

VIPilot

Virtual Instrument Pilot

by Derman Software

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Figure 1 - VIPilot Switch Box

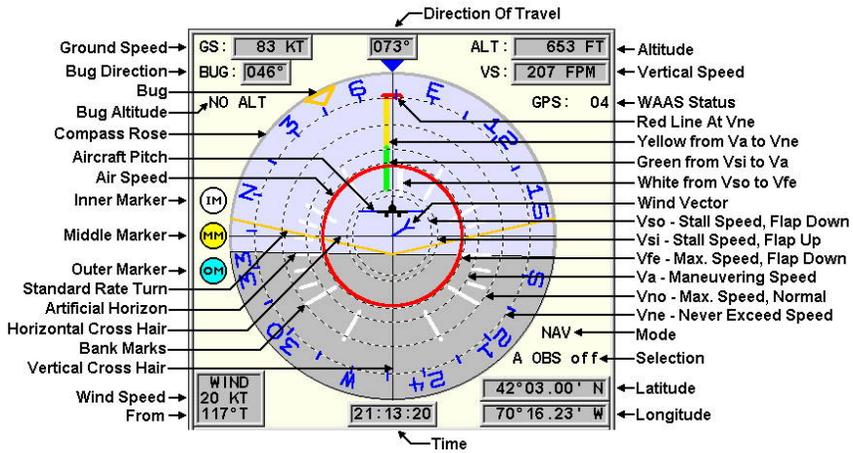


Figure 2 - Instrument Display

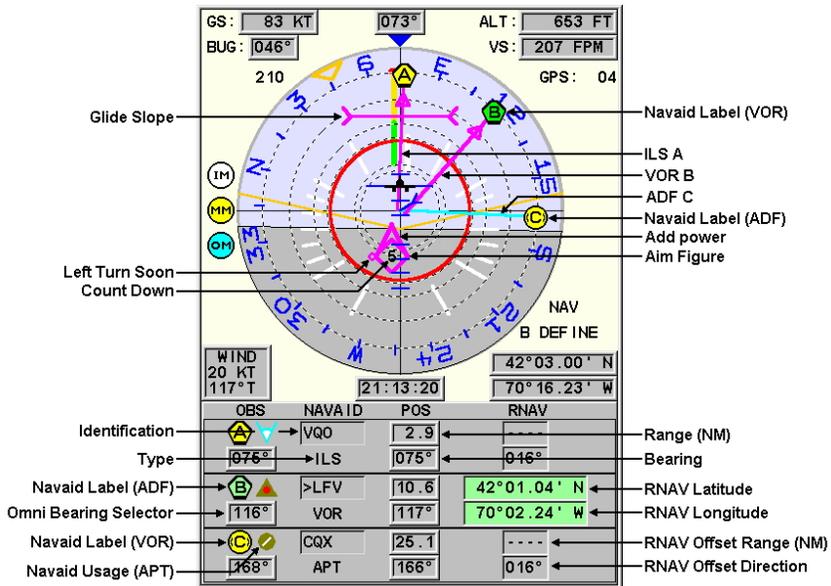


Figure 3 - Navigational Aids

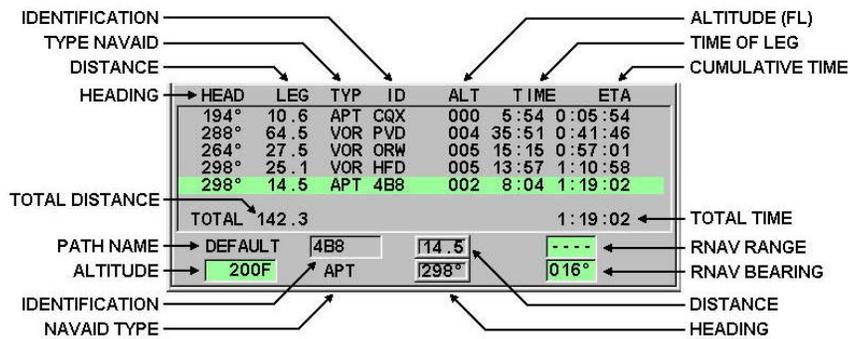


Figure 4 - Flight Path

Display Icons - A, B, or C		
Selected		
		Not Displayed
		Display as ADF
		Display as VOR
		Display as Final Approach Fix
Usage Icons		
		Location point - Locked / Volatile
		Learned location - Locked / Volatile
		Airport
		Learned Airport - Ground / Air
		ILS / Final Approach Fix

Figure 5 - Navigational Aid Icons

VIPilot

I. Introduction

Introducing the Virtual Instrument Pilot or VIPilot for short. The VIPilot provides a backup for most aircraft instruments. The VIPilot provides the average pilot with the luxury of high-end navigational aids at an affordable price. And the VIPilot is bag-able, requiring only a single plug into a 12-volt power source.

A. Why would anyone use an non-TSO'ed device

It generally takes about 7 minutes of flying time to really understand why. The VIPilot is just so much easier to use than conventional instruments. Yet it provides all the functionality of most conventional devices. It alleviates much of the stress and exhaustion associated with the normal IFR scan pattern. You can reasonably consider it a life raft should your primary equipment fail. And it travels with you, so you have identical controls regardless of which aircraft you fly.

B. A WORD OF WARNING

The VIPilot is not intended to be the primary navigation aid. It just happens to be easier to use, and in some cases, more reliable than conventional equipment. However, it is important to stress that you, as pilot in command, have the responsibility to cross check VIPilot readings with conventional equipment. You should be prepared to resume flight with conventional equipment should a failure occur.

C. Limitations to be aware of

1. Attitude indicator will not work below flying stall speed.
2. Attitude indicator will not work in inverted flight or above 85 degrees of bank
3. Attitude indicator shows pitch with flaps retracted. Value will be offset (but proportional) when flaps are extended

D. Ease of understanding - You don't have to do anything

The graphical display is intuitive to any licensed pilot. The Compass Rose, showing direction of travel, is placed around the Attitude Indicator. The Attitude Indicator provides enhanced pitch and bank information. Lines for standard rate turns, which automatically adjust for speed, are incorporated on the Attitude Indicator. A manual bug is provided for the pilot's convenience.

The display also acts as a Horizontal Situation Indicator (HSI), simultaneously showing the true direction of as many as three specified navigation aids. Glide slope indication is superimposed on the display. The aircraft indicated air speed and the wind speed vector are shown on the display. In addition, an "Aim" figure may be displayed to aid in navigation. Marker beacon indicators are on the left side of the graphical display.

Around the graphical display are textual readings for 1) ground speed, 2) direction of travel, and 3) altitude, 4) Rate of Climb, 5) Latitude, 6) Longitude, 7) Time, 8) Air Speed, 9) WAAS status, and 10) VIPilot status.

The above information will start up automatically and be displayed as long as the unit is turned on and satellites are being tracked. There is usually no action required by the pilot other than turning the unit on or off.

E. The few controls you will want to know right away

The first time you use the VIPilot, there are a few things you will want to know:

1. How to stow and deploy your VIPilot - Important (see section of BAGABLE)
2. How to set up for different aircraft.
3. How to select and display navigational aids

At this point, you already can use more instrument power than are available in most rental aircraft. Once you are comfortable with these operations, we suggest you learn:

4. How to create a wind vector
5. How to adjust the BUG and aircraft figure
6. How to set up and operate a flight PATH
7. How to work the AIM figure (PANIC, BUG, NAVAID, LAND, and FLIGHT PATH),
8. How to modify adaptation
9. How to record and playback flight data

Each time the VIPilot is taken into a different type aircraft, that aircraft must be selected in adaptation. Please see the section on Adaptation for details on initial setup.

During most normal operation, the Data section of the screen is devoted to three navigational aids which will display range and bearing to each of the aids. Each navigational aid may be selected from a vocabulary of all US airports, VOR facilities, ADF facilities, mapped intersections, or ILS facilities. This data is updated every 56 days and is made available to you on the Internet at no charge (suggested \$5 donation).

The pilot may choose to display each of these aids and to treat each (except ILS) as either a VOR or an ADF. The pilot may select the type and name of the aid, the OBS radial to be used with each aid. The pilot may also create an RNAV aid at a specified location relative to the selected aid or by latitude and longitude. The NAV button will always restore the NAV screen.

While the NAV screen is presented, the range and bearing to the specified aid will be updated once each second. A Data screen may also be selected to overlay the lower portion of the display screen to show additional information about a particular navigational aid.

The Pilot may choose to display each of these navigational aids graphically or just read out their range and bearing. Any combination from none to all three aids may be displayed graphically, creating a multi-function Horizontal Situation Instrument (HSI).

Wind speed is semi-automatic and must be selected by the Pilot. If selected, the wind speed vector may be entered directly (from tower or FSS reports), calculated by entering the current heading and indicated air speed, or calculated by executing a constant rate turn.

As with most aircraft instruments, the Pilot may choose to set the bug position or move the aircraft figure up or down.

The lower portion of the display may be used to lay in a flight plan. A flight plan will consist of any number of nodes, each containing the location of a navigational aid or RNAV as well as a desired altitude.

While flying such a plan, each node presents its ETA based on the aircraft cruising speed (adaptable) and the current wind vector.

The "Aim" figure is only shown during directed navigation functions such as PANIC, BUG FOLLOWING, NAVAID FOLLOWING, FLIGHT PATH FOLLOWING, or LANDING.

Many of the display parameters may be adapted to suit the individual pilot. These include changing the display appearance for night flight and reducing the number of navigational aids from which the pilot needs to choose.

There are two maintenance functions (not normally used) that show WAAS data on the graphic portion of the display. A single button restores normal operation.

The pilot may record all of the WAAS flight data during operation. The data may then be played back with different navigational aid settings. This was incorporated to aid us in development, but we decided to make it available in the finished product. There is also an off line program provided so that you may analyze flight patterns, etc.

F. Improvements over conventional instruments

Compass rose ... never needs adjustment. May be set to read magnetic or true. The compass rose shows the actual direction of travel, not the direction that that aircraft nose is pointing. The pilot no longer has to compensate for wind drift.

Attitude indicator... As with conventional units, the height of the airplane figure above the horizon indicates the aircraft pitch. The aircraft may be manually set higher or lower for flight maneuvers. In addition, the VIPilot provides a cross hair that indicates the glide or climb slope of the aircraft. When the airplane figure is manually set higher or lower, the wing tips remain to show the un-adjusted position of the airplane

figure. Unlike conventional units, the pitch scale markings remain parallel to the aircraft wings rather than the horizon, showing an accurate measure of the pitch relative to the travel through the air.

Horizontal Situation Indicator (HSI) ... Provides a single vector whose tail end moves away from the center cross hairs rather than the broken line used in mechanical HSIs. This gives a more true to life picture of where the radial is in relation to the aircraft. The TO-FROM flag has been replaced with an arrow on the radial vector itself, again making the display more true to life. The “Off” flag has been removed since navigational aids are never out of range. This simple, uncluttered radial makes it practical to view more than one radial at a time without confusion. Up to three such radials are shown on the display simultaneously, making the aircraft position relative to multiple navigational aids easy to understand in a single glance.

Standard Rate Turn Indicator ... always had a slip and skid bubble incorporated. The standard rate turn was only accurate when the bubble was centered. The standard rate turn markings on the VIPilot are accurate regardless of slip or skid. They can be made part of the attitude indicator because they automatically adjust for speed.

Altimeter ... reads accurate altitude above mean sea level information regardless of barometric pressure.

Vertical Velocity Meter has a shorter latency than barometric instruments. It also retains its accuracy at altitude (barometric pressure instruments are generally correct at standard sea level air density).

Rather than display slant range, the Distance Measuring Equipment (DME) shows horizontal range. This is of more value to the pilot for general navigation. Aircraft travel is intended to be horizontal or at shallow angles.

II. Getting Started

Once properly installed, the software will start up automatically when the computer turns on. With the full configuration, this is done by:

1. Plugging in the 12 Volt supply
2. Pressing the power button on the display
3. Pressing the start/stop button on the processor

Note that the display must be turned on before the processor. Otherwise the processor will default to the Video output rather than the VGA. In that case, the screen will remain blank. The only recourse is to turn the processor off and then turn it on again in the proper sequence.

The use of the processor during flight does not require a mouse or keyboard. However, if you are using the processor for other purposes, make sure the keyboard and/or mouse are plugged in before turning the unit on. Otherwise the system will not see these devices. The VIPilot software will automatically start up after the processor does its self-check. You may exit the VIPilot software and return to the Windows operating system by either pressing GOTO after the unit starts, or by right clicking the mouse button and saying "yes" to the exit box.

The VIPilot software may be restarted by double clicking the VIPilot icon on the desktop.

It is not necessary to exit the VIPilot software to shut down. Simply press the start/stop button on the processor and wait for the normal shutdown procedure. Then press the power button on the display.

WARNING: Do not unplug the processor before the shut down procedure has completed. Doing so may result in loss of data.

Most functions of the VIPilot are operational as soon as the WAAS detector locks on to the required satellites. Graphic display settings for each navigational aid will be the same as it was when the unit was turned off after the previous use. The bug and airplane figure positions are also retained. The graphical display will show ground speed until the wind vector is turned on. Similarly, the aim figure will not be visible until the PANIC or GOTO buttons starts the guided function.

We recommend that the pilot reduce display clutter by turning off the graphical presentation of any navigational aid not currently in use. The range and bearing to each of the three aids will continue to update in the data window even when the vector is turned off.

The navigation data display may be temporarily hidden to allow other data to be presented, such as:

1. Display of data about a specific navigational aid
2. Selection of a runway for guided approach and landing
3. Entering or editing a flight PATH for guided navigation
4. Control of flight recording or playback
5. Modification of display parameters such as screen display colors, critical speeds, etc.

In each of these cases, the navigation data may be restored with a single push button.

III. The Hardware Supplied With A system

Most of your VIPilot consists of commercial, off-the-shelf, hardware. Included in the current full system are:

1. A 1 GHz processor, 128 MByte ram, 10 GByte hard drive, CD reader, high speed interface buss, telephone interface, RS232 interface, 2 USB ports, parallel printer port, VGA video, S-video, standard-video, keyboard, and mouse ports, and an AC Adapter.
2. A high brightness display 360+ nits with a solar filter with a 640 x 480 pixel display on a 9:16 aspect ratio screen. AC power adapter and stand are included for home use.
3. A Garmin WAAS receiver.
4. A 12-Volt to 18-Volt Power Adapter for remote operation with wires spliced in to give a 6' connection to the 12-Volt power source and a direct power connection to the display.
5. A keyboard
6. An optical mouse
7. The Derman Software VIPilot switch box.
8. The software CD
9. A Tote Bag large enough for the portable components

Derman Software provides the switch box, the software CD, and the tote bag. We also splice additional wires onto the Power Adapter (which voids our warranty with the manufacturer, but makes cockpit management somewhat easier).

You may have chosen to use your own computer, display, etc. Our software has been tested and shown to work well on Windows 98, Windows 2000, and Windows XP systems with 233 MHz or more processors.

Note that this full function personal computer system may be used for other computing needs when you are not flying. You may also use it to download data updates directly from the Internet, or by connection to your home computer.

IV. The Switch Box

Central to the VIPilot operation is the VIPilot Switch Box. The controls have been designed to give all the functionality you need to easily deal with the VIPilot functions and its associated database of more than 40,000 navigational aids. Figure 1. is a photograph of the switch box. It consists of four rotary switches, six buttons, a WAAS outlet, and an interface cord with plugs.

A. Switch Box Controls

The controls are as follows:

NAV Button	Common "Home" key to restore the standard screen. Select OBS. Turn off wind.
GOTO Button	Take action on selected item. Select a file Start or stop track or pattern. Set hold pattern.
DATA Button	Displays detailed information. Return to previous screen from DATA
PANIC Button	Show "Aim" figure to restore straight and level flight 2000 feet above nearest airport
ID Button	Acts to select navigational aids. Wind Vector Save file. Rename file
RNAV Button	Acts to create RNAV aids. Rename file. Delete file.
Large SELECT Knob	Select normal display row. Select items from a list. Scroll list

Small SELECT Knob	Used to set character position. Set altitude. Set RED color brightness
Large VALUE Knob	Set bearing parameter. Select navigational aid type. Set BLUE color brightness
Small VALUE Knob	Set range parameter. Select navigational aid identification. Set GREEN color brightness.

In addition, combinations of buttons have special meaning to VIPilot:

MENU (NAV & DATA)	Maintenance menu. PATH save, load, rename menu
PATH (ID & NAV)	Brings up the directed flight paths
DIGIT (ID & RNAV)	Force deletion of a waypoint in PATH

Several other unmarked shortcuts are also available using combinations of buttons. These functions are duplicates of functions found in the MENU screen:

NAV & RNAV	Start and Stop Recording
DATA & GOTO	Start and Stop Playback of Recorded Data
ID & PANIC	Bring up the Exit Screen

B. Navigating the Display with the Switch Box

Throughout this document you will hear the word "mode". A mode refers to the state of the VIPilot and can best be recognized by the screens that are displayed. There are actually 20 different screens that can show on the display: 3 on the top portion and 17 on the lower portion. But most of these are self-explanatory and use similar controls.

Appendix B shows the entire hierarchy of screens. The modes you are most concerned with are NAV, PATH, MENU, and ADAPTATION. These are each dealt with separately in this document. The remainder of the screens represent details, selections, or input for these four modes.

Most of the time, your VIPilot will be in NAV mode. The two screens visible will be similar to that shown in Figure 3, with the Instrument Display on the top and the Navigation Control on the bottom. No matter what mode you are in, you can always return to NAV mode by pushing the NAV button on the switch box.

The PATH mode is entered by pushing both the PATH buttons (NAV & ID) as labeled on the switch box. In PATH mode, the lower screen is replaced with that shown in Figure 4. PATH mode is discussed in a subsection to the section on Autopilot.

The MENU mode is entered by pushing both the MENU buttons (NAV & DATA) as labeled on the switch box. In PATH mode, the lower screen is replaced with a menu as described in the PATH mode section.

The ADAPTATION mode is entered from MENU mode by selecting ADAPTATION with the large SELECT knob and pushing the GOTO button. ADAPTATION is described in the Adaptation section.

V. Graphic Instrument Display

The basic Graphical Instrument Display is shown in Figure 2. It provides, in a single display, the same information as the pilot currently sees on the aircraft's 8 basic standard instruments. These are:

Parameter	Graphic	Text
1. Attitude Indicator	X	
2. Gyroscopic Compass	X	X
3. Indicated Airspeed	X	
4. Angle / Rate of climb	X	X
5. Standard rate turn	X	

6. Altimeter		X
7. Clock		X
8. Marker Beacons (O,M, I)	X	

In addition, the Instrument Display provides:

Parameter	Graphic	Text
9. Ground Speed		X
10. Wind Vector	X	X
11. Latitude - Longitude		X
12. Heading Bug	X	X
13. VIPilot configuration		X
14. GPS/WAAS status		X

Once turned on, the instrument display will become functional without any action on the part of the pilot.

It generally takes from a few seconds up to a few minutes for the system to acquire the four satellites required for position information. During that time, the pilot is presented with a screen, which shows the status of that acquisition. The expected locations of satellites relative to true north are displayed on a map. As each satellite is acquired (as indicated by its color), the power level of that satellite is shown by the size of the dot on the map. As soon as a three-dimensional fix has been established, the instrument display replaces the satellite screen. This satellite map screen will re-appear if, for any reason, the satellite information is lost and the coast mode period has expired.

As long as the Virtual Instrument Pilot is turned on and position information is being received, the instrument display shown in Figure 2 will be presented. The instrument display provides a single point of focus for the pilot to keep track of the attitude and position of the aircraft. When paired with a WAAS sensor, the VIPilot is capable of replacing the functionality in normal flight of the following standard instruments: attitude indicator, sensitive altimeter, rate of climb indicator, gyrocompass, rate of turn indicator, and clock. As discussed

later, Navigation and Autopilot information may optionally be displayed on the instrument display.

A. Attitude Indicator

Unlike current attitude indicators, the VIPilot artificial horizon is only accurate when in coordinated flight. However, unless the slip or skid is excessive, the bank will represent a good approximation.

To move the aircraft figure up or down on the artificial horizon, you must be in NAV mode (always achieved by pressing the NAV button). Turn the large SELECT knob counter-clockwise (0 to 4 clicks, depending on what is currently selected) to highlight the BUG numeric display. The small VALUE knob may now be used to move the aircraft figure.

When the aircraft figure is moved, the wing tips will remain at the computed position showing the true data as well as reminding the pilot that he/she has applied an offset.

As with a conventional artificial horizon, the pitch of the aircraft can be seen by the height of the airplane figure above the artificial horizon. It is the sum of the glide slope and the pitch of the aircraft relative to the airflow. The VIPilot displays both of those components.

The computed height of the cross hairs above the horizon gives the pilot a visual indication of the glide slope of the aircraft.

The computed height of the aircraft above or below a cross hair represents the pitch of the aircraft relative to the flight path.

B. Gyroscopic Compass

The Virtual Instrument Pilot instrument display incorporates a compass rose. The compass rose has several advantages over its conventional counterpart. The compass never has to be adjusted for drift, is not

affected by any metal in the aircraft, shows the direction of travel rather than the aircraft heading, and is not affected by wind speed. In addition, there is a digital readout for accurate direction of travel information.

The directions for most functions are usually shown as magnetic. The pilot has the option of displaying all directions as true. The wind vector text is always set as true. Directions shown relative to true north will always have a "T" after the degree sign (see the wind direction in figure 3).

C. Indicated Airspeed

Another novel feature of the instrument display is a circle representing the aircraft's average air speed (if an accurate wind vector has been entered) or ground speed (if no wind vector is present). The Virtual Instrument Pilot does not show the instantaneous airspeed due to gusts.

Included on the display are dashed line rings indicating critical air speeds for your aircraft. These serve to let the pilot know the aircraft is near a critical speed. However, for critical speeds, the instantaneous air speed from the aircraft's built in air speed indicator is required.

If the aircraft's air speed indicator has failed (as can happen in icing conditions when pitot heat is not on), the air speed indicator may be used as a backup (something is better than nothing), with caution.

D. Rate of climb

The rate of climb indicator responds faster than a conventional rate of climb indicator. Because the old system used a mechanical bellows, accurate readings were not available for 6 to 9 seconds after a change in vertical velocity. The lag in the Virtual Instrument Pilot may be set as low as 1.5 seconds (set to 1). However, the pilot will often choose to adapt this to a larger value for a smoother response.

E. Standard rate turn

There are two lines provided on the display to indicate when the aircraft is doing a standard rate (2 minute) turn. Aircraft Standard Rate Turn indicators generally incorporate a slip and skid indicator to show the pilot if the aircraft is doing coordinated turns. They are required because the Standard Rate Turn indicator is only accurate in a coordinated turn.

The flexibility of a graphic display allows the markings to adjust for aircraft speed and the system will show a standard rate turn even if in a slip or skid. If you must have a slip and skid indicator, a simple bubble level may be placed near the screen. Or the pilot may use the "seat of his pants", in that any slip or skid has the same effect as the pilot sitting on an incline – one of the few senses which does not get confused even with your eyes shut.

F. Altimeter

The altimeter also has an advantage over the conventional instrument. It does not have to be adjusted for barometric pressure and always shows actual altitude above mean sea level.

G. Clock

The clock always shows Universal Time as received from the satellites.

H. Marker Beacons (Outer, Middle, & Inner)

Incorporated on the same display are the outer, middle, and inner marker beacon indicators. These not only function normally, but as outlined in

the further text, will be used to indicate virtual marker beacons and missed approach points.

I. Ground Speed

The speed relative to the ground is displayed in knots.

J. Wind Vector

The wind vector will be turned off when the VIPilot is started. To set the wind vector and turn it on, you must be in NAV mode (always achieved by pressing the NAV button). Turn the large SELECT knob to highlight the wind speed text window (-1 to 3 clicks counter-clockwise depending on what is currently selected).

If the wind speed has been set and the window is already highlighted, the NAV button will turn the wind speed off. The label, "GROUND SPEED", replaces the numerical value on the screen. However, the current wind direction and speed will be saved for re-use during that flight.

Three methods are provided to enter the wind direction and speed. The values may be entered manually, the current magnetic heading and true air speed may be entered, or the Virtual Instrument Pilot will calculate the wind direction and speed while the pilot executes a constant 360-degree turn.

1. Wind Direction and Speed Entry

With the wind speed window selected, pressing the ID button turns on the wind vector. The wind vector is shown on the instrument display and the word "WIND" shows above the wind direction and speed values. The

pilot may change the wind direction and speed using the large and small VALUE knobs respectively.

For takeoff and landing at larger airports, the pilot will generally enter the wind speed and direction as broadcast for that airport since the wind vector is usually quite different near the ground than above the airport.

2. Airspeed and Magnetic Heading

With the wind speed window selected, pressing the RNAV button turns on the wind vector. The wind vector is shown on the instrument display and the word "HEAD" is now shown above the direction and speed text. The window now shows the aircraft indicated air speed and magnetic compass heading which would result from the current ground speed and direction of travel for the currently entered wind vector.

The pilot flies a straight constant course and reads the indicated airspeed and magnetic compass heading from the aircraft instruments. The pilot then uses the small VALUE knob to enter the indicated air speed and the large VALUE knob to enter the magnetic compass direction into that window. The wind vector on the display will move to show the actual wind vector. Switching back to WIND, the new wind vector direction and speed are displayed in the window.

This method (heading and air speed) is recommended for flights between airports because it can be done without deviating from the planned route.

3. Calculated Value

Pressing the RNAV button a second time arms the wind direction algorithm and the word "CALC" appears in the window. As soon as the aircraft enters at least a standard rate turn, the word "CALC" is followed by a count down of the number of degrees remaining in a 360-degree turn. If the aircraft does not maintain a fairly constant rate of turn, the

countdown restarts. When the aircraft has completed a fairly constant rate of turn, the wind vector is calculated and the control automatically switches back to the "WIND" position, displaying the new wind vector. The pilot may abort the calculation by pressing a NAV, ID, or RNAV buttons before the calculation is complete.

This method has been provided to deal with the case where air speed and/or heading are not readily available.

While the Virtual Instrument Pilot is not recommended for critical air speeds, if the airspeed indicator is not functional (which happens if the pitot tube has iced up), the air speed indication on the Virtual Instrument Pilot will provide some degree of safety for this emergency situation.

K. Latitude - Longitude

The pilot has a constant readout of Latitude and Longitude. They are presented at the bottom right corner of the Instrument Display to a precision of 0.01 minutes. That represents 18.5 meters in Latitude and somewhat less in Longitude. That is more than adequate for a small aircraft traveling at 50 meters per second.

L. Heading Bug

Many pilots make use of a bug on the Heading Indicator as a reference point, which will adjust for aircraft direction. The VIPilot provides that same convenience. As you will see later on, the bug may also be used for the autopilot functions.

To control the Bug, you must be in NAV mode (always achieved by pressing the NAV button). Turn the large SELECT knob counter-clockwise (up to 4 clicks, depending on what is currently selected) to highlight the BUG text display. The large VALUE knob will now allow you to set the BUG heading. The knob is speed sensitive, so only a few

turns will get you to any direction. The graphic bug will move as the value is being set.

M. VIPilot configuration

The mode and current input selection are indicated just above the Latitude-Longitude readout.

N. GPS/WAAS status

The position sensing equipment provides an indication of the health of the WAAS equipment. The WAAS Status is presented on the upper right portion of the screen. It indicates whether "WAAS" or "GPS" is functioning. The number of satellites being tracked is also displayed.

WARNING: If the status indicates "GPS" instead of "WAAS", then the WAAS correction is not being received. Please assume an additional 100 feet error in altitude.

VI. Navigation

The VIPilot supports display of any three navigational aids A, B, or C in normal operation. When any of the three navigation aids are selected, the buttons allow the user to choose:

NAV	Set the OBS and control nav. aid graphic display
ID	Select the type and identification (ID) of the nav. aid
RNAV	Set location of nav aid relative to defined nav aid
RNAV - rpt	Set the latitude and longitude of user defined nav aid

A. NAV Button:

Press the NAV button to enter NAV mode. This may be done from any screen. The navigational aid window is displayed. The NAV button is also used to select the left most field of a navigational aid. This field displays two icons, the first showing the graphic display status of the navigational aid and the second indicating how that aid might be used, whether it be an airport, location, final approach fix, or an instrument landing system. See Figure 5 for a complete list of these icons.

The left field controls the graphical display of the navigational aid, final approach fix, and, if applicable (i.e. - not ILS) the OBS setting. Note: If the large SELECT knob is turned while in NAV mode so that another navigational aid strip is highlighted, the system "pushes the NAV button" for you and the highlighted field will revert to the left most field.

1. DISPLAY:

When the first field is highlighted (OBS selected - default for the NAV button), the smaller VALUE knob allows three display options:

1. Counter-clockwise - Hide display of graphic navigation aid on the instrument display. (Text display remains visible.)
2. Mid-position - Display graphic as ADF on the instrument display for APT, VOR, NDB, or FIX. When an ILS is selected, the mid-position generates and displays a final approach fix about 3 miles from the runway as an ADF.
3. Clockwise - Display graphic as VOR or ILS on the instrument display.

The navigational aid will continue to show the text range and bearing regardless of the knob position.

2. OBS:

With the OBS selected (default for NAV button), the large VALUE knob sets the bearing direction for all navigational aids except the ILS. OBS selection is speed sensitive.

The OBS value has no meaning unless the navigational aid is displayed. In order to save work for the pilot, turning the large VALUE knob will automatically switch the Display of the navigational aid to show the graphic as a VOR. If the graphic display is not desired or if an ADF display is desired, it must be set manually.

The Display State of each navigational aid and type is retained, even when the Virtual Instrument Pilot is turned off. However, the OBS setting will be changed to point TO the navigational aid upon startup.

a) ILS Differences:

As with normal aircraft instrumentation, when an ILS is selected, the behavior is slightly different. The pilot may no longer control the OBS field. Instead, the OBS indicates the runway direction associated with the ILS. The mid position of the small VALUE knob temporarily replaces the ILS with an ADF placed as a final approach fix (3 nautical miles before the runway along the glide slope).

When a virtual ILS is selected, the system generates an ILS display based on the nearest airport and runway direction with a 3.0-degree glide slope (adaptable). Virtual inner, middle and outer marker beacons are provided at 100 feet, 225 feet, and 1000 feet above the runway altitude respectively along the glide path.

B. ID Button:

The ID button will highlight the second column of the selected navigational aid. The type and specific aid may be selected.

1. Type - ID Button:

The Virtual Instrument Pilot maintains separate selections for each type of navigational aid. When ID button is pressed, the second column (NAVAID) is highlighted and the large VALUE knob is used to select the navigational aid type from:

APT	Airport
VOR	Vector Omni Range site
NDB	Non-Directional Beacon
FIX	FAA or user defined fix location
ILS	Instrument Landing System

2. ID - ID Button:

The pilot has two ways to select a specific navigational aid. After selecting the type of navigational aid, the pilot may:

- 1) Distance - Turn the small VALUE knob to select from an ordered list showing the nearest navigational aid of that type when the small VALUE knob is turned counter-clockwise, or
- 2) Alphabetic - Turn the small SELECT knob to highlight one or more characters of the navigational aid identification and turn the small VALUE knob to sequence through navigational aids starting with those characters alphabetically. As the pilot approaches the correct navigational aid, more characters may be highlighted to quickly reach any particular item.

The small VALUE knob is speed sensitive when selecting from nearest aid. That is, as you move it faster, it moves more steps with each click. When selecting alphabetically, the speed sensitive feature is turned off to avoid skipping letters.

There are over 40,000 list items in the database. These have been separated into logical lists of airports, VORs, NDBs, ILSs, and fixes. Even so, with over 5,000 public airports in the United States and over 29,000 fixes, the lists can become uncomfortably long. Several methods have been used to simplify the selection process.

The pilot may limit the range of items which will show on the list. The range is relative to the aircraft's current position. It is unusual for the pilot to be concerned with facilities more than a few hundred nautical miles away. Note: when generating a flight path (described later), the range is relative to the previous waypoint entered rather than the aircraft's position.

With the alphabetic procedure, the pilot may select items by spelling out the navigational aid identification (ID) letter by letter. Numerals and punctuation marks are sequenced before letters. If any button is pressed except the DATA button, alphanumeric sequence is turned off and navigational aids are resorted by distance.

Several settings have been made automatic to minimize the pilot's task. When the pilot changes the ID of a specific type of navigation aid (except ILS), the Virtual Instrument Pilot automatically sets the OBS to the bearing TO that navigational aid.

a) APT Differences:

The first APT selection (all the way counter-clockwise) is reserved for the special case of the nearest Airport. Its name will appear preceded by asterisks, "*". As the aircraft flies, this airport will change automatically when the aircraft comes closer to a different airfield.

b) ILS Differences:

The first ILS selection (all the way counter-clockwise) is reserved for the special case of the nearest Airport runway. Its name will appear as a runway number preceded by an asterisk, "*". As the aircraft flies, this runway will change automatically when the aircraft comes closer to a different runway. In addition, virtual inner, middle, and outer marker beacons are provided at 100 feet, 225 feet, and 1000 feet altitude respectively along the glide path.

C. RNAV Button

Press the RNAV button to highlight the RNAV fields of the current navigational aid. The small VALUE knob will now select an offset range in increments of 0.1 nautical miles. The large VALUE knob will select the bearing relative to the specified navigation aid in increments of 1 degree. Both of these knobs are speed sensitive.

An RNAV is created whenever the selected range on a navigational aid is changed. Note that if the change was from an RNAV that is "in use" somewhere else in the system, multiple RNAVs will be created. This is important because the pilot may want more than one RNAV associated with a specific navigational aid. The previous RNAV might also be part of a flight path that should not change.

An RNAV may be deleted from the system by setting its range to zero. If you find that the RNAV is still there when scrolling through navigational aids, then it is being used elsewhere or it has been locked. (Locking is discussed later in this manual.)

Once an RNAV has been created, it becomes part of the database until the pilot overtly deletes it or the VIPilot is turned off. The RNAV will also be retained between flights if it was either the last navigational aid

of its type used by any of the three navigational aids or it was specifically locked as a retained location. An RNAV, which is part of a saved flight path, will also be available whenever that flight path is loaded into the VIPilot.

a) ILS Differences:

When an ILS is selected, the RNAV field is disabled.

D. RNAV Button Repeated:

Each additional pressing of the RNAV toggles between range-bearing and latitude-longitude.

In the latitude-longitude mode, the small VALUE knob will select the latitude and the large VALUE knob will select the longitude of a user defined navigation aid. Latitude and longitude are set in increments of 0.01 minutes.

Hint: Use RNAV to set approximate location. Then press RNAV again to set exact latitude and longitude. In this way, a location may be defined within a radius of about 45 feet.

E. RNAV LOCK - DIGIT (RNAV & DATA) Buttons:

An RNAV will remain available to the system when the VIPilot has been turned off if it is the last selection of that type in any of the three navigational aids. It will also remain available if it is a part of the path loaded into the system.

If you want to assure that a particular RNAV will always remain available between flights you may put a LOCK on it. The RNAV will

then behave as though it were used in an additional path except a LOCK icon will appear on the navigational aid data strip.

Learned runways behave in a similar fashion except they are initially locked when they are generated. Learned runways are discussed later in this manual.

You may toggle the lock off or on by pressing the RNAV and DATA buttons simultaneously while the NAV screen is showing.

F. DATA button:

The DATA button may be pressed at any time and the listed information about the currently selected navigational aid will replace the entire navigation aid window. Either pressing NAV or DATA may restore the navigational aid window. The large SELECT is used to scroll through data if the information on the navigational aid is more than 8 lines long.

G. Learn - GOTO Button:

The VIPilot is able to learn a new airport runway. That runway may be a real (on the ground) or virtual (in the air). Real learned runways could be a dirt field or a remote lake. Virtual runways are used for practice approaches without adding to airport traffic or to mark a specific location. This function has been grouped with the Wind Vector and it uses the Wind Vector data area during the learning process.

In NAV mode, select the wind vector with the large SELECT knob. To start the learn process, taxi into position (or fly to the desired position) and then press the GOTO button. The current location will be taken as the runway threshold. As soon as the aircraft has traveled 1000 feet, the runway will be added to the system. A learned runway will show an airport icon (green for on ground, blue for above ground). If any switch

or knob has been pressed or turned before the 1000 feet have been traveled, the learned runway is discarded.

The pilot may wish to disable use of a learned runway when making a landing using a simulated ILS at the "nearest" airport. A learned runway may be disabled by unlocking the learned airport. Be sure to re-lock the learned airport if you wish to retain the location between flights. The runway icon will show as a volatile navigation point while unlocked (as shown in figure 5).

VII. Autopilot

There are five types of autopilot directed flight:

1. Panic
2. Bug
3. Navigational Aid
4. Landing
5. Path

All of these autopilot functions display the "Aim" figure.

The GOTO button is used to start and stop autopilot functions. Its effect depends on the current system selection:

1. If the "Aim" figure is displayed - GOTO stops the panic or autopilot function. If a hold or search pattern is being processed, the pattern is terminated. In that case, second press of GOTO is required to turn off the path.
2. If the bug setting is highlighted - GOTO provides instructions to achieve a given heading and altitude.

3. If a FIX, VOR, or NDB is highlighted - GOTO provide instructions to fly to a given fix at the Bug altitude. If no bug altitude is present, the current altitude is used.
4. If an APT is highlighted - GOTO provide instructions to enter one of the landing patterns for a specified runway and land.
5. If an ILS is highlighted - GOTO provides instructions to land via a final approach fix and then direct along the ILS path.
6. If the PATH screen is displayed - GOTO provides instructions to follow a flight path or pattern sequence.

The type of autopilot function being performed is indicated in the lower left corner of the instrument display just above the wind vector window.

A. Flying The Aim Figure:

In addition to the screen display, a Panic function will provide the letter "P" inside the "Aim" figure, a Bug function will show the letter "B" inside the "Aim" figure, and a Fix function will show the letter "F" inside the "Aim" figure. Both Land and Path "Aim" figures are empty except during the last 9 seconds before a maneuver change, during which time a seconds countdown will show within the figure.

The "Aim" figure represents a different approach to both deal with disorientation and make navigation easier. In essence, the "Aim" figure is presenting the pilot with the same directions that would be given to the hardware of an autopilot. It is done in a way that requires a minimum of interpretation by the pilot.

A diamond shaped figure appears on the screen. The pilot need only move the controls to push the figure toward the middle of the screen. It takes into account, not only the desired attitude of the aircraft, but the rate at which that attitude should be achieved.

When you first try it, you will probably remember when your instructor used to say "slow and smooth". The slow is important here because there is a slight delay between the pilot's action and the VIPilot evaluating the attitude calculation.

If the diamond moves right, turn the wheel to the left. If it moves up, push the stick forward. If it moves down, pull the stick back.

In addition, if an extension appears on the top of the diamond, reduce power. If an extension appears on the bottom of the diamond, add power.

When flying a path, the system also gives you a heads up before you have to perform a maneuver. Depending on which way you will be moving the controls, a small circle appears blinking on one or two of the corners of the diamond (two if both heading and altitude changes are anticipated) about 10 seconds (adaptable) before the maneuver. A number appears in the diamond and counts down by seconds. The pilot executes the maneuver when the count reaches zero (0).

B. PANIC button:

The PANIC button takes precedence over all autopilot functions. When the PANIC button has been pressed, the "Aim" figure appears with the letter "P" in it and provides instruction to achieve straight and level flight at least 2000 feet (adaptable) above the nearest airport. The PANIC button may be pressed regardless of which screen is currently displayed (except when suspended - See Appendix D). The intent is to give the pilot time to re-orient while he regains control of the aircraft.

The Panic operation is really a superset of the BUG following autopilot function. The target altitude and heading are loaded into the BUG and BUG-following procedures are followed. That means, once you are comfortable with the aircraft again, you have the option to change the

BUG heading and/or altitude to one which is more to your liking. As with all autopilot commands, the change will be slow and smooth.

WARNING: It is important for the pilot to recognize the need for the PANIC button while the aircraft is still in somewhat normal flight. Remember that the Virtual Instrument Pilot operates well up to about 85 degrees of bank. Above 85 degrees of bank or in inverted flight, the PANIC button will give wrong information.

In most installations, the WAAS antenna will not be able to see the navigation satellites during inverted flight. When a minimum of 4 satellites are not visible, the VIPilot can not function since altitude information is no longer available. Reacquisition of satellites after inverted flight generally takes a few seconds.

To exit the PANIC function, simply display the NAV screen and press GOTO. The system will resume its normal operation.

C. GOTO button:

As outlined in the following paragraphs, the GOTO button is used to start all types of Autopilot functions except PANIC. If the NAV screen is active and an Autopilot function is being performed, the GOTO button will stop that function and remove the "Aim" figure.

D. BUG:

Pressing GOTO while the BUG is selected starts the BUG autopilot function. The operation is similar to the PANIC operation, except the "Aim" figure provides direction to achieve straight and level flight according to the heading and altitude already entered in the BUG.

These values may be changed any time during the flight, including while the BUG autopilot is in operation. The "Aim" figure will just give directions toward the new setting.

E. VOR, NDB, or FIX Navigational Aid:

Pressing the GOTO button when a VOR, NDB, or FIX navigational aid is selected will cause the "Aim" figure to direct the pilot to that navigational aid. The BUG altitude will be automatically set to the current altitude. The BUG altitude may be changed any time during the flight, even while the autopilot is functioning.

F. APT LAND:

If the GOTO button is pressed while an Airport is selected, the pilot is shown a choice of runway to land on and approach patterns with the preferred runway selected. The pilot may accept this runway by pressing GOTO again, or he/she may modify the selection and then press GOTO to start the autopilot function.

A list of the airport's defined runways will replace the navigational aid screen. The runways will be sorted by runway name. The cursor will be pointing to the preferred runway based on the wind direction. If no wind direction is available, the cursor will point to the top of the list. The cursor may be scrolled with the large SELECT knob to choose a different runway. The type of approach may be changed with the large VALUE knob.

The default pattern direction for each runway is provided in the airport database. However, the pilot may chose to change the pattern direction using the small VALUE knob. Needless to say, both announcement and extra caution are indicated with such a choice.

After selecting an airport (and optionally a runway and/or approach), if the GOTO button is pressed, the "Aim" figure will direct the pilot to achieve that landing pattern. Once the selection is made (or aborted with the NAV button), the NAV screen is restored.

G. ILS Land:

If the GOTO button is pressed while an ILS is selected, the aircraft directed to a virtual final approach fix located along the glide path, 1000 feet above the runway altitude. The "Aim" figure then leads the aircraft around a procedure turn (if needed) and then down the ILS flight path. The flight path is complete when the inner marker is reached.

H. PATH Mode:

To enter, edit, or execute a flight path, press the PATH buttons (NAV and ID) simultaneously. The lower screen now lists each step of the current flight path. The step nearest the current aircraft position will be highlighted. The bottom strip of the lower screen is the control template for the highlighted step.

As with other lists, the highlighted step may be selected using the large SELECT knob. As each step is selected, its information is also displayed in the control template. The Type and ID are also highlighted in the template and their values may be changed with the large and small VALUE knobs respectively.

A flight path consists of a series of waypoints. It may be loaded from disk file that was prepared off line or saved from a previous flight, or it may be generated during flight.

1. Starting Autopilot on a Path

Assuming we have a flight path loaded, the flight path autopilot function is started selecting the preferred start point in the path list and pressing GOTO. The pilot will be presented with a choice:

1. GOTO DIRECT - Track after heading to the selected aid.
2. GOTO NEAREST - Track after intersecting the path.
3. STOP TRACK OR PATTERN - Stop pattern or path
4. HOLD / SEARCH PATTERN - Specify a hold (or search) pattern at the selected waypoint

The pilot makes a selection by scrolling through the options and pressing the GOTO button. Alternatively the pilot may choose to return to the PATH list by pressing the ID button or the RNAV button. The DATA button will also abort the GOTO and will show details about the selected waypoint.

Hold or search patterns are assigned to waypoints. The pilot does not initiate the pattern directly. Instead, the pilot enables the pattern and starts the PATH. When that waypoint is reached, the enabled pattern takes over. When the pattern is complete or stopped, the PATH continues from that point. Note that hold patterns are continuous. They must be stopped with either a stop command in the GOTO menu of PATH or a GOTO button when the NAV screen is displayed.

2. Creating and Managing Flight Paths

The PATH screen, shown in Figure 4, is used to manage travel paths. The PATH shows up as a list of waypoints. The large SELECT knob now moves a cursor through the list, which will automatically scroll (except for the "TOTALS" line).

There are a few differences (from NAV entry) when entering waypoints of navigational aids to form the PATH list:

1. There is no need to set an OBS, or for an ILS navigational aid, in the flight path.

2. We needed a way to insert and delete nodes. See ID below for details.
3. Each flight path node also contains an altitude. See RNAV below for details.
4. We needed a way to save or load other PATH files. See Path MENU Buttons below for details.
5. A flight PATH may include an imbedded hold pattern (or search pattern).

a) Path ID Button:

The default highlight in PATH mode is the TYP/ID field. Both VALUE knobs and the small SELECT knob work the same as they do in NAV mode, allowing modification of the selected navigational aid for each step in the path. See the ID Button subsection under Navigation for details.

The only difference to these functions in PATH mode is that ILS-type navigational aids are not available.

b) Path ID Button Pressed Again:

While the PATH screen is displayed, the pilot may press ID button a second time to insert a step in the path after the current cursor position. Initially that step will be a duplicate of existing step. The new step is highlighted and details of that location are shown in the bottom of the window. The new step may then be modified to any NAV or RNAV location as is done in NAV mode. (Note: to insert a step before the first line, simply insert a step and then move the SELECT knob up one step.)

The pilot may press ID button again to delete a waypoint in the path at which the cursor is pointing if that waypoint is one of a duplicate pair (even if the altitudes are different).

c) Path DIGIT Buttons (ID & RNAV):

Pressing the DIGIT buttons (ID and RNAV) simultaneously will force a step to be deleted even if it does not match an adjacent waypoint.

d) Path RNAV Button

Both VALUE knobs work the same as they do in NAV mode, allowing creation and modification of the selected navigational aid for each step in the path. See the RNAV Button subsection under Navigation for details.

In addition, when the RNAV fields are selected, the small SELECT knob is used to set the waypoint altitude.

e) Path RNAV Button Repeated:

Both VALUE knobs work the same as they do in NAV mode, allowing creation and modification of the selected navigational aid for each step in the path. See the RNAV Button Repeated subsection under Navigation for details.

f) Path DATA button:

The DATA function works the same as it does in NAV mode, presenting detail information about the currently highlighted navigational aid. See the DATA Button subsection under Navigation for details.

g) Path MENU Buttons (DATA & NAV):

The VIPilot provides a shortcut menu into the adaptation screens to save, rename, or restore a previously stored flight path. In addition, the pilot is given the option to reverse the sequence of the current flight path. Pressing the MENU buttons (DATA and NAV) brings up this MENU screen. (Note that the DATA button must be pressed first or the screen will quickly revert to the NAV screen and the normal MENU will appear.) The PATH screen may be restored from the special MENU by pressing the DATA, ID, or RNAV buttons.

h) Path NAV Button:

The NAV button will exit the PATH list and restore the NAV screen. If started, tracking will continue until the flight path is completed, the GOTO button is pressed again, the PANIC button is pressed, or the unit is turned off.

3. Hold and Search Patterns

Any waypoint may be made the focus of a hold pattern or a search pattern. Hold patterns may be requested by controllers during IFR flights to provide proper separation of aircraft. They are often designated as the conclusion of an IFR missed approach.

The VIPilot also provides four of the five search and rescue patterns listed in the Coast Guard Auxiliary manual. These are particularly helpful because there are seldom landmarks (especially over water) available to assure the complete coverage of a search area.

The pilot is given the opportunity to define the hold pattern at a waypoint in terms of direction, speed, altitude, and length. Search patterns may also require definitions of width and/or sector angle. See appendix C for details of the search and rescue patterns.

The pattern screen is opened from the PATH screen by pressing GOTO, selecting HOLD / SEARCH PATTERN, and pressing GOTO again. Your VIPilot control box now has the following functions:

The large Select knob allows selection of the type of pattern from:

1. HOLD PATTERN (DEFAULT)
2. TRACKLINE PATTERN
3. PARALLEL TRACK PATTERN
4. CREEPING LINE PATTERN
5. SQUARE PATTERN
6. SECTOR PATTERN

The Contour pattern is not provided because it would require detailed ground contour information.

The small SELECT knob sets the altitude of the pattern (default is the current altitude).

a) ID Button in Search (default)

The small and large VALUE knobs set the length and initial direction of travel (not applicable for Trackline pattern - defaults to RNAV).

b) RNAV Button in Search

The small VALUE knob sets the speed. The large VALUE knob sets the area width or sector angle for search patterns. The large VALUE knob also determines the turn direction or side of Trackline. An "R" in the width represents right turns, right side of Trackline, or progression to the right of the initial leg. An "L" in the width represents left turns, left side of Trackline, or progression to the left of the initial leg.

c) DATA Button in Search

Return to the GOTO screen of the PATH function with the hold or pattern disabled.

d) GOTO Button in Search

Return to the GOTO screen of the PATH function with the hold or pattern enabled.

VIII. MENU MODE

MENU mode is used for all functions not covered by NAV or PATH modes. These functions also operate with the list and actions depend on the functions being performed. As with other modes, the large SELECT knob chooses the category being worked on from:

SHOW FAA DATES - List the current navigation aid files and their legal dates

EXIT - To exit the VIPilot program

ADAPTATION -To modify colors, parameters, default files, etc.

WAAS (HIDDEN, MAP, DATA) - To allow display of input data (in MENU mode only)

RECORD - To save the WAAS data of a flight

PLAYBACK - To play back a recorded flight WAAS data as a simulation

LOCK LIST - To present an alphabetical list of all locked RNAVs and allows deletion from that list

AERIAL VIEW - To see the flight path being followed

STATISTICS - To get the WAAS statistical average of a given geographical point

The pilot selects the special mode and presses GOTO to invoke the appropriate screen or function.

IX. Adaptation

The VIPilot is designed to allow use in many different types of small aircraft. In order to accommodate movement from one aircraft to the next as well as flight in different condition such as day and night, your VIPilot may be set up with a number of named adaptation files. Only the aircraft type needs to be set for your initial flight. Later, you may want to change other parameters to suit your personal needs.

A. INITIAL SETUP:

Each time your VIPilot is used in a different aircraft, the aircraft characteristics should be set in your instrument. This is normally done by selecting the aircraft type from a list. Your VIPilot has been provided with a number of aircraft descriptions. As more pilots share their usage with us, we will post additional aircraft description files on the web. If your aircraft is not listed, start with one whose flight characteristics best match your aircraft. In this chapter, we will also describe the simple steps needed to generate such a file.

To change the aircraft characteristics from the current setting, do the following:

1. After the VIPilot has started, press the MENU buttons (NAV and DATA) simultaneously.
2. Turn the large SELECT knob to highlight ADAPTATION
3. Press GOTO and the general adaptation will be shown.

4. If your type aircraft is shown next to the word "Aircraft", it is the current default and you need not do anything. Simply press the NAV button and go fly. You need not do these steps again until you change aircraft type or system defaults.
5. If a different type aircraft is shown, turn the large SELECT knob to scroll down and highlight the "Aircraft" line.
6. Press GOTO to bring up a list of aircraft profiles
7. Turn the large SELECT knob to scroll down to the aircraft that most closely matches the one you will be flying.
8. Press GOTO to activate the aircraft profile and return to the ADAPTATION screen.

If you would like the VIPilot to always start with a particular aircraft, do the 5 steps listed above and then:

9. Turn the large SELECT knob to scroll down and highlight the "Config" which at startup is always set to "CONFIG".
10. Press the ID button to allow saving (and/or in other uses, renaming).
11. Turn the large SELECT knob one click to the right to select "CONFIG" as the target name.
12. Press GOTO to save the new configuration.
13. Since you plan to overwrite a file, the system will ask you to confirm the request. Press GOTO once more to complete the saving operation and return to the ADAPTATION screen.

DEFINING YOUR OWN AIRCRAFT CHARACTERISTICS:

If your aircraft is not listed in the VIPilot, defining the aircraft characteristics is not difficult. Most of the aircraft parameters may be taken directly from the aircraft flight manual. The PitchScale should be adjusted during a short flight.

The following characteristics are generally available in the flight manual (note: if the flight manual gives these numbers in miles per hour, convert to knots by dividing by 1.15). Replace the following numbers with those of your aircraft type:

SpeedNe	186	Vne - Never exceed speed
SpeedNo	149	Vno - Maximum structural cruising speed
SpeedFe	98	Vfe - Maximum flap extend speed
SpeedSi	62	Vsi - Stall speed flaps up
SpeedSo	54	Vso - Stall speed flaps down
SpeedVy	88	Vy - Best rate of climb speed
SpeedVa	116	Va - Maneuvering speed
CruiseSpeed	107	Normal cruise speed

The "V" speeds are used to paint the dashed line circles on the attitude indicator. The yellow, green, red, and white speed markings representing the indicated airspeed between pairs of these critical values. Note that these markings are only correct when an accurate wind vector is entered in the VIPilot.

The "normal cruise speed" is the indicated air speed at which the artificial horizon should be centered during normal cruise at low altitude.

PitchScale 30 Pitch scaling factor

This factor depends on the shape of the aircraft wing. It is most easily set by slow flying straight and level and adjusting the factor until the pitch on the VIPilot attitude indicator agrees with the aircraft's built in attitude indicator.

The procedure to generate a new aircraft characteristic is as follows:

1. Press the MENU buttons (NAV and DATA) simultaneously.
2. Turn the large SELECT knob to highlight ADAPTATION
3. Press GOTO and the general adaptation will be shown.
4. Turn the large SELECT knob to highlight the "Aircraft" line.
5. Press the DATA button to list the details of that profile.
6. You may now scroll down and highlight any of the aircraft parameters with the large SELECT knob and adjust its value with the large VALUE knob.
7. When you are happy with the values, press the DATA button to return to the ADAPTATION MENU with "Aircraft" still highlighted
8. Press ID to create a new profile.
9. Enter the aircraft type (up to 8 characters) using the small SELECT knob to highlight each characters and the small VALUE knob to choose a character from the set of 0-9, A-Z, _(underscore). The name used will be each character starting from the left until the first space. The remaining characters are shown to allow entering the characters in any sequence.
10. Press the GOTO button to save the new profile. Note: if the type aircraft name already exists in the system, you will be asked if you want to overwrite that file. If not, simply change the name and try again. Of course you may abort the whole procedure with the NAV or DATA buttons as described later.

You may continue with steps 9 through 13 of the INITIAL SETUP if you wish to make this your default aircraft.

Note: Any of these values may be changed at a later time. For example, to determine the "PitchScale" value in flight:

1. Press the MENU buttons (NAV and DATA) simultaneously.
2. Turn the large SELECT knob to highlight ADAPTATION
3. Press GOTO and the general adaptation will be shown.
4. Turn the large SELECT knob to highlight the "Aircraft" line with your type aircraft selected.
5. Press the DATA button to list the details of that profile.
6. Turn the large SELECT knob to highlight "PitchScale"
7. Slow fly the aircraft straight and level and turn the VALUE knob until the pitch on the VIPilot attitude indicator agrees with the pitch of the aircraft as shown on the aircraft's built in attitude indicator.
8. Press the DATA button to return to the ADAPTATION screen with "Aircraft" still highlighted.
9. Press the ID button to allow saving (and/or in other uses, renaming).
10. Turn the large SELECT knob one place to the right to select the old name.
11. Press the GOTO button to start the save. Then press the GOTO button again to confirm that you want to overwrite the old value.

12. Press the NAV button to return to normal flight operation.

B. ADAPTATION IN GENERAL

Aside from changing aircraft as described above, there is very little that need be done with adaptation. However, the VIPilot has been designed so that the pilot may change a number of parameters to suit his/her taste. A consistent set of controls is used for these changes so that the procedure for change will quickly become intuitive.

Two sub-categories of adaptation have been set aside from the general adaptation because they are usually changed as a group. You have already been introduced to one of these sub-categories, the aircraft characteristics. The second sub-category is the display appearance.

There are three types of screen available during adaptation. The ADAPTATION screens allow the pilot to modify the values of each item. The SAVE screen allow saving and/or renaming of adaptation. The LIST screen allows the selection, deletion and/or renaming of adaptation or recorded data files.

The controls available to modify adaptation in general or sub-category are as follows:

Large SELECT knob	Step through and scroll to select an item
Large VALUE knob	Change value (blue brightness for color)
Small VALUE knob	Change value (green brightness for color)
Small SELECT knob	Change value (red brightness for color) or select name digit
DATA button	Toggle between general and other screens
GOTO	Select a name or confirm deletion from list
ID	Save and/or rename general or named sub-category

DIGIT (ID & RNAV)	Change individual characters of name
RNAV	Delete an unused name from list (must confirm)
NAV	Return to normal navigation
PANIC	Return to normal navigation with AIM figure

Note that the DATA, GOTO, ID, DIGIT, and RNAV buttons only apply to named adaptation and recorded data. Any action in the SAVE or LIST screen is ignored unless the GOTO button is pressed (i.e. - you can change your mind by pressing the DATA, NAV, or PANIC button).

C. GENERAL ADAPTABLE PARAMETERS

MaxRange	500	limit navigational aids to this distance
Config	CONFIG	current general adaptation file
Aircraft	C172	currently selected aircraft characteristics
Display	DAY	currently selected display characteristics
PathData	DEFAULT	flight path data
SimData	PATTERN	currently selected playback file
Starttime	0	seconds into recorded file to start replay
ClimbSmooth	3	number of seconds to average for vertical velocity
StdClimb	500	standard rate of climb
Glideslope	3.0	simulated ILS glide slope
Threshold	35	simulated ILS threshold crossing height
Taximax	20	max taxi speed knots - disables attitude
Magnetic	T	use magnetic heading
Playloop	T	loop playback
Maneuver	10	seconds to announce path maneuver

SafeAlt	2000	feet above airport for panic
AptHot	10.0	distance checked each second for near airports
AptWarm	100.0	distance checked in groups of 4 for near airports
MarkHot	10.0	distance checked each second for near markers
MarkWarm	100.0	distance checked in groups of 4 for near airports

Notes:

MaxRange - The full complement of navigational aids (Over 40,000) are loaded into the VIPilot. In order to reduce the number of navigational aids that the pilot might select from, any navigational aid more distant than MaxRange from the aircraft is hidden from the pilot.

These aids are updated by the FAA every 56 days and may be downloaded from the VIPilot website. As of May 2003 there were:

5,027	Public Airports (APT)
14,530	Public Airport Runways
2,322	Non-Directional Beacons (NDB)
1,327	Vector Omni-Ranges (VOR)
30,769	Fixes on charts (FIX)
1,415	Instrument Landing Service (ILS)
2,059	Marker Beacons

Config - Whenever the VIPilot is turned on, it is configured according to the "config" adaptation. However, the pilot may define any number of configurations.

Aircraft - Aircraft characteristics as discussed earlier in this document

Display - Display colors and line widths as discussed later in this document.

PathData - The name of the current PATH.

Simdata - The pilot may select which recorded flight to play back. While flight recordings may be given any name, the list of recordings also includes the date, time, and time duration of each flight.

Starttime- This feature was added to the VIPilot so that we could replay any portion of a flight from a given point. But you may use it to examine a specific part of your flight. The Starttime is given as the number of seconds into the flight.

Climbsmooth - The WAAS reports altitude in increments of 0.1 meter. A single digit difference over 1 second translates into a difference of 20 feet per second in vertical velocity. We call this quantization noise error. The altitude error will also change as different satellites come into view. By averaging the altitude changes over n seconds, we reduce the noise by a factor of 1/n. Unfortunately, this also increases the latency. However, even with a setting of 9, the latency will be less than the 6-9 seconds found most aircraft vertical speed indicators.

StdClimb - Rate of climb allowed for autopilot

Glideslope- Each runway may be used to generate a simulated ILS approach, including glide slope, compass locator, and three marker beacons. The glide slope used (which is currently 3 degrees for the majority of FAA defined approaches) may be set here.

Threshold - The combination of the Threshold height and the Glideslope determine the touchdown point on the runway. For example, a Glideslope of 3.0 degrees and a Threshold of 35 feet implies a touchdown point 668 feet down the runway. The value of 35 feet should allow for WAAS error, but should be increased by the height of any known obstructions near the start of the runway.

Taximax - The Taximax value is used to turn off the attitude indicator while taxiing. The Taximax value should be set significantly lower than the aircraft stall speed of the aircraft. Otherwise you risk losing any pitch indication when slow flying upwind with the wind vector turned off.

Magnetic - If T (True), the compass rose reads in degrees magnetic (preferred). If F (False), the compass rose reads in degrees true.

Playloop - If T (True), when recorded data reaches the end of the data, the play will repeat until it is stopped manually.

Maneuver - Seconds in advance of a maneuver that the "Aim" figure will alert the pilot when the autopilot is path following or landing.

Apthot, Aptwarm, Markhot, & Markwarm - have been optimized for general system performance. There is currently no reason to change these values.

D. DEFINING YOUR OWN DISPLAY APPEARANCE:

As with aircraft types, you may define any number of display appearance sets. Two display appearance files are provided with the VIPilot, "Day" and "Night". The pilot has control over:

	Red Green Blue	
col_select	155 255 155	highlighted text fields
col_panel	255 255 235	attitude background panel
col_base	255 255 255	text panel background
col_digit	100 100 255	single character select when using digits
col_sky	225 225 255	sky color in attitude indicator
col_port	180 180 180	border color for attitude indicator

col_horiz	190 190 190	ground color in attitude indicator
col_bank	255 255 255	bank angle markings
thick_bank	3	thickness of bank
thick_rate	2	thickness of standard rate angle line (dots)
col_std_rate	255 200 0	color of standard rate angle line
col_high_spd	255 230 0	color of yellow arc (Vno to Vne)
col_speedne	255 0 0	color of never exceed speed (Vne)
col_norm_spd	0 255 0	color of green arc (Vsi to Vno)
col_flap_spd	255 255 255	color of white arc (Vso to Vfe)
col_speed	255 0 0	color of air speed circle
col_compass	0 0 255	color of compass rose markings
col_bug	255 200 0	color of bug
col_aim	255 0 255	color of "aim" figure
col_vor	255 0 255	color of VOR vector
col_adf	0 255 255	color of ADF vector
col_wind	0 0 255	color of wind vector
col_crit_spd	0 0 0	color of critical speed circles (Vne, Vno, ...)

With the exception of the thick_bank and thick_rate, each of these adaptation parameters represents a color. Colors are expressed in terms of red, green, and blue components; each having a value from 0 to 255 where 255 is the brightest. Text characters (except the compass rose) are always black. There is also a lower limit on the combined brightness of the three colors in col_base and col_select so that the pilot can not inadvertently adapt the system so that the menus are unreadable.

The resultant colors will be visible on the VIPilot as they are adjusted with the exception of the first 4 items. These items are fully implemented when the pilot returns to the ADAPTATION MENU.

X. BAG-ABLE

There is one fault with the VIPilot that needs discussing.

In an attempt to develop a system that would not become obsolete overnight, we chose to use commercial, off the shelf devices as much as possible. The feeling is, that whatever we put together, something better will come along shortly. Those feelings proved true, as it was well into the development phase that a graphic display became available that could be seen in daylight and a processor came along that was not oppressive in size or weight. Our product is essentially the switch box and the software. A minor modification was made to the power inverter to reduce the number of connectors involved.

But the system still has too many wires. Perhaps some day there will be a small data tablet available that is bright enough to see in daylight and contain some backup power.

Please be careful with the wires. Cockpit management is very important to flight safety. Make sure that the wires will not interfere with the flight controls.

The wires can also represent a problem when stowing and deploying the equipment. Wire straps found on three of the wires should be used. The following procedures will speed up storage and deployment as well as help avoid a tangle of wires.

WARNINGS:

1. IMPROPER STOW OF DISPLAY MAY DAMAGE SCREEN SURFACE.

2. LACK OF VENTILATION MAY DAMAGE HARDWARE.

We suggest you take the time to practice storage and deployment a few

times before you use the VIPilot for the first time. It will make your cockpit management task much easier.

We generally store the unit in its carry bag with the switch box connected to both the RS-232 connector and the USB port as well as the display connected to the VGA port. Looking at the bag with the handle toward you.

A. STORAGE

1. Unplug the main power cable from the aircraft.
2. The processor is placed in the bag in the back right corner, button side up, with the VGA, RS-232, and USB connectors to the left. The power plug is removed from the processor.
3. The WAAS antenna is unplugged from the switch box, the wire coiled in a 5-6" diameter and the tie fastened.
4. Place the WAAS antenna on its side on the left front of the bag and lay the wire coil on top of the processor.
5. Lay the display power cable next to the VGA cable starting from the display to where it joins the main power cable. Then lay the main power cable back toward the display (it will extend beyond). The three wires are then coiled together starting from where the display power wire joins the main power cable in a 5-6" diameter. It may be necessary to twist the display in order to coil the wire. Tie the coil and place above the previous coil and place above the processor. Place the Adapter in the front of the bag.
6. Coil the switch box cable to a 5-6" diameter and tie fastened. Zip the bag on the right side. Slide the switch box in, knobs up with the wire toward you. Then place the coil on top of the other coils over the processor.

7. Slide the display into the bag with the screen side up. This is very important since the bag contains a plexiglass sheet in the top to protect the screen surface. Dress any remaining wire into the bag and zip the remaining two sides.

B. DEPLOYMENT

1. Place the Bag where it will remain and unzip the top.
2. Remove the switch box, unfasten the tie, and extend the wire to place the switch box where it will be used.
3. Remove the display, unfasten the tie, and extend the wire to place the display where it will be used (we usually Velcro it to the switch box). It may be necessary to twist the display as the wires are extended.
4. Separate the main power cable from the display and display power cables and place it near the cigar lighter outlet. Plug the main power cable into the cigar lighter outlet.
5. Remove the WAAS antenna, unfasten the tie, and uncoil enough cable from the plug end to reach from where the antenna will be located (usually under the front windshield) to the switch box. Refasten the tie if many coils remain. Plug the cable into the switch box.
6. Plug the Adapter into the processor. Be sure that the plug and wire are between the processor and the adapter as that guarantees space for airflow, which enters the processor through the holes near the power outlet.
7. Plug the main power cord into the cigar lighter outlet. Turn the power on to the display first. Then press the button on top of the processor. Make sure that the processor top and power outlet sides remain unobstructed to allow airflow.

XI. Appendices

A. Appendix A - Accuracy

1. Range-Bearing Accuracy

A word about accuracy: The VIPilot is calculation intensive. Every time the pilot switches to set the ID or type of a navigational aid, the type database is resorted by distance either from the current location, or in the case of a path, the previous node in that path. When the pilot selects a navigational aid alphabetically, the database is sorted by ID and upon completion, resorted by distance.

There are mathematical procedures that yield extremely accurate results. The oblate spheroid shape of the earth may be dealt with using techniques such as Transverse Mercator Projection. A simpler model gives a good approximation for global transportation by assuming a spherical earth and performing great circle calculations.

For the purposes of the VIPilot, the average heading between any two points is used. The error associated with this simplification increases as we head away from the equator. At the latitude of New York or Chicago, the heading error on a 140 nm segment in an east west direction may be as much as 1 degree. The accumulated error of such a path is about 0.7 nm or 20 second per hour of flight. In general, navigational aid locations are chosen at about half that distance resulting in insignificant error.

2. WAAS Accuracy

The Garmin WAAS boasts an accuracy better than 3 meters 95 % of the time when traveling at 0.1 knots. The processor receives messages from the WAAS once per second. A typical small aircraft traveling at 100 knots will travel 51.44 meters in one second. Clearly, by the time the position appears on the screen, the least significant digit will have changed by 2 or 3 steps. We are dealing with old information.

Fortunately, for the purpose of other instrumentation, aircraft trajectories do not change very fast. There is little lost in dealing with one-second old information as long as that information is regular.

At times, if the WAAS signal is not available, the Garmin receiver continues in GPS mode. The accuracy is then degraded to better than 15 meters 95% of the time when traveling at 0.1 knots. This will have little effect on the Latitude-Longitude readout, but is very likely to show up as noise in the attitude indicator. Not to worry, we have flown the VIPilot with a regular GPS unit and found that it was still quite flyable. However, should your VIPilot indicate "GPS" rather than "WAAS", please be aware that we have seen an additional 100-foot error in terms of altitude.

B. SCREEN HIARCHY

Product Disclaimer

Instrument Display (top window)

NAV

Data

Runway Selection

Path

Start /Stop / Hold & Search Patterns

Path Data

Path Menu

Select

Delete

Save / Rename

Menu

Adapt

Select

Delete

Save / Rename

Aircraft

Colors

WAAS Map (top window - only with Menu)

WAAS Data (top window - only with Menu)

Aerial View

Statistics

C. APPENDIX C – SEARCH PATTERNS

As with holding patterns, all turns in search patterns are generated using standard rate turns (3° / second). At 94 knots, that results in a half-mile radius turn. The search patterns are defined as follows:

Trackline pattern - fly parallel to a specified flight path at a distance of one turn radius to the side. At the end of the flight path, make a standard rate turn and fly parallel to the flight path in the reverse direction and on the other side of the flight path.

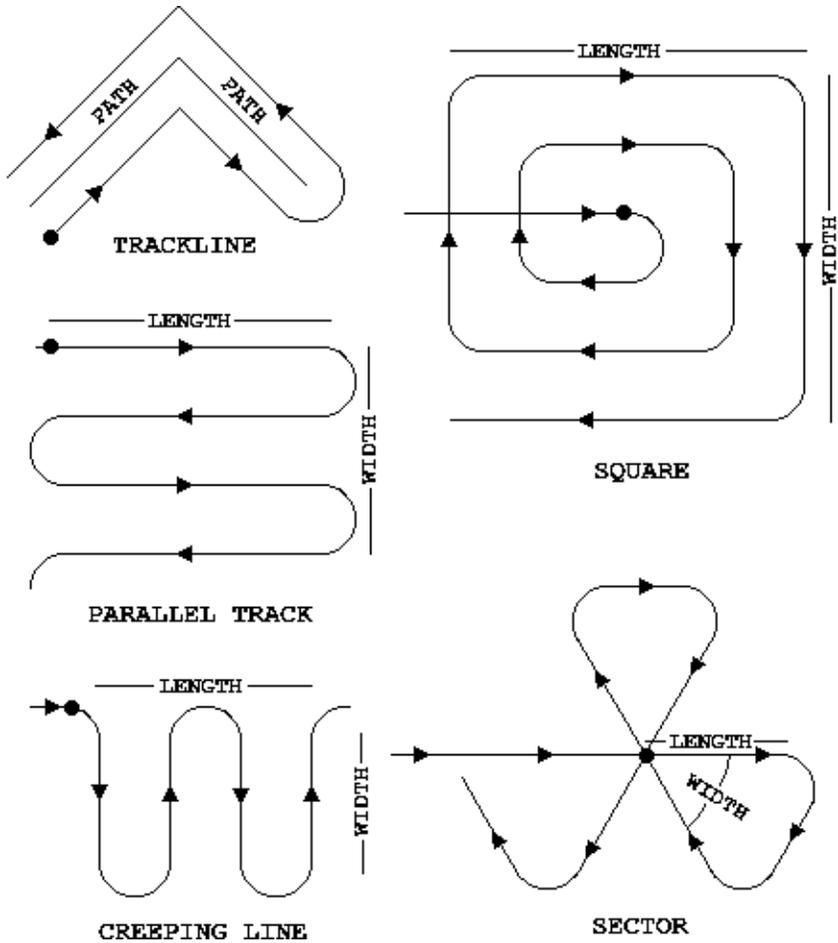
Parallel Track pattern - fly from the start point in the specified direction for a specified length. Then do a 180° turn and fly parallel to the first leg at a distance equal to two radii until adjacent to the start point. Then do a 180° turn in the opposite direction. That places the aircraft four radii from the start point. Repeat the process until the specified width is covered.

Creeping Line pattern - this is identical to the Parallel Track pattern except the specified direction is now perpendicular to the direction of each leg. The words "length" and "width" are also interchanged.

Square pattern - this pattern consists of concentric squares or rectangles. The size of the square (or smaller dimension of the rectangle) is an odd number of radii. Fly from the start point in the specified direction for a distance "a" equal to the difference between length and width (zero for a square). Then turn 180° and fly the same distance "a" in the opposite direction. Then turn 90° and fly a distance "b" of two radii. Then turn 90° , increase the distance "a" by two radii and fly the distance "a". Repeat, alternating between "a" and "b" distances, each time increasing the distance by two radii until the specified area is covered.

Sector pattern - this is a pie shaped pattern, starting from the center in which the aircraft flies triangular wedges of the pie, crossing over the

center at the completion of each wedge until the entire circular area is covered. In this case, the length refers to the radius of the circle and the width represents the angle of the pie shape covered by each triangle. The maximum and minimum width will be determined by the length and turn radius values.



D. APPENDIX D – KEY / MOUSE SIMULATION

The VIPilot is intended for use without benefit of mouse or keyboard. However, the operating system may, on rare occasion, pop up another application window or maintenance alert. Without a mouse or keyboard, the pilot would have no way to close the pop-up. In addition, the pilot may want to perform other PC related tasks.

For these reasons, a method has been provided in which the pilot may suspend VIPilot operation and use the control box to simulate a mouse and keyboard. To suspend VIPilot operation, go to the INTRODUCTION screen (either by MENU selection or pressing ID and PANIC simultaneously) and press the DATA button. The VIPilot screen will be minimized and the control box functions will be as follows:

NAV Button	Restore VIPilot operation
Small SELECT Knob	Move cursor in x direction (longer)
Large SELECT Knob	Move cursor in y direction (shorter)
DATA Button	Left mouse button
PANIC Button	Right mouse button
Small VALUE Knob	Select a keyboard key
Large VALUE Knob	Normal, Control, or Shift keys
RNAV Button	Press the selected keyboard key
ID Button	Press the Back Space key
GOTO Button	Press the Enter key

During suspended operation, the currently selected keyboard key will be displayed on the VIPilot icon on the taskbar.