT).
4. Printer may be used with this program.

DEAD RECKONING

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 10	
2	Select degree mode.		[2nd] [Deg]	
3	Enter starting time.	t_S (HH.MMSS)	[2nd] [A′]	t_S (HH.hh)
4a	Enter starting latitude (+N, −S)	L_S (DDDMM.m)	[A]	Prev. L_S (DDD.dd)
4b	and longitude (+W, −E).	λ_S (DDDMM.m)	[A]	Prev. λ_S (DDD.dd)
5a	Enter speed and	SMG (knots)	[D]	Prev. SMG (knots)
5b	true course made good.	CMG (DDD.dd)	[D]	Prev. CMG (DDD.dd)
6	Enter dead reckoning time.	t_{DR} (HH.MMSS)	[2nd] [E′]	t_{DR} (HH.hh)
7a	Display latitude and		[E]	L_{DR} (DDDMM.m)
7b	longitude of dead reckoning position.		[R/S]	λ_{DR} (DDDMM.m)
	To find new dead reckoning position, go to step 6. (If SMG or CMG has changed perform step 8 and return to step 5.)			
8			[2nd] [D′]	0.0

NOTES:

1. Data entries and correction by reentry may be performed in any order (part b must follow part a). In correcting data, both parts of Steps 4 and 5 must be performed even if only one entry is to be altered.
2. All time entries are based on the 24-hour clock and should be in the same time zone (or GMT).

RHUMBLINE (MERCATOR) NAVIGATION

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 11	
2	Select degree mode.		[2nd] [Deg]	
3	Initialize.		[2nd] [A′]	0.
4a	Enter starting latitude (+N, −S)	L_S (DDDMM.m)	[A]	Prev. L_S (DDD.dd)
4b	and longitude (+W, −E).	λ_S (DDDMM.m)	[A]	Prev. λ_S (DDD.dd)
5a	Enter destination latitude (+N, −S)	L_D (DDDMM.m)	[B]	Prev. L_D (DDD.dd)
5b	and longitude (+W, −E).	λ_D (DDDMM.m)	[B]	Prev. λ_D (DDD.dd)
6	Compute.		[C]	0.
7	Display distance.		[D]	D (nau. mi.)
8	Display true course to make good.		[E]	CMG (DDD.dd)
9	Display total distance.		[2nd] [D′]	tD (nau. mi.)
10	Enter time interval and display speed to make good.	Δt (HH.MMSS)	[2nd] [E′]	SMG (knots)
11	Perform this step to use the destination as a new starting position and go to step 5.		[2nd] [B′]	0.

NOTES:

1. Major data entry steps (4 and 5, not 4a and 4b) may be performed or corrected by reentry in either order; however, both parts of a step must be performed even if only one of the values entered by that step is to be corrected (Step 10 must follow 6).
2. Step 10 may be performed in succession for any number of time intervals.
3. Use of the print cradle is optional.
4. This program may not be run in engineering mode.

CHART INITIALIZATION

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 12	
2	Select degree mode.		[2nd] [Deg]	
3	Enter magnetic variation (+W, −E).	V (DD.dd)	[2nd] [A′]	V (DD.dd)
4a	Enter latitude (+N, −S) and	L_1 (DDD.MMSS)	[B]	Prev. L_1 (DDD.dd)
4b	longitude (+W, −E) of object 1.	λ_1 (DDD.MMSS)	[B]	Prev. λ_1 (DDD.dd)
5a	Enter latitude (+N, −S) and	L_2 (DDD.MMSS)	[2nd] [B′]	Prev. L_2 (DDD.dd)
5b	longitude (+W, −E) of object 2.	λ_2 (DDD.MMSS)	[2nd] [B′]	Prev. λ_2 (DDD.dd)
	EITHER			
6a	Enter nautical miles in latitude interval,	L_m (nau. mi.)	[C]	Prev. L_m (nau. mi.)
6b	in longitude interval,	λ_m (nau. mi.)	[C]	Prev. λ_m (nau. mi.)
	OR			
7	Enter average latitude (+N, −S).	L(DDD.MMSS)	[2nd] [C′]	1.
8	Load the constants.		[E]	0.
9	Record the constants on a blank card for future use.	4	[2nd] [Write]	4.
	Feed card into card slot.			4.

NOTES:

1. Major data steps (4 and 5, not 4a and 4b) may be entered or corrected in any order; however, both parts of the step must be performed in correcting data even if only one value is to be changed.
2. Printer usage is optional with this program.
3. If the proper data has already been stored on a magnetic card, simply clear the calculator's display, feed the card into the card slot, and press [2nd] [Pgm] [1] [2] [E].

RUNNING FIX FROM ONE OBJECT (LAT/LON)

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 13	
2	Select degree mode.		[2nd] [Deg]	
3	Enter magnetic deviation of compass used to find bearings (+W, −E).	De (B) (D.dd)	[2nd] [A′]	De (B) + V (DD.dd)
4a	Enter vessel speed,	S (knots)	[A]	S (knots)
4b	compass course, and	C_c (DDD.dd)	[A]	C_c (DDD.dd)
4c	magnetic deviation of the vessel's compass (+W, −E).	De (D.dd)	[R/S]	De + V (DD.dd)
5a	Enter drift and	Dr (knots)	[2nd] [B′]	prev. Dr (knots)
5b	set of current.	St (DDD.dd)	[2nd] [B′]	prev. St (DDD.dd)
6	Enter first compass bearing to object.	B_{c1} (DDD.dd)	[B]	prev. B_{t1} (DDD.dd)
7	Enter first time.	t_1 (HH.MMSS)	[C]	t_1 − prev. t_2 (HH.hh)
8	Enter second bearing.	B_{c2} (DDD.dd)	[B]	prev. B_{t2} (DDD.dd)
9	Enter second time.	t_2 (HH.MMSS)	[C]	Δt (HH.hh)
10	If using object 1. If using object 2.		[D] [2nd] [D′]	9. 11.
11	Compute fix (L = +N, −S; λ = +W, −E).		[E] [R/S]	L (DD.MMSS) λ (DD.MMSS)

	For two new observations, go to step 6.			
	To enter a new second observation and use the previous second observation as the first observation, go to step 8.			
	To enter a new second observation without altering the first observation, perform step 12 and go to step 8.			
12	Save first observation.		[2nd] [E′]	B_{t1} (DDD.dd)

NOTES:

1. In entering or correcting data by reentry, minor steps (a, b, and c) must be performed in sequence even if only one value is to be entered or reentered. Also, Step 8(9), must accompany and follow Step 6(7) and Step 3 must precede 6 and 8.
2. The option provided in Step 10 is designed to allow use of either object recorded on a customized card.
3. All time entries are on a 24-hour basis and should be in the same time zone (or GMT).
4. If the value of any entry is zero, enter zero.

FIX FROM TWO OBJECTS (LAT/LON) NG-14

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 14	
2	Select degree mode.		[2nd] [Deg]	
3	Enter magnetic deviation of compass used to take bearings (+W, −E).	De (D.dd)	[2nd] [A′]	De + V
4a	Enter compass bearing to object 1,	B_{c1} (DDD.dd)	[B]	prev. B_{t1} (DDD.dd)
4b	to object 2.	B_{c2} (DDD.dd)	[B]	prev. B_{t2} (DDD.dd)
5	Compute fix (L = +N, −S; λ = +W, −E).		[E] [R/S]	L (DDD.MMSS) λ (DDD.MMSS)

NOTES:

1. Data must be entered in the above order.
2. Data may be corrected by reentry; however, both bearings must be reentered even if only one is incorrect.
3. Printing unit may be used with this program.
4. If the value of any data is zero, enter zero.

TIME OF SUNRISE/SUNSET/TWILIGHT NG-15

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 15	
2	Select degree mode.		[2nd] [Deg]	
3	Enter dead reckoning latitude (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR}
4	Enter dead reckoning longitude (+W, −E).	λ_{DR} (DDDMM.m)	[B]	λ_{DR}
5	Enter tabulated latitude at or above L_{DR} (+N, −S).	L_1 (DD)	[C]	L_1
6	Enter tabulated latitude below L_{DR} (+N, −S).	L_2 (DD)	[D]	L_2
7	Enter tabulated time for L_1.	t_1 (HH.MM)	[E]	t_1 (HH.hh)
8	Enter tabulated time for L_2.	t_2 (HH.MM)	[2nd] [A′]	t_2 (HH.hh)
9	Compute time of event at DR position		[2nd] [B′]	GMT (HH.MMSSs)

NOTES:

1. Data may be corrected by reentry.
2. Steps 7–9 may be repeated as necessary.
3. If GMT ⩾ 24, subtract 24 for the proper result.
4. Printer usage is optional.

PLANET LOCATION

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 16	
2	Select degree mode.		[2nd] [Deg]	
3	Enter latitude of dead reckoning position (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR}
4	Enter longitude of dead reckoning position (+W, −E).	λ_{DR} (DDDMM.m)	[B]	λ_{DR}
5	Enter minutes and seconds of estimated GMT at DR position.	MS (.MMSS)	[C]	MS (.hh)
6	Enter ν correction.	ν (M.m)	[D]	intermediate calculation
7	Enter GHA of desired planet at twilight.	GHA (DDDMM.m)	[E]	sin LHA
8	Enter d correction.	d (M.m)	[2nd] [A′]	MS (.hh)
9	Enter declination of desired planet (+N, −S) and compute estimated altitude.	Dec (DDMM.m)	[2nd] [B′]	Hc (DDMM.m)
10	Compute estimated azimuth.		[2nd] [C′]	Zn (DDD.ddd)

NOTES:

1. If GHA is entered incorrectly, press [INV] [2nd] [St Flg] [0] and reenter. Remaining data may be corrected by reentry.

2. If data for more than one planet for same time and DR position is desired, after completing the work for the first planet, repeat Steps 6 through 10.
3. Use of printer is optional.

STAR IDENTIFICATION

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 17	
2	Select degree mode.		[2nd] [Deg]	
3	Initialize.		[2nd] [D′]	0.
4	Enter latitude of dead reckoning position (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR} (DD.dd)
5	Enter longitude of dead reckoning position (+W, −E).	λ_{DR} (DDMM.m)	[B]	λ_{DR} (DD.dd)
6	Enter sextant reading.	Hs (DDMM.m)	[C]	Hs (DD.dd)
7	Enter observed azimuth.	Zn (DDD)	[D]	Zn
8	Enter Greenwich hour angle of Aries.	GHA ♈(DDDMM.m)	[E]	GHA ♈ (DDD.dd)
9	Enter minutes and seconds of GMT at DR position.	MS (.MMSSs)	[2nd] [A′]	MS (.hh)
10	Compute estimated declination (+N, −S).		[2nd] [B′]	Dec (DDMM.m)
11	Compute sidereal hour angle of star.		[2nd] [C′]	SHA (DDDMM.m)

NOTES:

1. If Zn is entered incorrectly, press [INV] [2nd] [St Flg] [0] and reenter. Remaining data may be corrected by reentry.
2. The print cradle may be used with this program.

SEXTANT CORRECTION

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 18	
2	Select degree mode.		[2nd] [Deg]	
3	Initialize. (Perform 4-15 for each sight.)		[2nd] [E′]	0.
4	Enter sextant reading.	Hs (DDMM.m)	[A]	Hs (DD.dd)
5	Enter instrument error.	IE (MM.m)	[A]	IE (.dd)
6	Enter index correction.	IC (MM.m)	[A]	IC).dd)
7	Enter additional correction for Venus or Mars.	♂, ♀ (MM.m)	[A]	♂, ♀ (.dd)
8	Perform this step only if you observed the lower limb of the sun or moon.		[B]	♂, ♀ (.dd)
9	Enter semi-diameter of the sun or moon.	SD (MM.m)	[C]	±SD (.dd)
10	Enter height of eye above water.	EYE (ft)	[D]	Rm (.dd)
11	Enter horizontal parallax (moon only).	HP (MM.m)	[E]	HP [cos (ha - RM)]

12	Enter air temperature.	T (°F)	[2nd] [A′]	T′
13	Enter barometric pressure.	P (inches)	[2nd] [B′]	P′
14	Compute observed altitude.		[2nd] [C′]	Ho (DD.MMSSs)
15	Store Ho.		[2nd] [D′]	sight no.

NOTES:

1. If [B] is erroneously pressed, correct by pressing [INV] [2nd] [St flg] [0].
2. If [2nd] [D′] is pressed at the wrong time, press [INV] [2nd] [St flg] [0] [2] [INV] [SUM] [0] [0] [1] [INV] [SUM] [0] [3] and return to Step 4. (If the error is made on the first sight, simply initialize and begin again.)
3. Program space will not allow simple corrections, therefore, for any data entry error, press [INV] [2nd] [St flg] [0] [0] [STO] [0] [4] and return to Step 4. Do not initialize the program again as the altitudes will then be improperly stored.
4. Do not initialize the program between sights as this will cause improper storage of the observed altitudes when stacking.
5. The print cradle may be used with this program.

SIGHT REDUCTION (SUN)

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 19	
2	Select degree mode.		[2nd] [Deg]	
3	Enter latitude of dead reckoning position (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR} (DD.dd)
4	Enter longitude of dead reckoning position (+W, −E).	λ_{DR} (DDDMM.m)	[B]	λ_{DR} (DD.dd)
5	Enter minutes and seconds of GMT at DR position.	MS (.MMSS)	[C]	Intermediate calculation
6	(Omit for sun.)			
7	Enter GHA of sun for whole hours of GMT	GHA (DDDMM.m)	[D]	sin LHA
8a	Enter *d* correction	*d* (M.m)	[E]	*d* (.dd)
8b	Enter declination (+N, −S) of sun for whole hours of GMT to find computed altitude.	Dec (DDMM.m)	[2nd] [A′]	Hc (DD MMSS)
9	Compute intercept.		[2nd] [B′]	a (nau mi.)
10	Compute azimuth.		[2nd] [C′]	Zn (DDD.dd)
11	Store azimuth.		[2nd] [D′]	sight number

SIGHT REDUCTION (MOON, PLANET) NG-20, 21

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.[1]		[2nd] [Pgm] mm	
2	Select degree mode.		[2nd] [Deg]	
3	Enter latitude of dead reckoning position (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR} (DD.dd)
4	Enter longitude of dead reckoning position (+W, −E).	λ_{DR} (DDDMM.m)	[B]	λ_{DR} (DD.dd)
5	Enter minutes and seconds of GMT at DR position.	MS (.MMSS)	[C]	Intermediate calculation
6	Enter v correction.	v (MM.m)	[D]	Intermediate calculation
7	Enter GHA (for whole hours of GMT) for moon or planet.	GHA (DDDMM.m)	[E]	sin LHA
8a	Enter d correction.	d (M.m)	[2nd] [A′]	d (.dd)
8b	Enter declination (+N, −S) for whole hours of GMT of moon or planet to find computed altitude.	Dec (DDMM.m)	[2nd] [B′]	Hc (DD.MMSS)
9	Compute intercept.		[2nd] [C′]	a (nau. mi.)
10	Compute azimuth.		[2nd] [D′]	Zn (DDD.dd)

11	Store azimuth.		[2nd] [E′]	sight number

NOTE: 1. For the moon, use [2nd] [Pgm] 20; for a planet, use [2nd] [Pgm] 21.

SIGHT REDUCTION (STAR)

NG-22

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 22	
2	Select degree mode.		[2nd] [Deg]	
3	Enter latitude of dead reckoning position (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR} (DD.dd)
4	Enter longitude of dead reckoning position (+W, −E).	λ_{DR} (DDDMM.m)	[B]	λ_{DR} (DDD.dd)
5	Enter minutes and seconds of GMT at DR position.	MS (.MMSS)	[C]	Intermediate calculation
6	Enter SHA of star for whole hours of GMT.	SHA (DDDMM.m)	[D]	SHA (DDD.dd)
7	Enter GHA of Aires for whole hours of GMT.	GHA ♈ (DDDMM.m)	[E]	sin LHA
8	Enter declination (+N, −S) of star for whole hours of GMT to find computed altitude.	Dec (DDMM.m)	[2nd] [A′]	Hc (DD.MMSS)
9	Compute intercept.		[2nd] [B′]	a (nau. mi.)
10	Compute azimuth.		[2nd] [C′]	Zn (DDD.dd)
11	Store azimuth.		[2nd] [D′]	sight no.

FIX BY TWO OBSERVATIONS

NG-23

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 23	
2	Select degree mode.		[2nd] [Deg]	
3	Enter latitude of dead reckoning position (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR} (DD.dd)
4	Enter longitude of dead reckoning position (+W, −E).	λ_{DR} (DDDMM.m)	[B]	λ_{DR} (DDD.dd)
5	Enter number of first sight to be used.	sight no.	[C]	intermediate calculation
6	Enter number of second sight to be used and compute longitude of fix.	sight no.	[D]	λ (DDDMM.m)
7	Compute latitude of fix		[E]	L (DDMM.m)

NOTES:

1. Steps 3 and 4 may be omitted if the DR position of the last sight reduction program is to be used.
2. DR latitude and longitude may be corrected by reentry.
3. Steps 5-7 may be repeated as needed.
4. Printer usage is optional.

TIME OF LOCAL APPARENT NOON AND SUN LINES

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 24	
2	Select degree mode.		[2nd] [Deg]	
3	Initialize.		[2nd] [D′]	0.
4	Enter latitude of dead reckoning position (+N, −S).	L_{DR} (DDMM.m)	[A]	L_{DR} (DD.dd)
5	Enter longitude of dead reckoning position (+W, −E).	λ_{DR} (DDDMM.m)	[B]	λ_{DR} (DDD.dd)
6	Enter equation of time for sun for 12 hours.	EQ (.MMSS)	[C]	EQ (.ddd)
7	Perform this step only if the meridian passage at Greenwich is after 12:00 GMT.		[D]	±EQ
8	Enter declination (+N, −S)	Dec (DDMM.m)	[E]	Dec (DD.dd)
9	Compute GMT of local apparent noon.		[2nd] [A′]	LAN (HH.MMSS)
10	Compute GMT of p.m. sun line.		[2nd] [B′]	p.m. sight
11	Compute GMT of a.m. sun line.		[2nd] [C′]	a.m. sight

NOTES:

1. *If [D] is erroneously pressed, correct by pressing again.*
2. Data may be corrected by reentry.
3. Printer usage is optional with this program.
4. Outputs are in GMT.

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1.	Select program.		[2nd] [Pgm] 25	
2	Select degree mode.		[2nd] [Deg]	
3	Enter GMT of local apparent noon.	LAN (HH.MMSS)	[A]	LAN-12
4	Enter equation of time for sun for 12 hours.	EQ (.MMSS)	[B]	EQ (.ddd)
5	Perform this step only if meridian passage at Greenwich occurs after 12:00 GMT.		[C]	− EQ
6	Compute longitude of observer.		[D]	λ (DDDMM.m)
7	Enter *d* correction for sun.	*d* (M.m)	[E]	*d* (.ddd)
8	Enter declination of sun (+N, −S).	Dec (DDMM.m)	[2nd] [A′]	Dec (DD.ddd)
9	Enter dead reckoning latitude and compute actual latitude.	L_{DR}	[2nd] [B′]	L (DDDMM.m)

NOTES:

1. If LAN or EQ is entered incorrectly or if [C] is pressed by mistake, correct by immediately repeating the step. For any other error begin the program again.
2. The order of the steps may not be altered.

3. Printer usage is optional.
4. Do not press [CLR] or perform keyboard calculations while running this program.
5. Do not run this program in engineering mode.

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 26	
2	Select degree mode.		[2nd] [Deg]	
3	Enter latitude of starting position (+N, −S).	L_S (DDMM.m)	[A]	L_S (DD.dd)
4	Enter longitude of starting position (+W, −E).	λ_S (DDDMM.m)	[B]	λ_S (DDD.dd)
5	Enter latitude of destination (+N, −S).	L_D (DDMM.m)	[C]	ΔL (DD.dd)
6	Enter longitude of destination (+W, −E) to compute great circle distance.	λ_D (DDDMM.m)	[D]	Dist (nau. mi.)
7	Enter intermediate longitudes (+W, −E) to find corresponding latitudes (+N, −S).	λ_i (DDDMM.m)	[E]	L_i (DDMM.m)

NOTES:

1. Data may be corrected by reentry.
2. Step 8 may be repeated as needed.
3. Use of print cradle with this program is optional.
4. Use the **RHUMBLINE NAVIGATION** program to determine courses between intermediate points.

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 27	
2	Select degree mode.		[2nd] [Deg]	
3	If on port tack. If on starboard tack.		[A] [E]	−1.0 1.0
4	Enter magnetic variation (+W,−E)	V (DD.dd)	[2nd] [A′]	V (DD.d)
5a 5b	Enter drift and set of current.	Dr (knots) St (DDD.dd)	[2nd] [B′] [2nd] [B′]	prev. Dr (knots) prev. St (DDD.d)
6a 6b	Enter distance and true bearing to mark.	D (nau. mi.) B_t (DDD.dd)	[2nd] [E′] [2nd] [E′]	prev. D (nau. mi.) prev. B_t (DDD.d)
7	Enter speed through water.	S (knots)	[B]	S (knots)
8a 8b	Enter apparent wind speed. and heel angle if desired. (If no heel angle is entered, the program uses HA = 0°.)	AW (knots) HA (DD.dd)	[C] [R/S]	AW (knots) HA (DD.d)
9a 9b	Enter apparent wind angle to find tacking angle and modified wind speed.	W_a° (DDD.dd)	[D] [R/S]	Tk (DDD.dd) MW (knots)
10a 10b	Enter compass course and magnetic deviation (+W, −E) to compute direction of modified wind.	C_c (DDD.dd) De (D.dd)	[2nd] [D′] [R/S]	C_c (DDD.d) W_m° (DDD.d)

NOTES:

1. Data may be corrected by reentry provided both parts of the entry step are performed in sequence even if only one value is to be changed.
2. If the value of any entry is zero, enter zero.
3. If only Tk and MW are desired, Steps 3-6 may be omitted.
4. The printing unit may be used with this program.

SMG, CMG, AND TIME TO LAY-LINE

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 28	
2	Select degree mode.		[2nd] [Deg]	
3a	Enter distance and	D (nau. mi.)	[2nd] [E′]	prev. D (nau. mi.)
3b	true bearing to mark unless stored by an earlier program.	B_t (DDD.dd)	[2nd] [E′]	prev. B_t (DDD.d)
4a	Compute true course to steer on port tack		[A]	C_{tp} (DDD.d)
4b	and enter magnetic deviation (+W, −E) to find compass course.	De (D.dd)	[R/S]	C_{cp} (DDD.d)
5a	Compute SMG_p		[B]	SMG_p (knots)
5b	and CMG_p.		[R/S]	CMG_p (DDD.d)
6a	Compute true course to steer on starboard tack		[E]	C_{ts} (DDD.d)
6b	and enter magnetic deviation (+W, −E) to find compass course.	De (D.dd)	[R/S]	C_{cs} (DDD.d)
7a	Compute SMG_s		[D]	SMG_s (knots)
7b	and CMG_s.		[R/S]	CMG_s (DDD.d)
8a	Calculate time and		[2nd] [B′]	Δt_p (HH.MMSS)
8b	length of port tack.		[R/S]	D_p (nau. mi.)
9a	Calculate time and		[2nd] [D′]	Δt_s (HH.MMSS)
9b	length of starboard tack.		[R/S]	D_s (nau. mi.)
10	Compute total time to the mark.		[2nd] [C′]	Δt (HH.MMSS)

NOTES:

1. D and B_t may be corrected by reentry provided both are reentered in the proper sequence.
2. If an erroneous value is entered for De and [R/S] is pressed, perform part a of the step again before reentering.
3. Steps 8 and 9 may be performed in either order. The order 6, 7, 4, 5 is also possible.
4. Steps 4b, 5b, 8b, and 9b are optional.
5. If the value of any data is zero, enter zero.
6. The printing unit may be used with this program.
7. When the print cradle is used, pressing [2nd] [C′] will cause the time for each tack and the total time to be printed.

DISTANCE AND BEARING TO THE MARK

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 29	
2	Select degree mode.		[2nd] [Deg]	
3a	Unless stored by a previous program, enter initial distance and	D (nau. mi.)	[2nd] [E′]	prev. D (nau. mi.)
3b	bearing to the mark.	B_t (DDD.dd)	[2nd] [E′]	prev. B_t (DDD.dd)
4a	Unless computed and stored by an earlier program, enter speed	SMG_p (knots)	[A]	prev. SMG_p (knots)
4b	and course made good for port tack.	CMG_p (DDD.dd)	[A]	prev. CMG_p (DDD.dd)
5a	Unless computed and stored by an earlier program, enter speed	SMG_s (knots)	[E]	prev. SMG_s (knots)
5b	and course made good for starboard tack.	CMG_s (DDD.dd)	[E]	prev. CMG_s (DDD.dd)
	IF FIRST LEG IS A PORT TACK:			
6	Enter time spent on tack to find distance made good.	Δt (HH.MMSS)	[B]	DMG_p (nau. mi.)
7a	Compute new distance and		[2nd] [B′]	D′ (nau. mi.)

7b	true bearing to mark.		[R/S]	B_t' (DDD.d)
	IF FIRST LEG IS A STARBOARD TACK:			
8	Enter time spent on tack to find distance made good.	Δt (HH.MMSS)	[D]	DMG_s (nau. mi.)
9a	Compute new distance and		[2nd] [D′]	D′ (nau. mi.)
9b	true bearing to mark.		[R/S]	B_t' (DDD.d)
10	Perform this step to use computed position as a new start. Make necessary changes in steps 4–5 and compute.		[2nd] [C′]	0.

NOTES:

1. Data may be corrected by reentry provided both parts of the step are reentered in order.
2. If any value to be entered is zero, enter zero.
3. Step 4(5) is not necessary for Step 8(6).
4. Do not clear display after Step 6 or 8.
5. Step 7(9) must follow Step 6(8).
6. Printer usage is optional with this program.

UNIT CONVERSIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 30	
	Length Conversions:			
2	Yards to nautical miles	Yards	[A]	Nau. mi.
3	Nautical miles to yards	Nau. mi.	[2nd] [A′]	Yards
4	Miles to nautical miles	Miles	[B]	Nau. mi.
5	Nautical miles to miles	Nau. mi.	[2nd] [B′]	Miles
	Volume Conversions:			
6	U.S. gallons to liters	Gallons	[C]	Liters
7	Liters to U.S. gallons	Liters	[2nd] [C′]	Gallons
	Weight Conversions:			
8	Pounds to kilograms	Pounds	[D]	Kg.
9	Kilograms to pounds	Kg.	[2nd] [D′]	Pounds
	Temperature Conversions:			
10	°F to °C	°F	[E]	°C
11	°C to °F	°C	[2nd] [E′]	°F

TEXAS INSTRUMENTS
INCORPORATED
DALLAS, TEXAS

Printed in U.S.A. 1015755-5