LAND NAV

USER'S MANUAL

BY

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Contents

Introduction

The Land Nav plug-in module has been designed as an advanced tool to supplement conventional land navigation skills. It allows new flexibility and precision to the orienteer while minimizing complexity. This user's manual provides detailed examples and explanations of the module as well as information on the HP-41 computer. The following is a brief summary of Land Nav's capabilities:

Course Changes and Recalculations

Before walking, you lay out a course with a number of sequential that points you wish to move to. The computer gives you the distance and direction between each point. Ordinarily, you would have to walk each leg and not be able to change direction, but with Land Nav, you can change course and walk wherever you want, as long as you keep the computer properly informed. When you are ready to go to the next point, you can recompute the distance and direction to it based on your current location. This capability can be very useful because the course you choose on the map may not be the best actual course.

Find an Unknown Point

The Target routine allows you to find the location of unknown points in eight digit grid coordinates. There are several different cases, depending on how much information you have. For one, you have one known point and a distance and direction to an unknown point. For an intersection problem, you have two known points and a direction from each to the unknown point. Resection problems are similar, using the back azimuth. Certain situations involving moving targets can also be solved.

If there is an explosion at the unknown point you can find the distance from you by using the Flash-Bang routine. Press FB when you see the flash, and again when you hear the bang. The computer calculates the distance by using the speed of sound and the time elapsed. (Works for HP-41C/CV with time module or HP-41CX.)

Section 1: HP-41

For detailed information on the operation of the HP-41, read your HP-41 Owner's Manual. It is well written and will tell you everything you want to know. This section is a short course that covers the things you need to know to use Land Nav.

Feel free to "play" with the HP-41 to get familiar with it. You can not damage the HP-41 by entering strange functions and a MASTER CLEAR will reset anything you change. Experiment now, once you actually start Land Nav you will not want to try unknown commands.

1.1 Compatability with the HP-41

Hewlett-Packard produces three 41-series hand-held computers: the HP-41C, 41CV and 41CX. Land Nav will not work in the HP-41C unless a Hewlett Packard Quad Memory Module is used. ~~(Cost $35)~~ The functions FB and ETA which relate to time will not work in the 41C or 41CV without a time module, but will work in the 41CX, which has a built-in time module.

1.2 HP-41 warnings ~~and~~ for Care

It is important ~~that~~ you to protect your HP-41, because it is a sensitive device and will not take certain types of abuse.

Never remove or replace any plug-in module, device or battery pack with the HP-41 turned on. It may clear the memory or even damage the circuitry.

The HP-41 is not waterproof, a ziplock freezer bag will go a long way towards keeping out moisture

Avoid extreme temperatures. The operating range is 32 - 113 degrees F.

If the HP-41 is dropped, it is possible for it to lose memory or start doing strange things. Protect the calculator by using some type of padded shock-resistant case. The vinyl carrying case does not offer much protection for field use.

Avoid static electricity and strong electromagnetic fields such as X-Rays.

When the BAT indicator comes on in the display, you have at least several more hours left of continuous operation and much more time if inactive, before the batteries go dead. Do not allow batteries to sit in the calculator for extended periods of time, especially if they are old. Corrosion from batteries is a sure killer of an HP-41. Also, if you use rechargable battery packs, throw them away after the warranty on the pack runs out (1 year). Your calculator's warranty is void if it is damaged by rechargable batteries that are out of warranty. Rechargable packs may vent corrosive chemicals if they are old.

If your calculator starts doing "weird" things like displaying odd characters, not working properly or "locking up", it may lose memory. To get control back, follow these steps:

1. Check for fresh batteries, proper installation and clean contacts.

2. Remove battery pack (with calculator off, if possible), wait a few seconds and replace it and execute a GTO .. To do this make sure USER mode is off, and press SHIFT GTO and decimal point twice. This will not clear memory.

3. If still not responding or acting abnormally, XEQ ALPHA N A V ALPHA to clear the memory.

4. If this is not possible execute a MEMORY LOST. (Turn calculator off, hold down backarrow key, turn on, and release backarrow). You will get a MEMORY LOST message if successful, and then have to execute NAV to restart.

5. In almost all cases, if you continue to do the above steps you will eventually get control. As a last resort, remove batteries and let the computer sit for several hours.

When installing batteries, pay attention to the + and - symbols on the battery holder. Use type N batteries.

Refer to HP Owner's Manual.

1.3 Using the HP-41

Find the following keys on your keyboard and try them out.

- ON - Toggles computer on/off.
- USER - Toggles user mode on/off. Key assignments are active in USER mode.
- PRGM - Toggles in and out of program mode. Stay out of program mode.
- ALPHA - Toggles in and out of alpha mode. Alpha mode activates the blue letters on the lower face of the keys.
- SHIFT - This is the gold key. It toggles shift mode on/off.

Notice that there are indicators in the display for USER, PRGM, ALPHA, and SHIFT.

Almost every key has two functions associated with it.
UNSHIFTED functions are in white and on the face of the keys.
   To activate an unshifted function, simply press that key.
SHIFTED functions are in gold and above the keys.
   To activate a shifted function you must press SHIFT first.
   Example: To execute BEEP, press SHIFT (gold key) and then press 4. Do not hold the shift key down, press and release.

If you press a key and immediately release it, the function will execute. If you press a key and hold it momentarily, the name of the function will flash before it executes. Finally, if you press a key and do not release it, the name will flash and then NULL will display. This means the function is cancelled and will not execute when you release the key. Try this with BEEP.

You will also need to know the following functions:

The number keys: Ø through 9
The decimal point: .
The run/stop key: R/S (For "running" the program)
The backarrow key: a lefthand arrow (Deletes previous number or letter or clears the display)
The change sign key: CHS (Makes a positive number negative and vice verse)
The X exchange Y key: X<>Y (This exchanges the contents of the X and Y registers, more on this later.)
These keys will be useful to you when you learn how to use the computer as a calculator: - + * / ENTER EEX and others.
The XEQ key

Alpha and Key Assignments

You also need to understand about key assignments. You already know that every key has two functions, shifted and unshifted, but it is not that simple. Most keys can have shifted and unshifted key assignments. An assignment takes the place of the original function, but only when in USER mode. If USER mode is off, assignments are not active. If USER mode is on, all keys have their normal functons except those that are assigned over. The key assignments will be controlled by Land Nav.

When you are in ALPHA mode, the alpha keyboard becomes active. You then have access to two more functions per key. Actually, most of these are simply letters. The UNSHIFTED ALPHA functions are the blue letters on the lower face of most keys. The SHIFTED ALPHA functions are written on the back of the computer. Assignments are not active in ALPHA mode. ALPHA letters are written in this text in double quotes.

Therefore, most keys can have up to six functions; the original shifted and unshifted functions, assigned shifted and unshifted functions when in USER mode, and shifted and unshifted alpha letters when in ALPHA mode.

XEQ (Execute)

Find the XEQ function on your keyboard and press it. When you see XEQ _ _ press ALPHA. Now use the blue letters to spell out "BEEP" and press ALPHA again. The calculator should beep just as when you pressed SHIFT 4. You have executed a function by naming it. There exist many more functions than you see on the keyboard and you can now execute any program by name also. In the text, functions and programs are written in all uppercase letters.

Flags

The HP-41 also has what are known as "flags". A flag is either set or clear. If a flag is set its actual value is equal to the number 1 and if clear equal to Ø. Flags Ø - 4 will appear in the display when they are set. Land Nav uses flags for several different purposes. For instance, flag 1 determines the units of distance. If flag 1 is clear, distances will be in meters. If flag 1 is set, distances will be in feet. A flag simply causes one thing to happen if set and another if clear.

1.4 Using the HP-41 as a Calculator

The HP-41 uses RPN (Reverse Polish Notation) logic. It will seem strange at first, but when you learn it, you will see the advantages.

$$53 + 21 = 74$$

When you enter this in an algebraic calculator, you enter it exactly as you see it, reading left to right.

With RPN, you punch in 53 ENTER 21 + and the answer appears. Think of it like this:

```
  53
+ 21
  74
```

You write down the two numbers first and then you perform the addition. This is known as a postfix operation. When you execute a math functon (+ - * or /), that function computes the answer from the two numbers already in the stack.

The stack consists of four registers: X, Y, Z and T. They are arranged as follows:

```
T
Z
Y
X (Displayed)
```

The number you see in the display is the number in the X register. You can exchange the contents of the X and Y registers with the function X<>Y. Every time you hit ENTER everything in the stack moves up to the next register, except the number originally in the T and the number in the X. The T contents are lost and the X contents stay the same. Observe the stack for the problem: (53 + 21) * (43 + 83)

T	Ø								
Z	Ø					74	74		
Y	Ø	53	53		74	43	43	74	
X	53	53	21	74	43	43	83	126	9324
You key in:	53	ENTER	21	+	43	ENTER	83	+	*

For a conventional calculator you would have to key in the problem with parentheses or you would get an error. RPN is simpler and once you are familiar with it, you will see that error recovery is much easier. To fully understand, try several problems on your own and read the Owner's Manual.

Section 2: Military Grid System

Study FM 21-26 chapter 3 if you are unfamilier with grid zones and grid coordinates.

Grid Zones

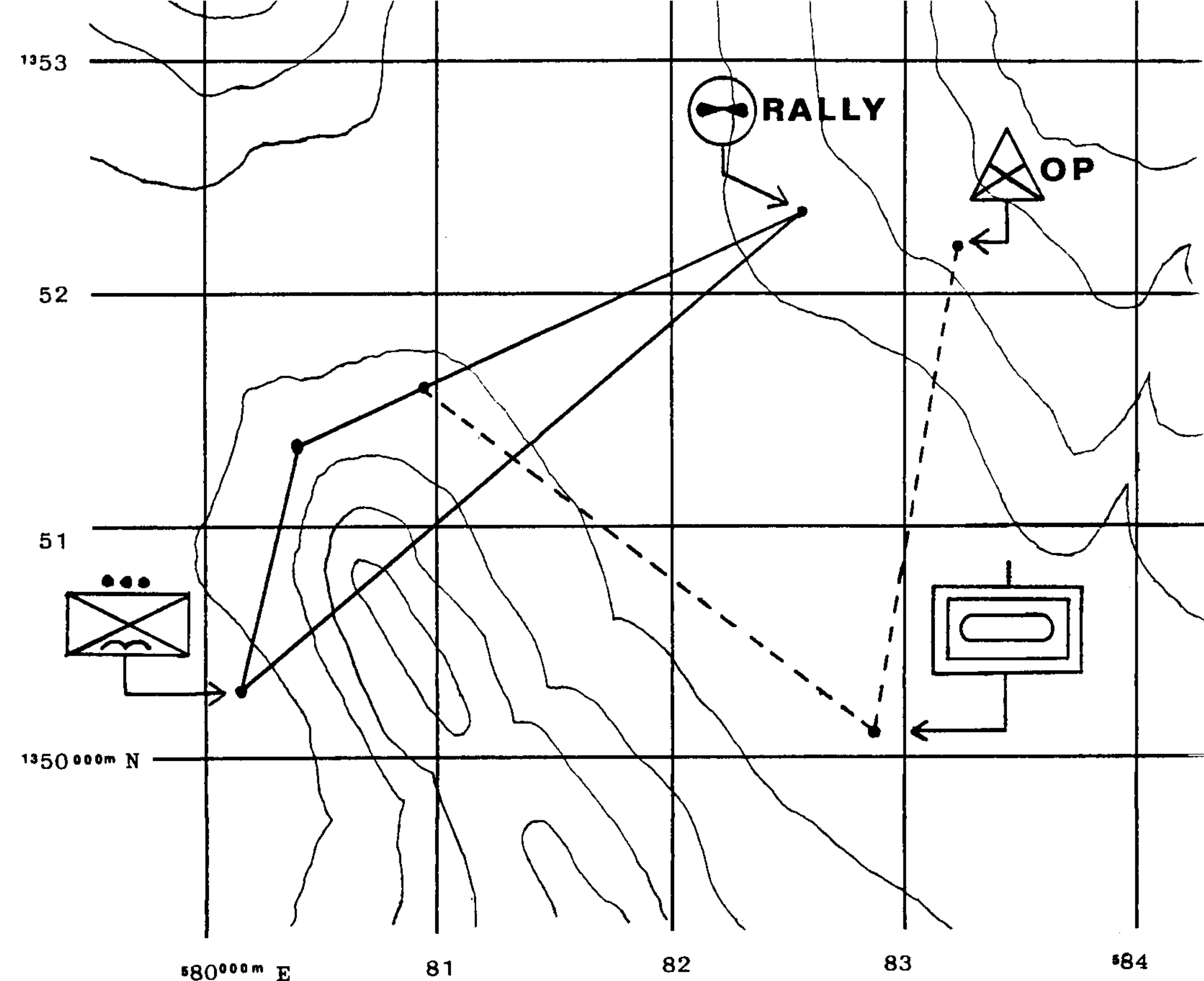
Land Nav will ask for the grid zone you are in. Since grid zones are so huge and it is very hard to convert coordinates from one grid zone to another, you will not change the grid zone once you enter it. When you give the grid zone, you enter a number from 1 to 60 and press ALPHA and enter a letter from C to X. (Excluding I and O) You will see this in the example later. Actually the grid *zone is not vitally important to Land Nav and you can skip it if* you don't know it, but give it if you do.

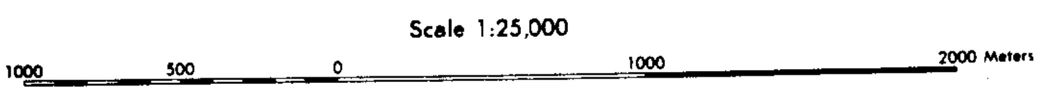
HTM Squares

The HTM (hundred thousand meter) square that you are in should be written on your map in two ways. First, you should find a two letter combination in the marginal information. This is assigned by the military and when reporting a coordinate in the military, you stick this on the front of the coordinate. Second, you should find the actual numbers of the square. These are the small numbers along the horizontal and vertical edges of the map. The number along the horizontal is always a single digit from 1 to 9, but the vertical can range from 1 to 99. You ignore the larger numbers and combine the smaller with a decimal point seperating them. For example, on page ? the small numbers are 5 and 13. You give this to Land Nav as 5.13 and then press ALPHA and give the two letters. This will be demonstrated in the example later.

Grid Coordinates

You should already know how to read a military map from FM 21-26, but to refresh, remember READ RIGHT THEN UP and read the larger numbers along the edges, ignoring the smaller HTM numbers. All grid coordinates are given to eight digits in Land Nav and the horizontal part is seperated from the vertical with a decimal point. In the map on page ?, the initial location would be given to Land Nav as 8016.5030 and this is given right after you give the HTM data.

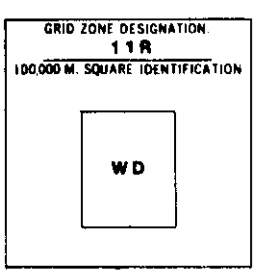


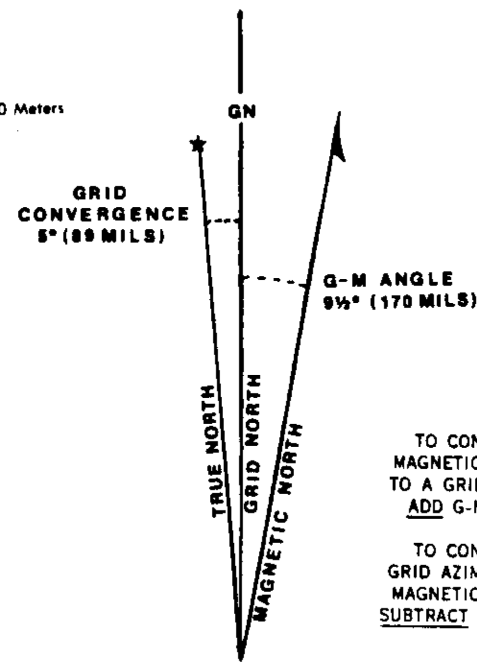


Starting Point
8016.5030

Rally point
8256.5237

Observation Point
8323.5222





TO CONVERT A MAGNETIC AZIMUTH TO A GRID AZIMUTH ADD G-M ANGLE

TO CONVERT A GRID AZIMUTH TO A MAGNETIC AZIMUTH SUBTRACT G-M ANGLE

Section 3: Land Nav Example

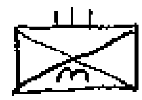
3.1 Installing Land Nav

1. Turn calculator OFF.
2. Insert LAND NAV module in any slot.
3. XEQ ALPHA N A V ALPHA

Land Nav is now installed anc active. It has automatically set all necessary flags and modes anc assigned its functions to your keys. It has also cleared the entire computer of any previously stored data.

3.2 Land Nav Example

The following is a brief example that will give you some idea how Land Nav works.

You are located at WD8Ø165Ø3Ø at the symbol  which is the military symbol for an airborne infantry platoon. You must move to WD82565237 at the symbol  Rally which is an airmobile rally point. You also know there is a friendly observation post at the symbol OP at WD83235222, and you have radio contact with them. A map check tells you that there is a steep mountain between you and your rally point. You have already cleared and reset everything with NAV, so next you will initialize the units and grid zone with INIT. Then, with PTS you will enter the three points mentioned above. Next, because you don't want to walk over the mountain, you will start out walking around it and then compute a new course to the rally point when clear of it. Then, you will spot an enemy tank company and use the target routine to find their location.

Before you move out, you need to set up the program.

You:	INIT	(Initialize routine SHIFT E+)
41:	<u>METERS-Ø?</u>	It is asking if you want distances in meters.
You:	R/S	By just pressing R/S you make no change.
41:	<u>DEGS-Ø?</u>	It is asking if you want degrees.
You:	R/S	No change.
41:	<u>G-M Ø.ØØ DG?</u>	It wants the grid to magnetic angle found on the map.
You:	14 R/S	G-M angle is also called declination.
41:	<u>G-T Ø.ØØ DG?</u>	This is the place to give the grid to true angle (also called grid convergence) found in the marginal

information on the map.
You: 10.11 R/S — Ten degrees and eleven minutes and R/S. (With a decimal point)

41: GZ ØØ? — It now wants the grid zone found on the map.
You: 11 ALPHA R R/S — You input 11 in number mode and switch to ALPHA mode to give the letter R and R/S.

You just gave the computer the units you want to work in, the declination and the grid zone. The computer will automatically go to the *PTS routine to get your points. Anything the computer* outputs to you will be underlined and next to that will be what you punch in.

PØ NAME? START R/S You name every point for convenience and since you start at point zero, you can name it "START". Note that it puts you in ALPHA mode automatically so you simply enter "START" and press R/S

PØ Ø.ØØ ØØ? 5.13 ALPHA WD R/S This is where you give the HTM (hundred thousand meter) square the point is in. It is given two ways, by meters from the center of the grid zone and by a two digit letter code assigned by the Military. The five is the small horizontal number and the thirteen is the vertical. Note that a decimal point is given in between them. The WD is given on the map sheet as the HTM identification.

PØ ØØØØ.ØØØØ? 8016.5030 R/S This is the eight-digit grid coordinate of the point. Note the decimal point is placed between the horizontal and vertical parts to make the number easier to read. Do not forget it.

1.ØØØØ R/S The program stopped because you finished point Ø (PØ) and it left the next point number in the display. R/S starts PTS for P1.

P1 NAME? RALLY R/S You name the next point.

P1 5.13 WD? R/S The computer automatically assumes the HTM square is the same and you make no change by simply hitting R/S. If it were not the same for this point you would enter the correct data.

P1 ØØØØ.ØØØØ? 8256.5237 R/S The coordinate for P1.

PØ:1 3169<35 R/S Notice there is no question mark. The computer is not asking, but telling you that the distance and direction from PØ to P1 is 3169 meters and 35 degrees MAGNETIC. The colon always means "to". You hit R/S to go on.

2.ØØØØ R/S P1 is finished and P2 is next.

P2 NAME? OP R/S The next point is the observation post and even though you will not be moving to it, you give it as a point.

P2_5.13_WD? R/S No change.

P2_ØØØØ.ØØØØ? 8323.5222 R/S Give it the coordinate.

P1:2_686<89 The computer calculated the vector (distance and direction) from P1 to P2. You will not be traveling to P2, so this is not useful to you.

Now you have given three points: your current location, the point you want to travel to, and an extra point. You are now ready to move out. You take a sighting on your compass and determine that if you travel at an azimuth of 359 degrees MAGNETIC, you won't have to go over the mountain. You start walking and after 1Ø8Ø meters you clear the mountain and make a brief stop. You will give the computer the distance and direction you just finished walking so that it can compute your new location and compute a new distance and direction to the destination point.

Execute CHG (Change routine, press the Σ+ key)
PV1_3169_M? 1Ø8Ø R/S The computer is asking for the first distance you have traveled, assuming the suggested distance of 3169. Since you have made a course change, you give the computer the actual distance of 1Ø8Ø. PV1 means Permanent Vector One. A vector is a distance and direction.

PV1_35_DG? 359 R/S Here you give the actual azimuth.

The routine ends after the computer stores V1 and calculates your new location.

Execute LOC (Location)
L_WD8Ø4Ø.5135 This allows you to see your current location. Find this point on the map. L means Location.

Execute DEST (Destination)
DEST_P1_RALLY? R/S The computer is asking if the destination is P1 and the name RALLY is added as a reminder. You make no change to this.

L:P1_2385<51 The computer is telling you that to go from your location to P1, you need to travel 2385 meters at 51 degrees magnetic. This is a suggested course, and you don't have to follow it.

Now you want to go straight to P1 so you will use the suggested course. Because you have changed your course you will start your pace count over. You walk 6ØØ meters and spot an enemy tank

company as represented by the symbol: . You are unable to

proceed without being seen so you must get rid of them. You estimate that they are approximately 2ØØØ meters away, and using your compass you see they are at an azimuth of 114 degrees magnetic to you.

Now it is vitally important that you update the computer on your position before you use the target function or else the answer will be in reference to your last updated position. Because you are not making a course change you use UPDT.

Execute UPDT (Update)
TV2 DIST M? 600 R/S The computer is asking for Temporary Vector Two distance. This is temporary because you have not finished walking it and will make it permanent later with CHG.

TV2 51 DG? R/S It assumes your suggested course which you did not change.

The computer know knows where you are, and if you want to see for yourself...

Execute LOC
L WD8095,5161

Now you are ready to find the enemy.

Execute ~~LTGT~~ LUKN (Location to ~~Target~~ unknown)
L:U DIST M? 2000 R/S It is asking for the distance from your location to the target which you guess to be 2000 meters. The U stands for Unknown.

L:U AZ DG? 114 R/S It is asking for the azimuth which is 114 degrees.

U WD8252,5038 This location is about 400 meters away from the target and could be used as a starting point for artillery, but there is also another method that is much more accurate in this case. It is possible to use the observation post to sight on the enemy. You use the radio and find that the OP sees the enemy at an azimuth of 176.

Execute ~~LTGT~~ LUKN
L:U DIST M? R/S You don't know the exact distance so you leave it undefined. If you don't define the distance, the computer automatically assumes you are trying to solve an intersection problem.

L:U AZ DG? 114 R/S The azimuth from you to the unknown.

K2 PT NUM? 2 R/S The computer is asking for the point number of the second known point which is P2. Your location is the first known point (K1) and the OP is the second known point (K2).

OP:U AZ DG? 176 R/S The azimuth from the OP to the unknown.

U1:U2 DIST M? R/S This is for the special case of a moving unknown which will be discussed later.

U_ND8286.5011   This is much closer and would allow a very accurate first round artillery hit, providing the enemy with maximum surprise.

You may continue on V2...

Execute DEST
DEST_P1_RALLY?   R/S   No change.

L:P1_1785<51   Remaining distance.

Hopefully by now you have some idea of how things work. There are still many details to cover before you can use this program, so you must read the next section "Functions in Depth" very carefully.

3.3 You must remember these rules!

You must update your position with CHG or UPDT before using LTGT or LOC.

You start your pace count over when you execute CHG.

Whenever you change direction, use CHG and give it the distance and azimuth you just finished walking.

When you want to find your location but are not changing direction, use UPDT giving it the distance and direction from the last direction change to where you are.

The azimuths you give to the computer and those you get from it are MAGNETIC azimuths. If you want grid there are conversion routines.

Don't Panic!

Section 4: Land Nav Functions in Depth

Main Routines

4.1 NAV (Land Nav)

When you execute NAV, the entire memory of the computer is cleared, the Land Nav key assignments are created and the computer is put in USER mode. You execute NAV whenever you want to start clear again.

It is not necessary to execute a MEMORY LOST before executing Land Nav, unless something weird happens to your computer and you can't get get control. This is rare, but may be induced through very low batteries, mechanical vibration or shock, or strong electromagnetic fields.

NAV is the only routine that is not assigned on the keyboard. This is to prevent you from accidently clearing memory.

4.2 INIT (Initilize)

INIT stores the units, declination, grid divergence and grid zone. The first prompt is for the units of distance showing either:

METERS-Ø? or
FEET-1?

depending upon which units you have already selected. When you first execute NAV, the units will be set to meters and to degrees. The next prompt will ask for:

DEGS-Ø? or
MILS-1?

Again this depends on which you have already selected. To change units, you must remember that the default units (meters and degrees) are both selected with a Ø and feet and mils are both selected with a 1. To make no change you simply R/S and continue.

METERS-Ø?	Ø R/S	Makes no change
METERS-Ø?	R/S	Makes no change
METERS-Ø?	1 R/S	Changes to feet
FEET-1?	Ø R/S	Changes to meters
FEET-1?	R/S	Makes no change

The same applies for degrees and mils:

DEGS-Ø?	R/S	Makes no change
MILS-1?	Ø R/S	Changes to degrees

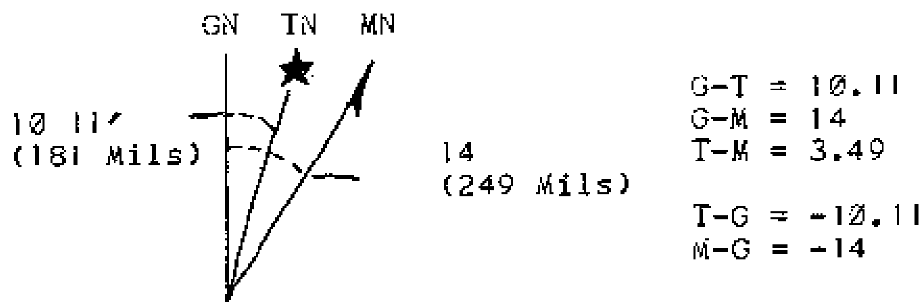
You will notice that a small 1 appears on the display if you select feet and a small 2 if you select mils. These are flags 1 and 2 and they appear when they are set. A flag is set if it is equal to 1 and clear it equal to Ø. If you remember the rule DISTANCE BEFORE AZIMUTH, you will not confuse flags 1 and 2. You may change these units as much as you want.

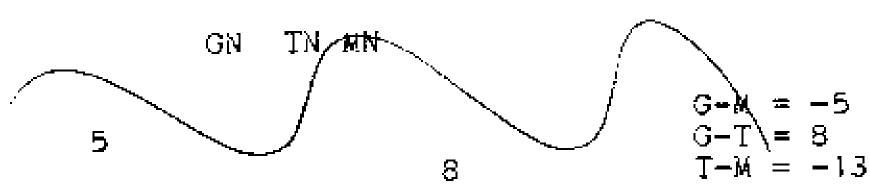
Next, INIT will ask for the G-M and G-T angles. The G-M angle is also called declination and it is the angle from grid north to the magnetic north pole. On most maps, grid north is shown as a line with the letters GN above it and magnetic north is a line with a pointer on it and maybe the letters MN.

When you read an azimuth off a map, you will have to convert grid to magnetic to get the same azimuth when you point your compass. You will either add or subtract depending on whether the G-M angle is East or West and whether you are going from G to M or M to G. Land Nav needs this angle to compute all of its azimuths, so be accurate.

An angle can be either positive or negative. If the G-M angle is requested, then give the sign according to whether the angle from the G-line is clockwise or counter-clockwise to the M-line in the declination diagram. Look at a protractor and you will see that clockwise angles increase and are therefore positive. You can also remember East is positive and West is negative. The sign is changed with the CHS (change sign) function on your keyboard. It makes a positive negative and a negative positive.

The G-T angle is also called grid convergance and it is the angle from grid north to true north. It is needed for the conversion routines involving true north only and can be left Ø if you wish. True north is indicated with a line and a star at the end and maybe the letters "TN".





The prompts will look like:

<u>G-M Ø.ØØ DG?</u> 14 R/S
and

G-T 0.00 DG? 10.11 R/S

depending upon which units are selected, and what data you have already given. If you have selected mils, the DG will be replaced with ML and the angle will be in mils. Again, like the other prompts in Land Nav, if you do not want to change anything simply R/S. If you want to change the data then enter the new data and R/S. To clear the prompt and see the X register, press the backarrow. It is possible for you to change these angles as much as you want, but don't because it will change the magnetic angles Land Nav gives you and cause confusion.

After this INIT prompts for the grid zone.

G ZN 00? 11 ALPHA R R/S

To change it, you must enter a number and a letter because the grid zone is a number and letter combination. Enter the number (1-60) into the X register and switch to ALPHA and enter one letter (C-X except I and O). The data you enter is not checked by the computer, so if you enter garbage, garbage will be stored. Again, to make no change simply R/S, and to view the number just backarrow and to see the letter switch into ALPHA. You can switch in and out of ALPHA as many times as you want to see the data. Once you start entering points, do not change the grid zone even though it is physically possible.

After this, INIT calls PTS to let you enter your points. Now lets run through INIT several times just to be sure you know it.

METERS=0 1 R/S Change to feet. After R/S, a small 1 should appear on the display after R/S

DEGS=0 1 R/S Change to Mils. A small 2 should appear.

G-M 0 ML? 249 R/S This is 14 degrees, see first diagram above.

You should also see a small 4. More on this later.

G-T 0 ML? 181 R/S This is 10 degrees and 11 minutes.

G ZN 00? 11 ALPHA R R/S Grid zone 11R.

P0 NAME? This is the PTS routine but we are not finished practicing with INIT.

Now execute INIT again, but first you are still in ALPHA from PTS, so press ALPHA.

FEET=1? 0 R/S Let's go back to meters.

MILS=1? 0 R/S And back to degrees.

G-M 14.00 DG? This is correct, but now lets change it to the second diagram above. That diagram shows the G-M angle as counter-clockwise or west. This is given as a negative. Enter the number and CHS to make negative.

5 CHS R/S

G-T 10.11 DG? 8 R/S Change this also.

G ZN 11R?
Press Backarrow; You should see 11.0000 which is the X register.
Press ALPHA; You should see R in the ALPHA register.
Press R/S; Make no change.

4.3 PTS (Points)
This routine stores all points and also computes the vector between them. Point zero (P0) is always your starting location and subsequent points are the points you may be traveling to. After you input all points you will be traveling to, you can input other points such as the locations of other people or reference points. When YOU execute PTS the first prompt you will see is:

Execute PTS
PT NUM? 0 R/S

This allows you to specifiy the point you would like to change or view. Notice that this prompt does not appear if PTS is automatically executed by INIT because INIT specifiys P0 as the first point you will see.

Next, you will get the name prompt.

P0 NAME?

If the name is undefined you will see "NAME". You may immediately enter the name since you are already in ALPHA. Use the backarrow to delete the previous character if you make a mistake, and remember only six characters will get stored.

START R/S

Next, you will see the UTM prompts.
P0 0.00 00? 5.13 ALPHA WD Enter UTM data and R/S
P0 0000.0000? 8016.5030 Enter the coordinate and R/S

After this, it will compute the vector between this point and the previous point and display it. Since there is no point before P0, that part is skipped. Let's go on to P1.

1.0000 R/S

PTS stops after every point and leaves the number of the next point in the X register. An R/S will skip the PT NUM? prompt and use the number in the X reigster as the next point.

```
    P1 NAME?   RALLY           R/S  Name the point.
    P1 5.13 WD?                R/S  HTM square.
    P1 0000.0000?   8256.5237  R/S  Eight digit coordinate.
    P0:1 3169<35               R/S  Here it gives the distance and
```

azimuth from P0 to P1. Remember it is a magnetic azimuths. Now every thing will start over with the next point. PTS will go to P2 and skip over the PT NUM? prompt.

```
    2.0000                     R/S
    P2 NAME?   OP              R/S
    P2 5.13 WD?                R/S
    P2 0000.0000?   8323.5222  R/S
    P1:2 686<89
```

There is one other case you may use if you do not know the coordinate for some point but you do know the distance and azimuth from the previous point to it. When you would ordinarily give the coordinate simply give a zero or R/S with no number entered if already zero. It does not matter what you give for the HTM.

```
    3.0000               R/S
    P3 NAME?   TRP100    R/S
    P3 5.13 WD?          R/S
    P3 0000.0000?        R/S
    P2:3 DIST M?   2000  R/S  (Arbitrary values)
    P2:3 AZ DG?     130  R/S
```

You give the vector from P2 to P3 and the location of P3 will be computed. Then it will go back to the beginning of PTS with the value 3 for P3. Remember that the point number does not increment or you may start entering data for P4 when you are still on P3.

```
    3.0000          R/S
    P3 TRP100?      R/S
    P3 5.13 WD?     R/S
    P3 8441.5060?   R/S  The computed coordinate P3
    4.0000
```

4.3 CHG (Change)
This routine prompts you for the distance and direction of the leg you just finished walking. Remember, make a CHG only when changing the azimuth you are walking and restart your pace count at every change. Every leg or vector of your course is given a number starting at 1. The first vector is V1 and is always from P0 to wherever you go.

You do not have to walk to P1 on V1. There is no correspondence in numbers. You may walk five vectors before finally arriving at P1 or you may never go to P1 at all. As you will see in DEST, you can walk anywhere you want.

When you have finished walking V1 you give it to the computer. Press CHG and:

PV1 3169 M? 1080 R/S
PV1 35 DG? 359 R/S

The PV1 means Permanent Vector One because you are making a permanent vector. You will notice that there is already some temporary data in V1. This is the vector from P0 to P1 and was stored by PTS to make things faster if you did decide to walk directly to P1. If this is the vector that you walked you make no change to it and simply R/S to make it permanent.

When you make a vector permanent with CHG it is stored just as you geve it in the memory of the computer. You do not need to use it again unless you make an error, and then you use RV.

4.4 RV (Reset Vector)
Resets the vectors, changes the current location back to P0 and makes the destination point P1. Does not actually clear the vectors, unless they ran out of memory and rolled over. See "MEM" error section. For example, if you enter the vectors below:

V1 1080 M 359 DG
V2 1385 M 51 DG
V3 1234 M 222 DG

and then discover that V2 is in error and should actually be 2385 M 51 DG, you can execute RV anc start over only having to reenter V2 distance.

You would execute RV
Then execute CHG
PV1 1080 M? R/S
PV1 359 DG? R/S

Execute CHG again for V2
PV2 1385 M? 2385 R/S Correct the error
PV2 51 DG? R/S

Execute CHG again for V3

PV3_1234_M?   R/S
PV3_222_DG?   R/S

And now you are back to where you were before with the error corrected.

4.5 UPDT (Update)
This allows you to store temporary data in the current vector so that your current location can be found. It is used when you are not making a course change, but need your location. The prompts look like:

TV3_DIST_M?
TV3_333_DG?

Whatever value you give for the distance and azimuth will be made the new temporary vector. You may make as many UPDT's as you want to the same vector and you may give any data to UPDT without any permanent changes being made. An advantage of UPDT is once you use it, you have prestored the actual azimuth you are on before you finish the vector, so you will not have to give it then possibly saving time. Each time you use UPDT, your location is recalculated from the last permanent change and the temporary vector you just gave and if there was a previous temporary vector it is forgotten.

4.6 LOC (Location)
This routine displays your current location as computed by the last change or update.

L_WD8252.5038

You may stop here or you may change your location. If you execute UTM, you will be able to modify the data stored in UTM. By pressing R/S when UTM finishes, you will return to LOC and this new data will be made your location. This should not be necessary if you navigate accurately, but in case you don't, you can make a spot correction to you location. If you do change your location, all vectors are cleared, since they would have no meaning. If you were successful in changing your location, DEST will execute afterwards.

To change your location by direct replacement:
Execute LOC
L_WD8252.5038
Execute UTM
L_5.13_WD?   R/S
L_8252.5038?   8000.8000   R/S
R/S to return to LOC
D_PI_RALLY?

This is where flag 4 is used. LOC sets flag 4, and when UTM gets it, UTM will return to LOC so LOC can change your location. This will be explained later, just remember UTM will not return to LOC if flag 4 is clear.

4.7 DEST (Destination)

This routine allows you to define a point that you would like to make your destination. It gives you advice on how to get there by displaying the vector from your current location to the destination point. It will also prestore this vector in the current vector IF you have not already stored a temporary vector. It first asks for the destination point number and gives you the name of the current destination as a reminder.

Execute DEST
DEST_P1_RALLY?   R/S

You may change it or leave it the same. This point is set to 1 at initialization under the assumption that you will travel to P1 first. Regardless of where you are, you can specifiy any point including PØ to be your destination and it will compute that vector and display it:

L:P1_2222<333

If your current location happens to exactly be your destination you will get a display that looks like:

L:P1_Ø<18Ø

The azimuth is meaningless if the distance is zero.

There is another thing that CHG does when a permanent vector happens to put you within 25 meters of your destination point. Instead of ending like normal, CHG increments the destination point number and calls DEST. The computer assumes that if you are within 25 meters of the destination point, you have found it and are proceeding to the next point.

4.8 UKN (Unknown)

TGT is an all-in-one routine that solves several different cases of stationary unknown problems. The particular case depends on the data you give for the distance and azimuth. It does this by checking to see what you left undefined. UKN starts out by asking you for the location of the first point. This point is called K1 for Known Point One and K2 will be called Known Point Two. The unknown is called U. You can make the location of these points to be at any of your prestored points P1, P2, etc. except PØ.

Execute UKN
K1_PT_NUM?

This is asking if K1 is a stored point and if so, which one. If you give it the number of some point, it will use that point's location for K1. The exception is PØ. PØ cannot be specified as K1 in this manner, because Ø is the undefined value.

R/S	Undefined
Ø R/S	Undefined
2 R/S	K1 is P2

If you do give it a point, the name of that point will replace "KI" as the identifier. If you pass an undefined value, UKN will get the exact coordinate of KI.

If undefined,

    KI 5.13 WD?
    KI 0000.0000?

4.9 LUKN (Location to UNKNOWN)

This is just like TGT except that it automatically defines KI to be your current location and does not ask you for KI.

After you specify KI in one way or another, UKN and LUKN ask for the distance and azimuth from KI to the unknown, or with "L" if LUKN.

    KI:U DIST M?
    KI:U AZ DG?

Again "KI" will be replaced with the actual name of the point if one was specified.

    RALLY:U DIST M?
      or
    L:U DIST M?

Both the distance and azimuth are initially undefined and if you do not change the values, they will go back to the main routine as an undefined value. There are now three cases depending on which ones you define.

If you define both the distance and azimuth, then the unknown point will be calculated from that data alone. You gave a known point and a vector and that is all that is needed to find the unknown.

Execute UKN

    KI PT NUM?   2 R/S
    OP:U DIST M?   100 R/S
    OP:U AZ DG?   76 R/S (90 deg grid)
    U WD8333.5222

If you did not define either distance or azimuth, then it is assumed that you know the location of the "unknown" and are seeking the distance and azimuth instead. UKN then prompts you for the location of the other point and just like for KI, it asks if this point is a stored point.

Execute UKN

    KI PT NUM?   1 R/S
    RALLY:U DIST M?   R/S
    RALLY:U AZ DG?   R/S
    U PT NUM?   2 R/S
    OP:U 686<89

For the last case, the distance is undefined and the azimuth is defined. This is called intersection, and it involves another known, K2. UKN gets the location of K2 just like for K1.

Execute LUKN

    L:U DIST M?   R/S
    L:U AZ DG?   114 R/S
    K2 PT NUM?   2 R/S

Again, if defined it uses the selected point and if undefined it uses UTM to get the location. Again, it uses either the name of the point or it uses "K2". Next, it prompts for the azimuth from K2 to the target.

    OP:U AZ DG? 176 R/S

It does not ask for any distance, just the azimuth. UKN now has two known points and an azimuth from each to the unknown. There is one more prompt that will be explained later.

    U1:U2 DIST M?   R/S

Just R/S to ignore it. It is possible for these two azimuths to be either perfectly perpendicular or parallel. If this happens, you will get a "DATA ERROR" and UKN will halt. Otherwise, the unknown point will display through UTM.

    U AD8236.5011

You may be wondering how a resection problem is solved. Resection is where you are at the unknown and shooting azimuths TO the known points. In a case like this, you have only to use the back azimuth and solve it like an intersection problem. There is even a BA function that you can use from within UKN. If you have two hilltops and know both locations, they will become K1 and K2. You will be at the unknown point called U sighting on the knowns. You will find the azimuths from yourself, the unknown, to K1 and K2. Because UKN asks for the azimuth K1:U you will have to find the back azimuth for each and give hat to UKN.

Execute UKN

K1 PT NUM?	1	R/S	Use P1 as one known
K1:U DIST M?		R/S	Intersection case
K1:U AZ DG?	111 BA	R/S	You read 111 degrees to K1
K2 PT NUM?	2	R/S	Use P2 as the other known
K2:U AZ DG?	222 BA	R/S	You read 222 degrees to K2
U AD????.????			Your location

The last case is for a moving unknown. This is time based with one known point shooting an azimuth to the unknown at the first time and later another known point shooting an azimuth to the unknown. During the time interval, the unknown has moved a distance and azimuth.

It is also for the two known points to be the same with only the unknown moving. You would have to enter the same coordinate twice, once for K1 and once for K2.

MEM Error

If you get a "MEM" message that means that you are out of memory for one of two reasons:

You may have used up all of you memory space with vectors. Because of the way data is stored, adding three dummy vectors with CHG will cause a roll over and free up vector memory. A dummy vector is Ø distance and Ø azimuth and does not change your location.

You may have added too many points and not have any vector memory left to take.

A "MEM" error occurs when the points try to overwrite the vectors. This occurs in the PTS routine and no damage will be done. When the vectors try to overwrite the points no error will result because the vectors will "roll over". A rollover clears all the vectors and saves only the current one at the top of memory, thus freeing some up memory. This will all be transparent to you, the only consequence of a vector roll over is that RV will not bring back the old vectors for you to modify.

You should note that it would take either 26Ø vectors or 8Ø points or some combination thereof to use up all of the computers memory, which is quite a large amount of data.

Conversion Routines

Any of the conversion routines can be used to convert data for you.

Flag 4 and Returning

You should have noticed a small 4 appear at what seems to be odd times. This is flag 4 and it has special meaning. This is porbably the hardest concept to explain, so you may need to read this more than once.

Flag 4 appears just before a place in a main routine (INIT, CHG, LOC, etc.) when you can use a conversion routine and be able to return to the main routine.

When you execute any routine and then execute another from the middle of the first, the computer will forget your place in the first.

If you execute CHG
    RV2 1111 M2
And then execute DEST, the computer will forget your place in CHG.

This also applies to conversion routines.

If you execute CHG
    PV2 1111 M?
And then enter 100 feet and execute F>M, you have lost your place in CHG.

EXCEPT that flag 4 allows a way around this. When flag 4 is set, a marker is placed in the first routine at the place you left off, and you CAN execute a conversion routine and be able to return to CHG.

If you execute CHG
    PV2 1111 M?   100 F>M   Flag 4 appears and marker is set
    30.4878
you now have the distance in meters, so all you have to do is R/S and you automatically return to CHG.
    R/S   PV2 222 DG?

The R/S at the end of a conversion routine with flag 4 set will return to the marker. If flag 4 is clear R/S will do nothing. Also you will return to the LAST routine that set flag 4.

The only warning with this is do not press R/S after a conversion routine if flag 4 should happen to be set and you have forgotten where the marker is or you might wind up returning anywhere.

Also, the return is not smart, so if you execute a G-T conversion at a distance prompt, everything will run fine, except you will get garbage for the answer.

The following are subroutine returnable places in Land Nav:
At any distance prompt
At any azimuth prompt
At any place where you exchange UTM data.

List of Subroutines

		Return to:
FB	Flash-Blast	Dist
M>F	Meters to Feet	Dist
F>M	Feet to Meters	Dist
BA	Back Azimuth	Az
ML>DG	Mils to Degrees	""
DG>ML	Degrees to Mils	""
M>G	Magnetic to Grid	""
G>M	Grid to Magnetic	""
T>M	True to Magnetic	""
M>T	Magnetic to True	""
G>T	Grid to True	""
T>G	True to Grid	""
SAVE	Save current UTM coordinate	PTS, TGT
RET	Reinstate saved data to UTM	PTS, TGT

All of the above routines will return to the last return point if R/S is given after their completion.

KM>MI   Kilometers to miles
MI>KM   Miles to Kilometers
F>C   Farenheit to Celcius
C>F   Celcius to Farenheit
SLOPE   Finds the slope in percent and degrees
ETA   Finds the travel time and ETA

These routines do not return to anything and R/S after them does nothing except clear the return flag.

FB (Flash-Bang)
You press this once and it starts the stopwatch in the HP time module and sets flag Ø. When you press it again it clears flag Ø and it prompts with the temperature and then calculates the distance based on the time elapsed and the speed of sound. The temprature must be given in degrees Farenheit.

Execute FB when you see the flash from the explosion
Execute FB again when you hear the bang
TEMP Ø F? 75 R/S You give the temp and R/S
424.ØØØØ Distance is in X register. (Your distance will be different)

Try it again
FB
FB
TEMP 75? R/S
342.ØØØØ

The C>F and F>C routines do not return to here or anywhere. The distance is in either meters or feet depending on flag 1. The temperature does have a substantial effect on the speed of sound so you might want to carry a backpacker's thermometer although accuracy to 1Ø degrees is adequate.

BA (Back Azimuth)
As mentioned above, BA finds the back azimuth of any azimuth. A back azimuth is simply the opposite direction. To convert, you add 18Ø degrees if less than 18Ø and subtract if greater.

The back azimuth of 9Ø = 27Ø
254 = 74
18Ø = Ø

The subroutine BA does this for you. To use it you simply enter the azimuth in the X register and execute BA. The back azimuth is put in the X register and there are no prompts. You can execute it again to find the back azimuth of the back azimuth which is simply the original azimuth. The back azimuth works in degrees or mils depending upon flag 2.

123 BA
303.ØØØØ The BA of 123 is 303
BA
123.ØØØØ The BA of 303 is 123

ML>DG, DG>ML etc through T>G

These all do the simple conversion indicated in the table above and they will all return to a main routine at the last return point.

SAVE, GET

These subroutines provide the user with a means to store a coordinate for later use. SAVE will work any time and it gets the last coordinate out of UTM's registers and puts it somewhere safe. It will return to a main routine if R/S is given after it. GET does the opposite, putting the saved data into UTM's registers and then with R/S returns, allowing a main routine to use this information.

SLOPE

Slope prompts for the change in elevation and then the distance between points.

CHG ELEV?	200 R/S
DIST?	420 R/S

You can give any units for CHG ELEV and DIST as long as they are the SAME. Don't give the change in elevation in feet and the distance in miles. It does not do any error checking either. It responds with the slope in percent and in degrees regardless of flag 2.

48% 25DG

ETA

This routine prompts for the rate of travel and for the distance. Again the units of distance are not important as long as they are the same. Don't give the rate in MPH and the distance in kilometers. The rate must be per hour.

RATE?	2.5 R/S	(Km/hr for this example)
DIST?	12 R/S	(Km)

It returns the time required to move this distance at this rate and then with the ETA based on the current time set in the time module if there is a time module. The + indicates additional calender days. +0 means the same day, +1 indicates the time given is for the next day.

TIME 4.48 R/S
ETA 23:14 +0

The ETA is in 24 hour mode and both are in normal HH.MM format.

Section 8: Glossary

Angle The measurement between two intersecting lines given in proportion to a full circle.

Azimuth A direction.

Back Azimuth The opposite direction of the (foward) azimuth.

Bearing The direction of travel.

Clear All A prompt in INIT that allows the user to clear all of the points and vectors stored in the HP-41. It does not clear the entire computer.

Coordinate A number having a vertical and horizontal component that identifies a specific location.

Declination Either the G-M or the T-M angle depending on how your map is ruled. (Either with grid lines or true lines)

Execute The act of executing a function.

Flag A flag is a one bit memory cell that is either set (=1) or clear (=0).

Function Any instruction whatsoever, either built into the HP-41 or a name of a program.

Grid Coordinate Specifically, a coordinate that is read from a military map's grid lines.

Grid Divergence The angle of divergence that occurs when the perfectly square grid system is overlaid on the geographically true lines. This G-T angle is zero at the central meridian and increase as distance away from the central meridian.

Grid Lines A set of vertical and horizontal lines that intersect at perfect right angles and are used in the Military System.

Grid Zone A number and letter combination locating a specific 6 degree by 8 degree area on the Earth. It is given in the form NNA where NN is 1 - 60 and A is C - X (except I and O).

HTM Hundred Thousand Meters.

HTM Square A square given by either a pair of numbers in the form X.YY or a pair of letters in the form AA that identifies one unique square one HTM on each side within each of the 60 major grid zones.

Master Clear The process of clearing the entire HP-41 and starting over fresh.

Mils There are 6400 mils in a circle. One mil is one meters tangent arc distance one kilometer away. (An object that is five meters wide and one kilometer away will appear as five mils).

Pace Count   An accurate measurement of distance by counting paces.

Program   A set of instructions stored in memory that causes certain operations to take place.

Prompt   A term used to describe the contents of the display at the instant when the computer halts its program and requests data or displays data.

Register   A memory location in the HP-41 that can be used to store data.

Routine   A program is composed of smaller routines that do specialized tasks.

Subroutine   In Land Nav, a subroutine is a very small program that does some simple task, usually a conversion.

Time Module   A plug-in module that gives the HP-41 time functions like a clock and a stopwatch. This module is built into the 41CX, but not the others.

Vector   A distance and direction pair describing a leg of a journey or a displacement to another point.

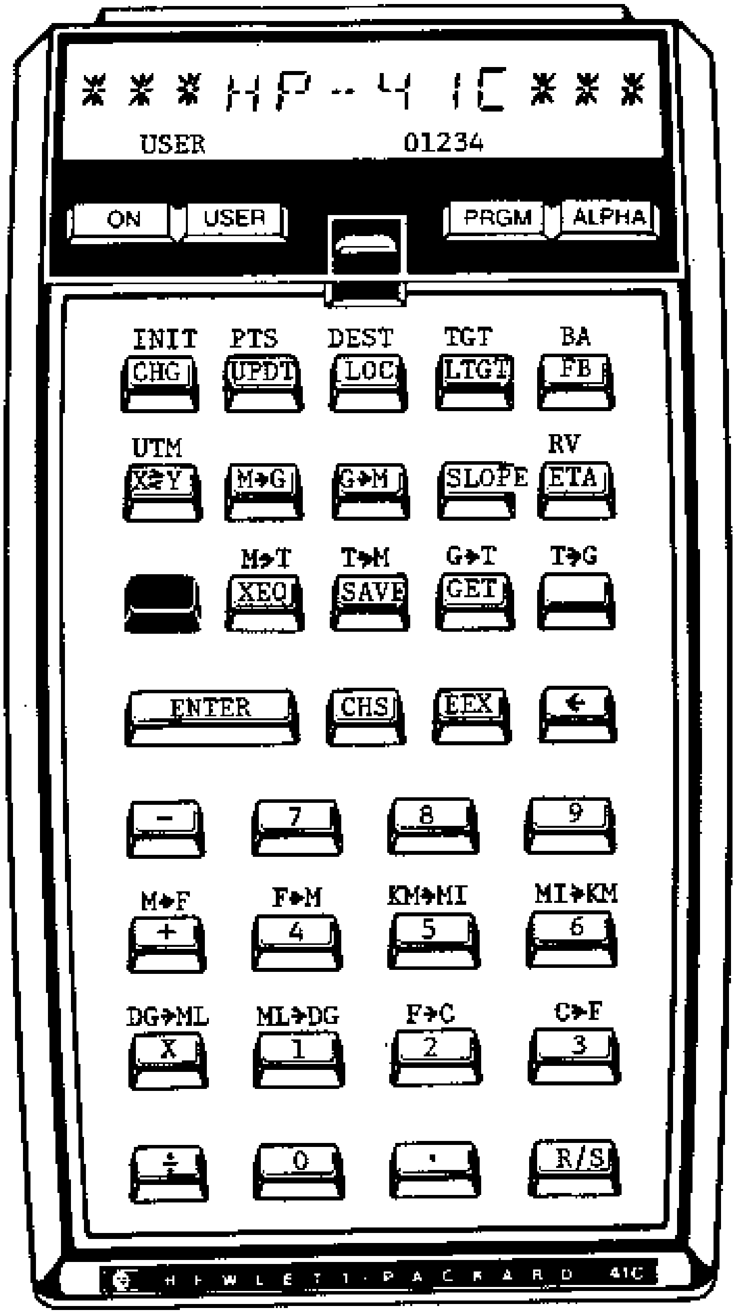
Let's go through the steps in running a land nav course. First you get your map out, find your starting point and pick a number of points you would like to walk to. Then you INIT the Land Nav module and punch in these points with PTS. PØ is always your starting point and P1, P2, P3, etc. are your destination points. You have arranged P1 to be the first point you will go to, P2 the second and so forth, but you don't have to stick to that order. The PTS routine gives you the distance and direction from PØ to P1 to P2 etc.

Now you start walking and keep track of your pace count and keep a steady azimuth. When you have completed the first leg of the course and go to the second leg, you need to report it to the computer. It is not when you change azimuths that you use CHG. CHG will prompt you for the distance and direction you just finished walking and will store this data as permanent vector 1. At the end of the second leg, you will store PV2. It is completely up to you where you actually walk to on V
Let's go through the steps in running a land nav course. First you get your map out, find your starting point and pick a number of points you would like to walk to. Then you INIT the Land Nav module and punch in these points with PTS. PØ is always your starting point and P1, P2, P3, etc. are your destination points. You have arranged P1 to be the first point you will go to, P2 the second and so forth, but you don't have to stick to that order. The PTS routine gives you the distance and direction from PØ to P1 to P2 etc.

Now you start walking and keep track of your pace count and keep a steady azimuth. When you have completed the first leg of the course and go to the second leg, you need to report it to the computer. It is not when you change azimuths that you use CHG. CHG will prompt you for the distance and direction you just finished walking and will store this data as permanent vector 1. At the end of the second leg, you will store PV2. It is completely up to you where you actually walk to on V1, you may walk straight to P1 or to P3 or you may walk to place that is not a stored point at all. Also at the end of V1, you can use LOC to compute your exact locaton and then you can use DEST to tell you the distance and direction to any stored point.

Now suppose you continue on V2 to P2, but somewhere along the way you need your location. This is whre you execute UPDT. You are not changing directios and making a permanent vector, so you will make a temporary vector. You give UPDT the distance and azimuth from your last change up o your locaton. You can then see your location with LOC or use to with LTGT just like when you make a CHG. Because this V2 is temporary, it cn be modified as much as you want. It would even get modified by DEST if there were nothing stored in ti. That means you can execute UPDT as many times as you want, each time you cn give a different vector and it will compute a location based on the last change. Also, don't worry if you execute CHG and it already contains some incorrect data, because that data is temporary and you can correct it.

LAND NAV KEYBOARD



FLAGS SET
0-FB Going
1-Feet
2-Mils
3-
4-Return Pending