

Pro Pilot



Operation and Installation Manual

Trio Avionics Corporation

Version 3.8

Notice: This manual uses illustrations that generally show the Pro Pilot model that mounts in a standard 3-1/8" round cutout in the instrument panel. However, all functions are duplicated in the stack mount version of the Pro Pilot. The instructions herein are valid for both systems with the following exceptions:

- The stack mount Pro Pilot requires an external power switch or breaker.
- The stack mount Pro Pilot does not include a slip-skid indicator

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Pro Pilot Control Head Diagram



H NAV - Horizontal Navigation (Activates/Deactivates Roll Servo)
V NAV - Vertical Navigation (Activates/Deactivates Pitch Servo)
H MODE - Sequences through Horizontal Navigation Modes
V MODE - Sequences through Vertical Navigation Modes

Chapter 1

Horizontal Navigation Overview (HNAV)

The **H NAV** function of the Pro Pilot controls the roll axis servo for attitude correction (wing leveling) and provides horizontal navigation using signals from a GPS receiver or EFIS system.

GPS Requirements

The Pro Pilot does not contain a built-in GPS or other navigation data source. It is necessary that an appropriate host GPS source be supplied and correctly connected to the Control and Display Head at the time of installation. (See the Installation Instructions later in this manual.)

The Pro Pilot uses a solid-state inertial rate sensor for attitude stabilization. It uses elements of the host GPS digital data stream for the navigation function. It accepts either a NMEA 0183, V2.XX stream format or the Aviation Link format for navigation guidance. An ARINC 429 upgrade is available to enable the GPSS and GPSV options.



Note: The Pro Pilot also uses the GPS derived information to monitor the inertial sensor performance and provides automatic corrections to the sensor data to correct for drift due to thermal shifts, inherent sensor drift and noise errors. The Pro Pilot has a flash based EEPROM memory that is updated automatically with the most current dynamic calibration information during each flight.

Operation

While the Pro Pilot is an excellent “wing leveler,” its greatest strength is following an active flight plan from a GPS source. This can be as simple as a “GOTO” a waypoint as commanded by the GPS, or a complex, multi-segment flight plan.

Three horizontal navigation modes allow the pilot to follow a selected GPS course or flight plan.

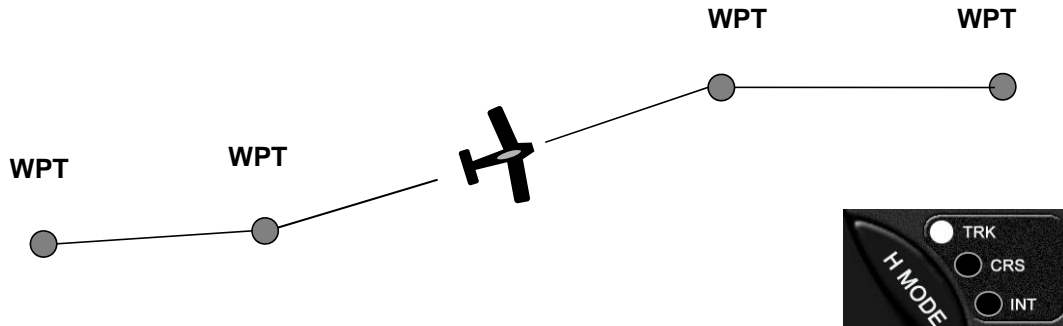
Basic H NAV Operation Modes

The capabilities of the **H NAV** system comprise four basic modes:

- 1.) Track Mode tracks a GPS directed flight plan courseline.
- 2.) Course Mode tracks a pilot directed heading.
- 3.) Intercept Mode flies the airplane back to a previously entered courseline.
- 4.) When directed, execute a 180 degree course reversal

Track Mode (TRK)

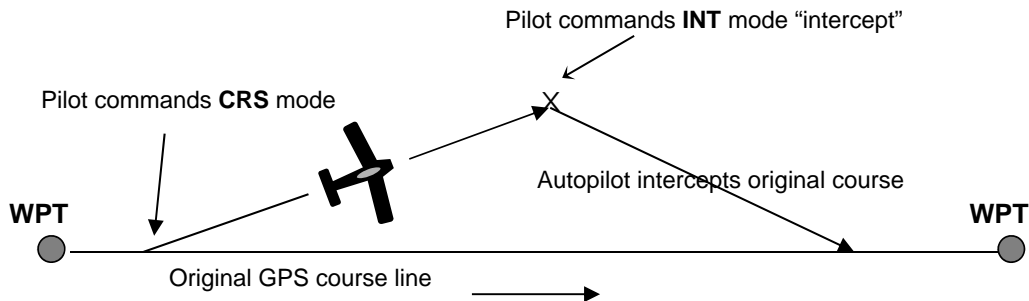
The track mode (**TRK**) is used for automatic tracking of a GPS flight plan. It is also used to “GOTO” a waypoint directly as selected in the GPS.



Course Mode (CRS)

The course mode (**CRS**) allows tracking a pilot selected course in lieu of a GPS route or GOTO waypoint. The **CRS** mode uses the GPS to provide heading information for the aircraft's ground track. This mode is useful for avoiding restricted airspace, weather, oncoming air traffic and following ATC directed vectors.

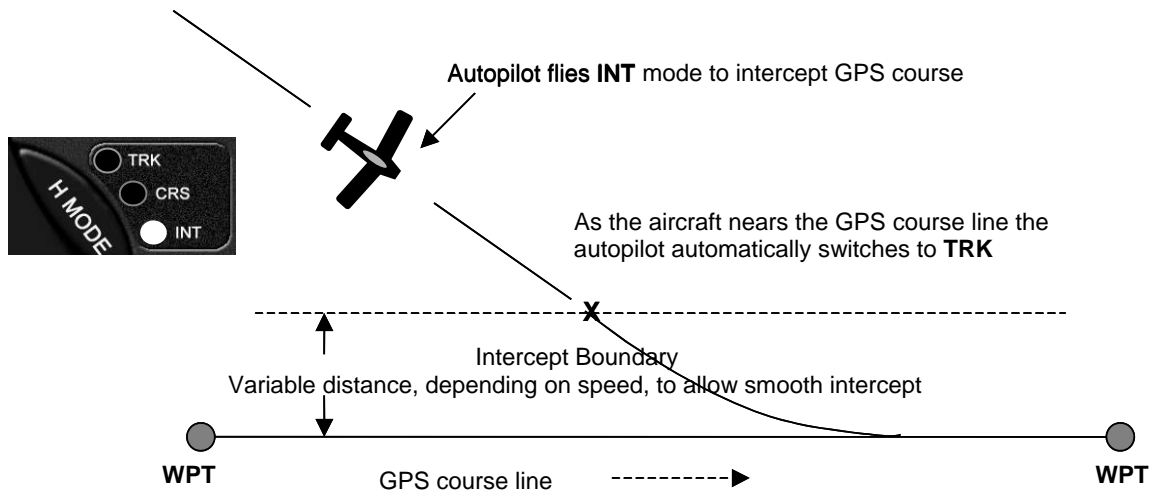
In this mode, the rotary encoder switch is used to change the commanded course.



Hint: An alternative method of using the **CRS** mode is in conjunction with the Pilot Controlled Steering (PCS) mode of operation (see pages 30 & 31).

Intercept Mode (INT)

The intercept mode is used to intercept or regain the original flight plan track for some reason, such as when you have flown some distance from your intended flight plan and wish to return to it.



In both the **CRS** and **INT** mode, the ground track heading may be changed by rotating the encoder knob or using the **PCS** steering mode of operation.

- In the Course (**CRS**) mode, rotating the encoder clockwise causes a course change to the right. Counterclockwise rotation will cause a course change to the left. The course will change by 1 degree per "click" of the encoder, or, if rotated briskly, will change the course by several degrees during rotation
- In the Intercept (**INT**) mode, the intercept angle to the original track may also be changed by rotating the encoder. The intercept angle will change in the direction that the encoder is rotated (as above). The Pro Pilot will automatically switch from the **INT** mode to the **TRK** mode as it crosses the intercept boundary.

Chapter 2

Vertical Navigation Overview (VNAV)

The **V NAV** function of the Pro Pilot controls the pitch axis of the aircraft. It provides commands to the pitch servo that attaches to the elevator control system. The **V NAV** system uses a rate gyro, pressure sensors, airspeed sensors and accelerometers as primary references in controlling the pitch attitude of the aircraft. The V NAV system does not depend upon a GPS signal for its functions.

Operation

While the Pro Pilot also has several vertical functions, the basic mode is that of “**ALTITUDE HOLD.**” A manual climb to altitude desired and a single press of the **V NAV** button will engage the pitch servo and maintain that altitude.

Three vertical navigation modes allow the pilot to maintain altitude, climb/descent at a selected vertical rate (in feet per minute) and preselect a target altitude. An additional pilot controlled steering capability allows the pilot to choose airspeed instead of vertical speed for the climb/descent by use of a button on the stick or yoke.

Basic V NAV Operation Modes

The capabilities of the **V NAV** system comprise three basic modes:

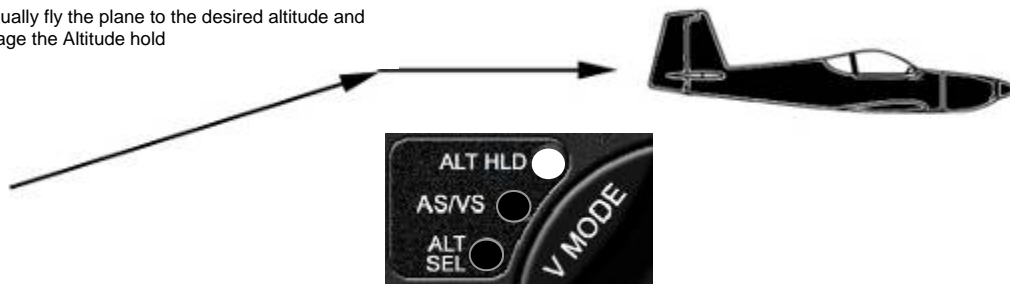
1. Altitude hold
2. Vertical climb and descent rates, and airspeed capture and control
3. Altitude pre-select, which can be used in conjunction with the vertical modes

Minimum and maximum safe airspeed management modes are also included to prevent stalling and over-speeding the aircraft.

Altitude Hold

To operate the altitude hold, fly to the desired altitude and level the aircraft in trim. Press the **V NAV** button to engage the pitch servo and the aircraft will hold at that altitude. Press the **V MODE** button and then rotate the encoder knob for minor adjustments to accommodate barometer updates.

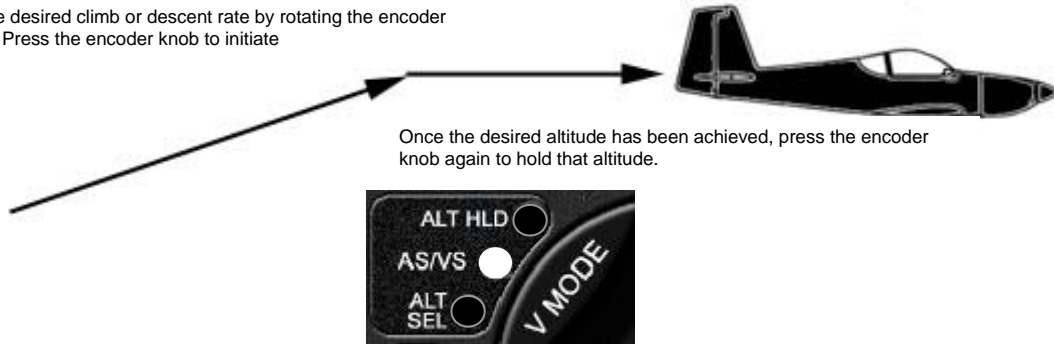
Manually fly the plane to the desired altitude and engage the Altitude hold



Vertical Climb/Descent

The Pro Pilot also allows the pilot to select a desired climb or descent rate (i.e. **VS** (vertical speed), in ft. per minute). Press the **V MODE** button again and:

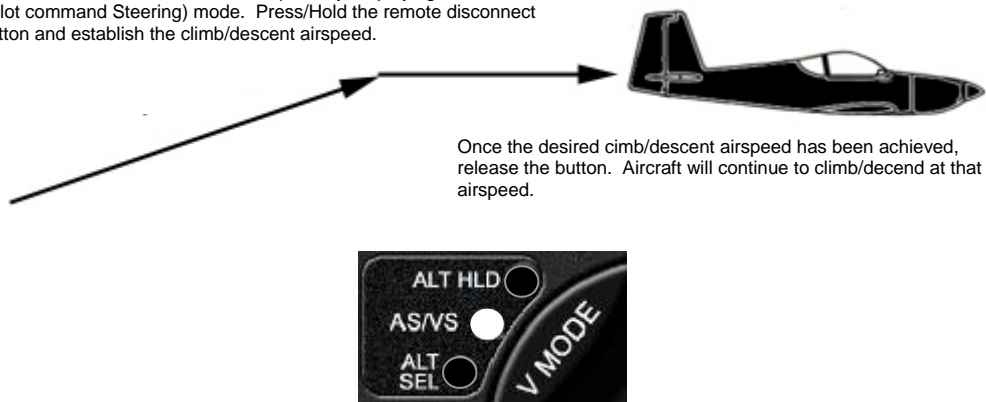
Set the desired climb or descent rate by rotating the encoder knob. Press the encoder knob to initiate



Airspeed Capture and Control (using PCS)

During climb and descent the desired airspeed can be adjusted using the **PCS** (Pilot Command Steering) mode (see page 31). After the airspeed has been captured the airspeed can be increased by rotating the encoder clockwise, or decreased by rotating the encoder counterclockwise. This feature can be useful to ensure adequate cooling of the engine during climb.

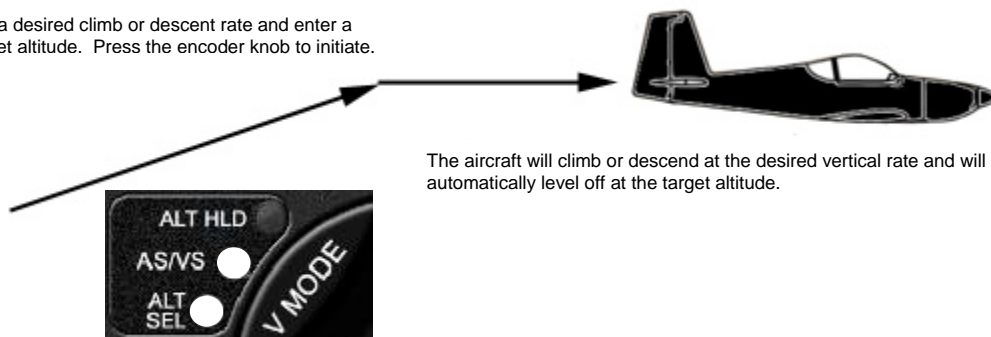
Set the desired climb or descent airspeed by employing the PCS (Pilot command Steering) mode. Press/Hold the remote disconnect button and establish the climb/descent airspeed.



Altitude Pre-Select

The Pro Pilot adds the ability to climb or descend to a pre-selected a target altitude. Press **V MODE** to advance to Altitude Select (**ALT SEL**). Rotate the encoder knob to select target altitude.

Set a desired climb or descent rate and enter a target altitude. Press the encoder knob to initiate.



Chapter 3

Control and Display Overview

The control and display unit is designed to fit in a standard 3 1/8 inch instrument cutout in the instrument panel and requires approximately a 7 inch clearance behind the instrument panel. The unit is powered from the airframe +12V DC system. +28V DC systems are also available. All controls are located on the front panel.

Switch Function and Operation

ON/OFF Switch

The **ON/OFF** switch applies aircraft power to the Pro Pilot. In the **OFF** position, the Pro Pilot is disconnected from the aircraft control system. It is recommended that the Pro Pilot be turned on immediately after engine start. Upon power up, the display presents a logo and the current Pro Pilot firmware code version (or a customized screen) and sets several default conditions as follows:

Upon power up, the screen will display the un-calibrated field elevation (if the aircraft is on the ground) or un-calibrated altitude (if the aircraft is flying). The value is expressed in feet.



BARO SET
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The pilot must adjust this value to agree with the primary aircraft altimeter, which has been previously adjusted to the reported barometer setting.

Once the Pro Pilot altimeter has been adjusted, pressing the encoder knob will enable the navigation screen.

Operation

Initially, with GPS data available, the **TRK** (Track) mode is selected and the **TRK** LED is illuminated. This mode is not fully operational until valid GPS data is available. When GPS is unavailable for seven seconds, or after initial power up, the display will default to a flashing "**NO GPS**" message.

NOTE: No H MODE LEDs will illuminate until valid GPS data is available.

Without GPS input, the autopilot will still function as a wing leveler and the rotary encoder can be used to initiate turns to the left or right or to correct airplane heading drift for straight ahead flight. Because the **V NAV** function does not rely upon GPS, the altitude hold system will be unaffected.

Once GPS data is present and validated, full navigation functionality is available and the **TRK** LED will illuminate.

If no flight plan or "GOTO" waypoint has been selected in the GPS receiver, a "**NO FLTPLN**" message will appear and the course mode (**CRS**) is automatically selected (**CRS** LED illuminated).

All servo power is initially off on power up and the Pro Pilot is disconnected from the aircraft control system.

H MODE and V MODE buttons

The **H MODE** switch controls the selection of the **TRK** (track), **CRS** (course) and **INT** (intercept) modes. With GPS data present, the default mode during power up is **TRK**.



Pressing the **H MODE** switch repeatedly advances the display screen from:

TRK ---> CRS ---> INT and then back to **TRK**.

The appropriate LED illuminates in each mode.

⚠ No **H MODE** LEDs will illuminate until valid GPS data is available.

At any time while in the **INT** mode, the pilot may transition to the **TRK** mode, or through **TRK** to **CRS** mode, by pressing the **H MODE** switch.



The **H NAV** button also provides the “**AUTOMATIC COURSE REVERSAL**” feature which does an automatic roll servo engagement and ground track reversal. Please see page 27 for operation instructions for this feature.

The **V MODE** switch controls the selection of the **ALT HLD** (altitude hold), **AS/VS** (airspeed/vertical speed), and **ALT SEL** (target altitude set) modes.



Pressing the **V MODE** switch repeatedly advances the display screen from:

ALT HLD ---> AS/VS ---> ALT SEL → BARO SET.

The appropriate LED illuminates to signify data has been changed or entered on that screen. The **ALT HLD** LED is illuminated when the altitude hold mode is active, or the **VS** mode is active and the vertical rate is set to zero. The **ALT HOLD** mode LED will flash to indicate that an executed fine altitude adjustment is in progress.

Roll (H NAV) & Pitch (V NAV) Servo Activation

The **H NAV** and **V NAV** pushbuttons activate the roll and pitch servos, respectively. When the **H** or **V** LED is unlighted, the respective servo is inactive and that autopilot function is disconnected from the control system. When the LEDs are illuminated, the Pro Pilot is engaged and providing control signals to the Pitch and Roll servos.

The roll servo is activated (or deactivated) by pressing the **H NAV** pushbutton momentarily.

The pitch servo is activated (or deactivated) by pressing the **V NAV** pushbutton momentarily.

The servos may be operated independently of each other.



Remote Disconnect Switch

A remote servo disconnect switch (not supplied) is strongly recommended and should also be mounted on the aircraft control stick. Pressing the remote disconnect button momentarily will immediately disconnect both the pitch and roll servo, freeing the aircraft controls for manual operation. This same remote disconnect switch also provides an important additional functionality called Pilot Command Steering (**PCS**) which is used for both for horizontal and vertical navigation.

Note: While it is not recommended, the user may wire a separate remote disconnect switch for independent control of each servo. See the wiring diagram in the back of this manual.

Rotary Encoder - Pushbutton Switch

The black knob in the center of the control head implements three important functional control mechanisms.

1. It can be rotated for inputting or changing selections or inputs
2. Pressing the knob activates a momentary switch
3. In a single operation it may be pushed in and rotated at the same time.

Each of these provides varying functions, depending upon which mode of operation has been selected with either the **H MODE** or **V MODE** pushbuttons. Pressing the **V MODE** button will allow the encoder to change parameters associated with the altitude control, while pressing the **H MODE** button will allow encoder adjustment of functions associated with horizontal navigation.

The encoder switch is used in conjunction with the **CONFIGURATION** or **PREFERENCE** modes to change various settings. These are described in the setup menus (Chapter 9) of the manual.

The Display Arrow

An arrow is centered in the top line of the display. The arrow indicates which functions (**H MODE** or **V MODE**) the rotary encoder (and its pushbutton) will control when it is operated.



- When the arrow points to the left, the encoder will control the **H MODE** functions.
- When the arrow points to the right, the encoder will control the **V MODE** functions.

The **H MODE** or **V MODE** button, when pressed, will change the arrow direction and transfer encoder control to the appropriate mode.

NOTE: When switching the display/encoder from **H MODE** to **V MODE** the initial button press will simply change the direction of the arrow and some display parameters.

The encoder pushbutton switch performs a number of functions, depending which way the arrow is pointing. **It is important to note the direction of the arrow BEFORE initiating any encoder action to assure that the proper values are changed.**

H MODE Encoder Functions

- If the arrow is not pointing to the left, press the **H MODE** button



1 – Display Data Fields

The pushbutton of the encoder switch selects what data is presented on the upper right field of the display. Rotating the encoder pushbutton advances the **lower right** line variable display field through the available field selections. The selections are described beginning on page 20.

Pressing and holding the encoder button down, then rotating it, selects and adjusts the track offset parameter which will be displayed in the **upper right** variable display field (see function 3, below).

2 – Scan Mode

Pressing the encoder pushbutton switch rapidly two times in quick succession (double-click) will cause the variable field data in the right part of the lower line to “scan” (or scroll), providing a sequential display of the various GPS data elements being received.

The turn coordinator information is not provided in the “scan” mode; however, it is available in the upper right field (see Function 5 below).

Exit from the scan mode is accomplished by double-clicking the display button again. Whenever the **SCAN** mode is active a small dot will appear in the display in front of the lower right data field indicating the **SCAN** mode is active.

3 – Top Line Data Selection

To select the data that will be displayed in the right side of the top display line, the user may momentarily press the encoder knob. A press and release cycle will advance the upper right display field to the next display parameter. (Do not rotate the encoder – press only!)

NOTE: The **TOP** field (track offset position) is selected and adjusted by pressing, then holding and rotating the encoder knob (in the **H MODE** only).

4 – Track Offset Position (TOP) Control

In the **TRK** mode, the rotary encoder is used to set a Track Offset Position (**TOP**). The **TOP** field is selected and adjusted by pressing, then holding and rotating the encoder knob (This is only possible while in the **H MODE** display with the arrow pointing to the left). The display will change in one-tenth mile increments to the left or right to a maximum of three miles from the centerline.

5 – Ground track Adjustment

In either the course (**CRS**) or the intercept (**INT**) modes the rotary encoder is used to select the ground track that the autopilot is commanded to follow. Rotating the encoder changes the commanded course in one-degree increments per “click” of the encoder. Rotating the encoder quickly changes the course in larger increments. Rotating the encoder counterclockwise alters the

commanded course to the left, while rotating the encoder clockwise alters commanded course to the right. (This is somewhat comparable to a traditional “Heading Bug” function).

6 – Drift Correction (NO GPS mode only)

Rotating the encoder to the right or left allows the pilot to adjust roll TRIM either right or left by one trim count. *This is a very fine trim adjustment.* The upper right field in the display will provide a graphic display of the trim position while the switch is activated and for about two seconds after the encoder action is stopped.

If the GPS data to the Pro Pilot is unavailable, as indicated by a **NO GPS** warning, the encoder knob switch provides a method to turn the airplane to a new heading or stabilize the aircraft in a straight and level attitude. The pilot may monitor the rate of turn by observing the aircraft directional gyro or compass.

7 – Entering “PREFERENCES MENU”

Pressing and holding the encoder pushbutton for more than 3 seconds causes entry into the **PREFERENCES MENU** for adjusting the parameters and features for both the horizontal and vertical portions of the Pro Pilot. This feature is explained in Chapter 9.

V MODE Encoder Functions

- If the arrow is not pointing to the right, press the **V MODE** button



1 – Activate Climb or Descent

Press the **V MODE** button repeatedly to display the **VS SET** screen. Enter a climb or descent rate by rotating the encoder. Pressing the encoder will initiate the function.

NOTE: The servo must be engaged by pressing the **V NAV** button for climb or descent. If engaged, the flashing LED(s) will confirm the execution of the commands.

2 – Activate Climb or Descent to a Pre-Selected Altitude

Press the **V MODE** button repeatedly to display the **ALT SEL** screen. Enter a destination altitude by rotating the encoder. Rotating the encoder will increase or decrease the selected altitude in hundreds of feet. Pressing and rotating the encoder will change the display in thousands of feet. Pressing the encoder momentarily thereafter will first present the **BARO SET** screen to allow correction of current altitude. A second press of the encoder (or waiting for 5 seconds to timeout) will initiate the function.

An altitude correction can be made and the encoder pressed to activate the vertical profile. If the encoder button is not pressed, the autopilot will automatically activate the vertical profile several seconds after the last rotation of the encoder.

NOTE: The climb/descent rate will be at the vertical speed selected on the **VS SET** screen or, if none was entered, the system will use the default vertical rate that was previously entered in the **CONFIGURATION** menu.

3 – Altitude Control Functions

When the Altitude Hold is engaged, the encoder knob is used to make fine adjustments to the altitude. It is also employed to set a desired climb/descent rate when on the **VS SET** screen, and it is used to select a target altitude when it is on the **ALT SEL** screen.

4 – Setting the Barometric Altitude

The encoder is used to adjust the barometric altimeter (**BARO SET**) when required.

Chapter 4

Preflight Power Up

This section discusses what must be accomplished when “powering up” of the Pro Pilot, items to be checked and adjusted, and a flight example

On power up the Pro Pilot will briefly display the logo screen. This will be followed by a screen requesting verification of the current field elevation or altitude.

Note: The **TRK** LED is illuminated after the GPS signal is acquired and the **H NAV** servo is not activated (“**H**” **LED** is not illuminated). The aircraft roll control (ailerons) should be free and clear indicating the servo is disconnected from the control system.

A preflight check on the Pro Pilot at this point would be to engage the servo by pressing the **H NAV** pushbutton momentarily and noting that the “**H**” **LED** illuminates. The servo is now locked to the control system. Using the control stick or yoke, the pilot should intentionally force the ailerons to their extreme positions to verify that the slip clutch on the servo will allow the pilot to continue to fly the airplane in the event the servo malfunctions.

If this check is satisfactory the **H NAV** button should be pressed again to disconnect the autopilot from the controls. Verify that the LED is not illuminated and the servo is not engaged for takeoff.



Important: If all of the above actions cannot be properly achieved, turn the Pro Pilot off and do not attempt to engage the autopilot in flight. If there is any indication of an aileron control system problem do not fly the airplane until it has been corrected.

Since the GPS is not yet powered up, after about 7 seconds the display will show the **NO GPS** message.

The pilot now applies power to the GPS unit that is connected to the Pro Pilot and programs the GPS flight plan. On GPS power up, the display on the Pro Pilot may show navigation data momentarily on the display, as some GPS receivers will send sporadic GPS data. Typically, the **NO GPS** message will return as this data transfer ceases.

When the GPS receiver attains satellite acquisition and lock, the Pro Pilot will display the power up default screen previously illustrated.



Some GPS receivers, even though they have obtained satellite lock, do not put out valid NMEA or AVLINK data until a flight plan or “GO TO” waypoint is entered or a preset groundspeed is attained (usually 2 to 5 knots). In this case either the “NO GPS” message or the “NO FPLAN” message will be displayed.

Some GPS receivers’ output data are capable of providing ground track and groundspeed information to the Pro Pilot after satellite lock, even before a flight plan is entered. The Pro Pilot will detect this and provide the pilot with a modified **CRS** mode capability.

In this mode, manual transition to the **TRK** or **INT** mode is inhibited and **NO FPLAN** is displayed on the screen. In the **NO FPLAN** mode the pilot may use the autopilot **CRS** mode to fly a selected ground track. Once a flight plan has been entered the **TRK** mode is automatically selected.

The flight plan is now entered and activated in the host GPS unit. As the first “TO” waypoint becomes active the Pro Pilot will display the parameters associated with navigation to that waypoint. A check should be made to verify agreement between the data displayed on the Pro Pilot and the host GPS system.

Chapter 5

Information Fields

Horizontal Navigation (H NAV)

Pilot information for navigation is provided on a high contrast, bright Polymer LED (OLED), or an optional transfective LCD screen. Several fields on this display are multiplexed (i.e. they use the same display space to present different information). This allows the pilot to view all navigation parameters including digital rate of turn information. This section will explain in detail the horizontal navigational features and display screens available.

Power up Display

When the Pro Pilot is powered on a logo display is present showing the firmware revision operating in the unit. (This can be field programmed to present a personalized screen at power on).

Initial Logo Screen



The initial factory logo screen shows the product information including the firmware revision level and unit serial number in the extreme right part of the display (represented by the X's).



The purchaser may program a personalized logo screen. Each time the unit is turned on it will display this information. This information can be field re-programmed at any time by entering the **CONFIGURATION** menu screens (Chapter 7).

BARO SET Screen



When the Logo screen expires after a few seconds, the **BARO SET** screen will be seen.

No functions will be available until the altitude value is set and the encoder is pressed. The value should be set to agree with the primary aircraft altimeter, which has been corrected for current reported barometric pressure. The value may be changed in either five foot (**ELEVATION**) while on the ground or twenty foot (**ALTITUDE**) increments while in flight.

If GPS signals are present on the Pro Pilot interface the display will switch automatically to the navigation display. If no GPS signals are present the screen will change to show that **NO GPS** is being received on the interface.

NO GPS Screen



The "**NO GPS**" screen will display on power up if no GPS signal is present or if the GPS signal is lost for a period exceeding seven seconds.

In all cases the navigation display will return to normal automatically when the GPS signals are reacquired.

Note: There may be a delay of up to seven seconds in restoring the display after a GPS signal becomes active on the interface.

In the event the GPS signal is lost during normal area navigation, the "**NO GPS**" screen will be shown and the Pro Pilot will automatically go into the wing leveler mode and follow a "straight and level" course. In this mode, manual corrections to the dead reckoning track can be made using encoder knob.

No **H MODE** LEDs will be illuminated until valid GPS data is available.

Normal Power Up Display, GPS Active

On power up, once the **BARO SET** has been performed, the Pro Pilot defaults to the **H MODE** display and the **TRK** mode of operation when valid GPS data is available.



The image shows the Pro Pilot display with a good GPS signal present, and flight plan entered. Note that the “**H**” (**H NAV**) LED is illuminated.

This indicates that the roll servo has been activated by pressing the **H NAV** button and the Pro Pilot is providing horizontal navigation, having taken control of the roll axis of the aircraft.

To view and control horizontal functions at any time it is necessary to press the **H MODE** button one time to transfer encoder control to the **H NAV** functions. The mid upper arrow will point to the left. No navigational changes will occur.

Track Display Information

Bearing To Waypoint Field (BTW)

The bearing to waypoint (**BTW**) field is located on the left side of the top line as illustrated. This field is updated whenever the GPS data to the Pro Pilot is refreshed, normally once every one or two seconds, depending on the GPS interface data rate. (A GPS with NMEA data output generally updates once every two seconds, while an Aviation Data Link updates once every second). **BTW** is the exact magnetic bearing from the current aircraft position to the next GPS route waypoint.

Note: The line directly below the **BTW** data contains the current track (**TRK**) information (if these two numbers are identical, the aircraft is tracking directly to the destination waypoint regardless of the actual magnetic heading of the aircraft).

Ground track Field (TRK)



The ground track (**TRK**) field is located on the line directly below the “Bearing to Waypoint” (**BTW**). The **TRK** field is the current track over the earth based on the GPS updates every one or two seconds.

Variable Field, Top Line

The right side of the upper line of the display may be changed to present any data derived from the GPS available in the bottom line right field or an electronic rate of turn display. The factory default display is to present the information shown, but the user may wish to otherwise configure this segment. The top line variable field may be changed by repeatedly pressing the encoder knob while in the Track (**TRK**) mode. Rotating the encoder will change the variable field in the bottom line. “Double clicking” the encoder knob will cause the bottom line variable field to continually sequence through all available information. “Double clicking” again will exit the scan mode.

Cross Track Error Field (XTK)



BTW 025 +XTK<0.02
TRK 025 KLAX

Cross Track Error Field (**XTK**) provides a distance measurement in miles, tenths and hundredths of how far the aircraft is positioned either right or left of the desired track (**DTK**). The maximum value in this field is 9.99 miles.

A positioning symbol, immediately preceding the numerical data, indicates the "fly to" direction required to null this error.

- If this symbol has its apex to the left (<), the autopilot will fly to the left to eliminate the error.
- If the symbol has its apex the right (>) the autopilot will fly to the right to eliminate the error.



BTW 025 +XTK<0.02
TRK 025 KLAX

Here the aircraft is just .02 miles to the right of the desired track, so the autopilot will fly to the left to resume correct **DTK**.

Other Available Fields on the Bottom Line

The bottom display line, extreme right field is another variable field used to display other tracking data of interest to the pilot. The possible data fields displayed are:

- **GS** Groundspeed, closure speed to the destination waypoint
- **ETE** Estimated time en-route, in hours and minutes format
- **Ete** Estimated time en-route, in minutes and seconds format
- **RNG** Distance from the current "TO" waypoint
- **(WPT)** "TO" waypoint identifier *
- **(TC)** Digital graphic turn coordinator display *
- **DIS?** Distance tolerance error indicator
- **TRN?** Turn tolerance error indicator
- **SPD?** Speed tolerance error indicator
- **TOP** Track Offset Position indicator
- **VS** Vertical Speed mode indicator**
- **AH** Altitude Hold mode indicator**

* No associated label field displayed

** Shown if the VNAV servo is on



Each field above except the **DIS?**, **TRN?** and **SPD?** fields is selected by pressing the encoder pushbutton momentarily. The **DIS?**, **TRN?** and **SPD?** fields are automatically displayed to indicate GPS data anomalies.

The **ETE** or **Ete** label format is selected automatically by the autopilot. The **TOP** field will not be displayed if the **TOP** value is 0.00 (no offset).

Groundspeed (GS)



BTW 025 +XTK<0.02
TRK 025 GS 200

The **GS** (groundspeed) field indicates the aircraft speed over the ground in knots as provided by the host GPS system. This field has a maximum value of 999 knots per hour.

Estimated Time En-route, HH:MM (ETE)



The **ETE** (estimated time en-route) field shows the time to the current waypoint based on the *closing velocity* (NMEA link only) to the waypoint (which may be different from the groundspeed **GS/distance** calculation discussed above).

If the last "E" in the **ETE** label is in upper case the display format is **HH:MM**, hours and minutes. This is switched automatically between **HH:MM** and **MM:SS** (minutes and seconds) as **ETe** depending on the results of **RNG/GS** (distance/closing velocity) calculation.

Estimated Time En-route, MM:SS (ETe)



This field is identical to the **ETE** field except the format is **MM:SS** (minutes:seconds). This format is automatically displayed when the **RNG/CLOSING VELOCITY** calculation indicates the next waypoint is less than 60 minutes away.

Range to A Waypoint (RNG)



This field contains the distance remaining to the current "TO" waypoint with the least significant digit being in tenths of a mile. If the distance is over 100 miles the least significant digit is in units of nautical miles (*GPS NMEA serial data output is*

always in nautical miles, even though the GPS screen may be set to statute miles). This field is limited to a maximum value of 999 miles.

Waypoint



The waypoint identifier currently programmed as the "TO" waypoint is presented in this field. Up to six alphanumeric characters are available for this data field, allowing for

intersection and user waypoint identifications. This field will flash at a 2 pulses per second (PPS) rate for approximately 10 seconds when past the last waypoint in the route or past the last GOTO waypoint or if the aircraft is being flown more than 90 degrees away from the waypoint.

Digital Rate of Turn Display



A digital graphic representing the current yaw rate is presented to the pilot when this field is selected. The limit on this rate is approximately ± 4.5 degrees per second full scale.

On the turn rate display the 3 deg/sec rate is denoted by the tip of the arrow presented in the display line. The display shows a standard rate turn to the right.

Automatic Field Scan Mode

If the encoder knob is momentarily pressed two times in quick succession (double-clicked) the variable field will enter or exit the "Scan Mode." In this mode the data displayed is sequenced in the display at a 2.5 second rate. Additionally, it will also show the status of the altitude control functions when they are engaged.

This can be useful for sequentially monitoring all of the parameters put out by the GPS without having to select each parameter manually.

GPS Data Anomalies

DIS?



BTW 025 ←XTK<0.02
TRK 025 DIS?

DIS? is displayed in this field whenever the maximum distance in the GPS data stream is greater than 999 miles. Tracking functions are not affected by this condition.

TRN?



BTW 025 ←XTK<0.02
TRK 025 TRN?

The **TRN?** warning is displayed in this field when the Pro Pilot detects a negative closing velocity (going away from the “TO” waypoint).

This usually occurs when a waypoint greater than ± 90 degrees from the current waypoint is selected. No pilot action is required.


SPD?



BTW 025 ←XTK<0.02
TRK 025 SPD?

The **SPD?** warning field is presented to the pilot when the parameters in the GPS data stream indicate a condition that results in an overflow of the ETE computation.

Under normal operation, these conditions should not exist; however, momentary corruption of the GPS data during signal acquisition or waypoint transitioning can cause these to appear. No pilot action is required.

 Tracking functions are disabled until the condition is cleared automatically, usually on the next GPS update. Wing leveling remains in operation.

Chapter 6

Horizontal Operation

Track Mode (TRK)

The track mode (**TRK**) is used to track a GPS flight plan or fly directly to a “GOTO” waypoint. The autopilot uses the data stream from the GPS to determine the direction of flight.

- If a flight plan has been entered into the GPS, the autopilot will fly the course line to each point in the flight plan in sequence.
- If a “GOTO” waypoint has been selected, the autopilot will fly directly to the waypoint.

To use the **TRK** mode, press the **H MODE** button to light the **TRK** LED. Press the **H NAV** button. The autopilot will engage and fly the plane directly to the waypoint or the flight plan course line. If the plane is some distance from the course line, the pilot may use the intercept mode (**INT**) to quickly get back to the flight plan course line.

This mode requires a valid GPS signal to provide position information. If no GPS signal is present, this function will not be available.

Tracking a Course (CRS)

The course mode (**CRS**) may be compared to flying a heading bug in a traditional system, keeping in mind that you are selecting a course-over-the-ground and not a magnetic heading. Initially when entering this mode the course and track will be identical. If the pilot wishes to change the track of the plane, rotating the encoder knob will change the heading (like changing a heading bug). The autopilot will then change course until the **CRS** and **TRK** are once again identical.

Example: If given a heading to fly by ATC, press the **H MODE** button to light the **CRS** LED, rotate the encoder until the desired course is shown and press the **H NAV** button. The autopilot will engage and smoothly turn the airplane to the desired course.

Using Course Mode



Assuming the track mode (**TRK**) is currently selected, press the **H MODE** pushbutton to change the **H MODE** LED and display to the course mode (**CRS**).

When switching to the **CRS** mode the **BTW** label on the left side of the top line changes to **CRS**.

The three numeric characters following **CRS** represent the pilot commanded ground track. The **CRS** will show the current ground track (heading) the plane was traveling when the mode is entered.

The Pro Pilot will turn the plane to keep the track (**TRK**) and the course (**CRS**) the same value.

Example: If the current ground track is 010 degrees when the **CRS** mode is selected, the commanded course (CRS) will be initialized to 010 degrees.

- If **H NAV** servo is activated while in the **CRS** mode, the current track over the ground is automatically entered as the commanded **CRS**.
- If the servo is OFF just select the **CRS** mode. Then, push the **HNAV** button (turning on the servo). This will cause the current course to be selected and flown.

The **TRK** field below the **CRS** field indicates the actual across-the-ground track (TRK) from the GPS.

While in the **CRS** mode, rotating the encoder knob allows the pilot to adjust the commanded course in one degree increments either right or left of its current value. Rotating the encoder more quickly changes the course in larger increments. After changing the CRS field with the encoder the plane will turn left or right until the CRS and TRK fields are once more the same.

The distance right or left of the desired track is indicated in the **XTK** field in the top right line and is preceded by a left or right pointing apex (< or >), which shows which direction the airplane needs to fly to get back on the original flight plan or "GOTO" waypoint.

The pilot may exit the **CRS** mode by pressing the **H MODE** button until the desired mode (**INT** or **TRK**) is selected.

Note: If the **XTK** error is inside the intercept boundary line, the autopilot will sequence directly from **CRS** to **TRK** (bypassing the **INT** mode) when the mode button is momentarily pressed.

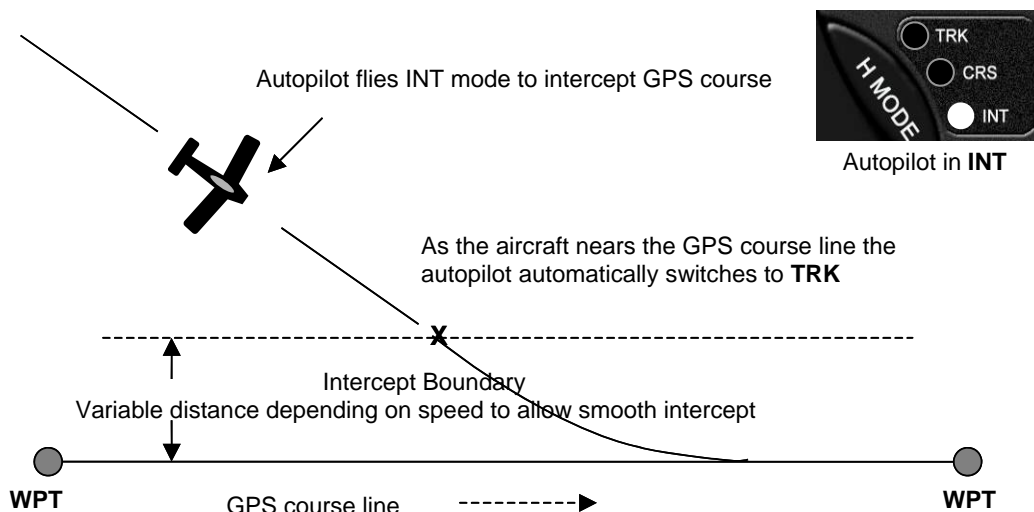
The **PCS** (Pilot Command Steering) mode provides an alternate mode of entry to the **CRS** mode and is described on page 31.

Intercept a Course (INT)

The intercept mode (**INT**) is designed to bring the aircraft back onto the original desired track after being vectored around by ATC or when avoiding weather or flying around airspace restrictions. **INT** is useful to bring the plane back to the original flight plan course (or Airway) instead of using the GOTO feature to take you to the next waypoint (e.g. "resume normal navigation"). While in the **INT** mode the pilot is also able to adjust the course intercept angle as desired.

Intercept Operation

INT is activated by pressing the **H MODE** switch (to sequence from the **TRK** or the **CRS** mode) until the **INT** LED is illuminated.



NOTE: The **INT** mode cannot be entered if the **XTK** error is less than the computed intercept distance (**IDS**) from the desired track line (usually about ½ mile depending upon speed). This variable distance is computed as a function of the intercept angle and groundspeed. The automatic switch from the **INT** to **TRK** mode occurs at this distance to allow a smooth intercept. If the **XTK** is greater than the computed distance, then the **INT** mode can be entered.

The automatic transition from the **INT** mode to the **TRK** mode is a function of the **XTK** (crosstrack error) magnitude, which is an index of the difference between the original course line and the position offset from the course line.

The **INT** mode automatically establishes an approximate 25 degree intercept angle (factory default setting) toward the course line (**DTK**). The commanded intercept course can be adjusted in the same manner as in the **CRS** mode using the rotary encoder switch or the pilot controlled steering (**PCS**) mode. The **INT** mode is automatically canceled and the **TRK** mode is entered when the aircraft crosses the intercept boundary line.

The unit will automatically sequence from **INT** to **TRK** if the track error magnitude is below approximately 0.5 miles (intercept distance increases with speed). The precise switching distance is displayed as **IDS** (intercept distance) on the upper right data field when the **INT** mode is selected. The **INT** function is not available if the crosstrack error is below this variable limit or the aircraft is on the ground.

NOTE: If roll servo (**H NAV** button) is turned on (cycled) while in the **INT** mode, the current track over the ground is automatically entered as the commanded intercept angle.

Forcing a Track Offset Position (TOP)

With the advent of highly accurate GPS navigation and couOLED autopilots, aircraft are tracking more and more closely to the airway centerlines on designated airways (the Pro Pilot can easily hold the course centerline within 50 to 100 feet in smooth air). This creates the real possibility of overtaking or head-on encounters with other aircraft that are also tracking the airway centerline, especially during climb and descent when normal altitude separation is not in effect.

To help avoid such encounters, the Pro Pilot incorporates a safety feature heretofore found only in high end navigation systems – Track Offset Position (**TOP**).

Track Offset Position allows the pilot to fly a ground track which is offset by up to three miles from the centerline between the waypoints (desired track, or **DTK**).

To **enable** the **TOP** function, do the following:

In the **TRK** mode (only) **press and rotate** the **ROTARY ENCODER** switch counterclockwise or clockwise to select the offset distance to track, (either to the left or the right of the **DTK** centerline). The arrow indicator denotes the direction of the offset and the numeric field indicates the offset selected (measured in miles and tenths of a mile). Changes to the offset may be made in 1/10th mile increments up to 3 miles.

To **disable** the **TOP** function, do one of the following:

In the **TRK** mode (only) **press and rotate** the **ROTARY ENCODER** switch counterclockwise or clockwise to change the offset distance to 0.0, or by changing modes, or by simply cycling power to the Pro Pilot using the **POWER** switch.



When activated, the arrow on the **XTK** changes from an outline arrow (>) to a fully filled arrow (▶).

Also note that there is a flashing “◆” diamond indicator present after the **BTW** label in the **TRK** mode. The **TOP** setting will also be flashed in the upper right display field periodically. These indicators alert you that the **TOP** feature is active.

NOTE: It is important to remember that the final waypoint will also be offset unless the TOP offset is brought back to “0.0” prior to arrival at the waypoint.


Initiating an Automatic Course Reversal

In an effort to increase safety and save lives, this mode may be initiated as an emergency aid to the VFR pilot who inadvertently enters IMC conditions and needs to execute an immediate course reversal.

NOTE: It is important to realize that the autopilot must be turned on and receiving a good GPS data signal for proper operation.

You may be tracking a flight plan but a sudden IMC encounter may not leave you with an opportunity to reprogram your GPS to invert the flight plan. **This procedure does not require you to adjust your GPS receiver.**

If you are manually flying your aircraft, this procedure will also work because *the servo does not have to be engaged* to initiate this emergency procedure so long as the power is on and the GPS has lock on the satellite data.

 The procedure is simple and straightforward. Press and hold the **H NAV** or **V NAV** button for three seconds. The Pilot Pro will execute a 180 deg turn. ***That’s all you need to do!***

After three seconds the following will occur:

- The servo will be energized (if off) and the wing leveler function will engage.
- The upper right display line will read “TRN 180”
- The lower right display line will be forced to the turn coordinator display
- If the **H NAV** button was held, a 180 degree **left** course reversal will be executed.
- If the **V NAV** button was held, a 180 degree **right** course reversal will be executed
- In each case, the **V NAV** servo will engage in the **ALT HLD** mode.



The display screen will change as shown. The reversed groundtrack will remain in effect until canceled by selecting another mode (or using the **PCS** mode).

Variable Display Field – Top Line

The right side of the upper line (normally the **XTK** field) may be reconfigured to allow any of the parameters displayed on the bottom variable field to be selected for display. The parameter to be displayed is selected by momentarily pressing the **ROTARY ENCODER** switch. To change the displayed parameter, do the following:

1. Momentarily press the **ROTARY ENCODER** knob
2. Repeat until the desired parameter is displayed

Corrupted GPS Data Stream

On occasion, when a new waypoint is manually selected on the GPS, the data in the GPS input stream might be corrupted momentarily. The Pro Pilot is programmed to detect this and will set the display fields to “----”(dashed lines) or may enter the **NO FPLAN** mode when the condition is detected. This is usually a condition that clears after another GPS sample or two is transmitted to the Pro Pilot. **No pilot action is required.** Normal **TRK** mode tracking computations are inhibited until the GPS data integrity is restored.

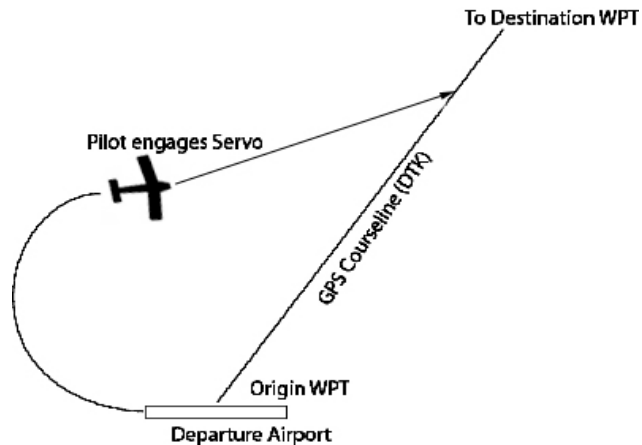
Chapter 7

Horizontal Flight Examples

Flying to a Courseline (DTK) or GOTO Waypoint

After takeoff, and at a safe altitude, select the flight plan on your GPS and press the **H NAV** pushbutton momentarily. Note that the **"H" LED** is now on and the autopilot has control of the aircraft.

Note: As a safety feature, during the takeoff roll, the Pro Pilot checks the status of the servos. At 25 knots GPS groundspeed, or 40 knots indicated airspeed (if GPS is not available) it will automatically disconnect the servos, allowing free movement of the control surfaces. This is a backup feature only and should not be relied upon to replace a necessary preflight checklist item.



One of the design features of the Pro Pilot is its ability to identify the desired track line (**DTK**) and fly to it regardless of the direction the airplane is heading when the autopilot is engaged. In an extreme example, the plane might be flying 180 degrees away from the GPS routing and the Pro Pilot will bring the aircraft around smoothly to the proper ground track and pick up the programmed **DTK** (zeroing the cross track error). In the example shown above, the pilot engages the servo after takeoff and climb to safe altitude. The Pro Pilot then intercepts and flies the course line (**DTK**) to the first waypoint.

Note: It must be remembered that the flight plan establishes a courseline between two points - in this case the departure WPT and the first destination WPT. Since the location of the plane is not on the courseline, when the **TRK** mode is selected and the servo activated the autopilot will **first** fly to the previously selected courseline and then turn toward the WPT.

As an alternate, to proceed directly to the WPT from your present position, the pilot would utilize the "Direct To" feature of the GPS receiver. The Pro Pilot would then track directly to the desired WPT and then begin following the courseline.

During the flight on this leg some other navigation parameters are available for review, such as estimated time to the waypoint (**ETE** or **ETe**). Turning the knob of the **ROTARY ENCODER** presents this data. Rotating the encoder knob again will show **RNG** (distance) to this waypoint. The knob is rotated until **GS** or **WPT** is back on the display, since this field is probably referred to most often in flight, or the pilot may engage the scan mode to see all parameters (see page 20). Additionally, the upper right display field can be programmed to display any of the GPS derived data as described on page 20.

Loss of GPS



With the GPS antenna placed where it can "view" all of the satellites available, it is unlikely that a loss of reliable GPS signal will occur. However, if the GPS receiver is a handheld device without an external antenna (especially if it is being used in the cockpit of a metal airplane) it is possible to experience a temporary loss of GPS signals.

In such case, after approximately 7 seconds without signal the Pro Pilot displays the **NO GPS** message. Since the Pro Pilot is no longer able to provide the navigation function, the **ROTARY ENCODER** can be used to control the aircraft turn rate, or to correct for gyro drift to effect a straight ahead flight path

The Pro Pilot servo is still engaged so the aircraft is being controlled in the “wing leveler” mode (aircraft roll stabilization). Without the GPS signal, the Pro Pilot solid-state gyro lacks a precise external reference and after several minutes may begin a slow change in heading due to gyro drift. In order to change the heading slightly to stop the drift, the pilot needs to monitor the compass heading and rotate the **ENCODER** either left or right to maintain the desired heading.

Course Mode Example



As the flight progresses the destination, Class B airspace is entered after getting the appropriate clearances.

Flying along on the pre-selected 010 degree **TRK**, Approach Control requests “Turn right 30 degrees for clearance from other traffic.”

This turn can be accomplished in one of two ways:

1. The **CRS** mode is selected by pressing the **MODE** pushbutton momentarily. The following changes in the display are noted:
 - The **TRK** LED extinguishes, the **CRS** LED is illuminated
 - The **BTW** field changes to **CRS**
 - The **TRK** field changes to **<010**
 - The **CRS** and **TRK** fields are, for the moment, identical (010)

Since the controller wants 040 degrees (formerly 010 degrees), a 30 degree turn to the right is needed. The desired **CRS** is 040 degrees so the **ROTARY ENCODER** is turned clockwise until 040 is displayed as the **CRS** value. The Pro Pilot turns the airplane until both the track (**TRK**) and the course (**CRS**) are the same (**040**).



-
2. **PCS** mode (see page 31) is invoked by pressing and holding the **Remote Servo Disconnect** switch and manually flying the aircraft to the desired ground track, releasing the switch when the proper ground track is achieved.

The illustration on the right now shows that the aircraft has turned right and is presently 1.08 miles to the right of course. A few minutes later, Approach advises to “resume normal navigation.”

There are two ways to use the autopilot to return to the original desired track (**DTK**).

1. The intercept mode (**INT**) may be used to return to the original preprogrammed route via a default 25 degree intercept angle, or a pilot adjusted intercept angle.
2. Going directly back to the **TRK** mode causes the aircraft to more gradually curve back to the **DTK**.

Alternatively, the pilot may choose to enter a “Direct” command into the GPS system, thus proceeding directly to the next waypoint rather than intercepting the original desired track (**DTK**).

NOTE: If a GOTO waypoint is selected the autopilot will automatically switch to the **TRK** mode since the cross track error will be zero.

Intercept Mode Example

Assume that, while in the **CRS** mode, the aircraft flew 5.1 miles right of the course line (**DTK**), as shown on the display’s cross track (**XTK**) field. Also assume that the computed intercept boundary switch point is 1.0 miles. The intercept (**INT**) mode is selected by pressing the **H MODE** switch. The **CRS** LED extinguishes, and the **INT** LED illuminates and flashes at the configured flash rate. The following changes are present on the display:



```
INT 345➔IDS<4.1
TRK 010➔ KPSP
```

The **XTK** label changes to intercept distance (**IDS**) and the value in the **IDS** field is 4.1 miles. This display indicates that you are in the intercept mode, correcting to the left and you are 4.1 miles from the switch point back to the **TRK** mode.

The **CRS** label changes to **INT** and the value in the **INT** field is about 25 degrees to the left of the current desired track. The Pro Pilot selects a 25 degree intercept angle automatically.

The aircraft now turns left to the ground track commanded in the **INT** field. The **IDS** value steadily decreases toward zero. After a short interval the **TRK** and **INT** values are approximately the same, indicating a steady intercept track.

If it is desired to change the default intercept angle (25 degrees), the pilot may engage the **PCS MODE** by pressing and holding down the Remote Servo Disconnect switch on the stick (or yoke) and flying the aircraft manually to the desired intercept course at which time the switch is released. Releasing the switch locks the new ground track as the desired intercept angle.

The **ROTARY ENCODER** may also be used to change the intercept angle (**INT** field) while in the **INT** mode. In the event that the **XTK** error is not decreasing in the **INT** mode (perhaps if an inappropriate intercept angle has been selected) the **INT** field will flash to signify the selected commanded angle will not allow an intercept.

Progressing toward the **DTK**, as the **IDS** value approaches 0.0 the Pro Pilot switches automatically from the **INT** mode to the **TRK** mode when the aircraft is 1.0 miles right of the **DTK**. The Pro Pilot now is turning the airplane back to the right slightly and the **XTK** is approaching 0.00. The Pro Pilot will now re-establish the airplane back on the **DTK** headed directly toward the programmed waypoint.

NOTE: While the pilot could have gone directly back to the **TRK** mode to get back on course, the **INT** mode provides a definite (and adjustable) intercept angle to accomplish the return to the course line. The **TRK** mode uses a different turn algorithm which may extend the time required to return to the course line.

Horizontal Use of Pilot Command Steering (PCS)

The Pro Pilot provides a convenient way for the pilot to control the course (**CRS**) that the airplane flies. By pressing, and holding, the remote **Servo Disconnect** switch on the control stick, the pilot can manually turn the aircraft to the desired course. Upon releasing the button, the autopilot will track that course. The switch must be held down for a minimum of 5 seconds to engage this feature. Holding for less than 5 seconds will cause the servo to disconnect and it will have to be re-engaged by pressing the **H NAV** and/or the **V NAV** button on the control/display unit.

If the **H NAV** servo is turned on (cycled) while in the **CRS** or **INT** modes, the current **TRK** is snapshot as the commanded **CRS** or intercept angle

When the remote button is pressed initially, the “**H**” **LED** will extinguish normally, and the servo will disconnect, giving the pilot full control of the aircraft. After the button is held down for 5 seconds or more, the “**H**” **Servo LED** will begin to flash, indicating that the servo will re-engage when the button is released. This allows the pilot to manually orient the aircraft to the desired course and re-engage the servo when the button is released.

NOTE: The PCS function also works with the altitude control portion of the Pro Pilot. This is discussed in detail later in this manual.

Chapter 8

Vertical Operation

Vertical Navigation (V NAV)



Generally speaking, except for warnings and alerts, the display screen will present the Vertical Navigation information on the right hand half of the display screen when the encoder has been assigned to the **VNAV** functions.

To view and control the vertical functions it is necessary to press the **V MODE** button one time to transfer encoder control to the **V NAV** functions.

Pressing the **V NAV** button once will dedicate the right hand half of the display to the **V NAV** functions (and the mid upper arrow will point to the right). No navigation changes will occur.

Altitude Hold (ALT HLD)

In the example shown the pilot has pushed the **V MODE** button one time to transfer encoder control to the **V NAV** functions (arrow points to the right).

Here, the “**V**” LED is illuminated, indicating that the pilot has pressed the **V NAV** button and the autopilot pitch servo is engaged and holding altitude. Additionally, the **ALT HLD** green LED will illuminate to show that the autopilot is in the Altitude Hold mode.



Rotating the encoder knob will then adjust the altitude up or down by about 5 feet per “click” on the encoder (Rotate clockwise to go up and rotate counterclockwise to go down).

The message “**ALT ADJ**” will then appear on the screen to indicate that a slow altitude change is underway. In addition, the **ALT HLD** green LED will flash while the altitude change is in progress. The “**UP/DN**” message will change to read either “**UP**” or “**DN**” depending upon which direction the knob was rotated.

Once the commanded altitude has been reached, the LED will stop flashing and the display will revert back to showing normal **ALT HLD** message.

NOTE: This function is used only for slight changes in altitude, such as adjusting for a change in barometric pressure on a cross country flight. After adjusting the primary aircraft altimeter, the Pro Pilot may be slightly off altitude.

Minor altitude adjustments will be made at about 100 fpm. If the required altitude correction is more than 30 or 40 feet, the pilot may simply rotate the encoder knob slowly a couple of times to initiate the gradual climb or descent and then, when the desired altitude is reached, press the encoder knob momentarily to once again hold the current altitude.



To restore the display to presenting the **H NAV** information, press the **H MODE** button and the center arrow will reverse, indicating that the display and encoder are now devoted to **H NAV** functions.

However, the **ALT HLD** LED will remain illuminated to indicate that the **ALT HLD** is still active.

Setting Vertical Speed (SET VS)

The Pro Pilot has enhanced altitude control features that allow the aircraft to climb and descend under autopilot control. This provides several additional capabilities and safety features:

- A major safety feature of the Pro Pilot is its ability to prevent the system from stalling or over speeding the aircraft. To facilitate this, the control head contains an airspeed sensor, which must be connected to the aircraft pitot system.
- Another safety feature is autopilot disconnect on take off. The autopilot will automatically disconnect the servos when approaching airspeed of approximately 40 kts IAS - if inadvertently left on during takeoff.
- Vertical climbs and descents may be performed by setting the desired vertical rate via the encoder knob and pushbutton switch.
- Pilot Command Steering (**PCS**) allows the pilot to press the remote disconnect switch to fly the aircraft manually to establish a desired climb or descent rate and (when the remote disconnect button is released) the aircraft will hold that vertical rate.
- Alternatively, the pilot may choose— via a **CONFIGURATION** setup menu – to have the **PCS** mode climb and descend on airspeed (instead of vertical speed). This will allow the ability to maintain a specific airspeed during climb or descent to help maintain proper engine temperature.

NOTE: In the **PCS** mode the vertical rate change must be at least 200 FPM or the Pro Pilot will enter **ALT HLD** upon releasing the **PCS** (remote disconnect) button. If the rate is greater than 200 fpm it will maintain the climb/descent that it senses when the button is released.

For the following discussion, assume that the pitch servo is on (“**V NAV**” servo LED is illuminated) and the Pro Pilot is in the **ALT HLD** mode.



Pressing the **V MODE** button once will bring up the **SET VS** screen. With this display present, rotate the encoder knob to dial in a climb or descent rate.



With the **SET VS**, the rotary encoder provides a means to set in a climb or descent in increments of 100 feet/sec.

Rotating the encoder clockwise increments the vertical speed display to show a positive rate of climb, while rotating the encoder to the left will set in a descent. On the screen to the above, the rate indicates that a positive 800 feet per minute has been entered as the desired climb rate.



Entering a climb or descent rate will cause the **AS/VS** LED to illuminate, indicating that a number has been entered. The **ALT HLD** LED will remain illuminated.



Please note that the climb will not begin until the pilot presses the encoder knob to initiate the climb.

If the encoder knob is now pressed, the **ALT HLD** LED will turn off and the aircraft will enter a climb at the selected rate.

While the climb (or descent) is underway the **AS/VS** LED will flash (unless otherwise configured on initial setup), providing a positive indication to the pilot that the mode is active. If the Pilot wishes to pause the climb/descent, momentarily pressing the encoder knob will invoke **ALT HLD**. Once this is done, the aircraft will level off, and the **AS/VS** LED will stop flashing (but remain lit). However, the selected vertical rate is still in the display indicating that the climb may be resumed by pressing the encoder knob again.

If the pilot wishes to cancel the selected vertical rate, it may be done by pressing (and holding) the **V MODE** button for 3 seconds. This will cause the **AS/VS** LED to turn off, and the autopilot will enter the **ALT HLD** mode. Any vertical speed (or altitude settings) that have been previously entered will be canceled.

If the Pro Pilot is commanding a climb to an assigned altitude of 10,000 ft and a controller asks the pilot to temporarily hold at 6,000 ft., the pilot may press the encoder button upon reaching 6,000 ft and the aircraft will hold at that altitude. When cleared to continue the climb, the pilot may press the encoder button again to resume the climb. Alternatively, the pilot may set the **AS/VS** rate-of-climb to zero at 6000 ft which will then hold that altitude until the vertical rate is changed

NOTE: The pilot may change the vertical rate even while the aircraft is climbing or descending. Rotating the encoder knob while on the **SET VS** screen will cause the Pro Pilot to increase or decrease the climb or descent rate.

For instance, if you are descending toward a destination airport at, say, 500 feet per minute and see that you need to steepen your approach to arrive at the approach end of the runway, you might rotate the encoder knob to change the descent rate to 700 ft/min.

To execute the climb/descent that was entered, the pilot must press the **V MODE** button to bring up the vertical information display screen, and then press the encoder button. This action will initiate the climb/descent and the **AS/VS** LED will begin to flash.

Altitude Pre-Select Function (ALT SEL)

The pilot may pre-select a destination altitude. When engaged, the system will command the aircraft to climb or descend to the selected altitude. Upon arrival at the destination altitude, the system will automatically switch to the **ALT HLD** mode and assume level flight.



To be accurate, the Pro Pilot must have current barometric altitude information. Once the pilot has adjusted the baro setting on the aircraft altimeter, the baro altitude in the Pro Pilot may be easily adjusted to agree with the aircraft altimeter by repeatedly pressing the **V MODE** button to display the **BARO SET** screen at any time and changing that number by rotating the encoder knob.

When initiating a climb or descent to a destination altitude, the Pro Pilot will begin the climb/descent at either the rate set by the pilot, or a default vertical speed that has been predetermined in the **CONFIGURATION** menu.

The factory preset is 500 fpm, but this may be changed by the user.

Once the climb or descent is under way, the display will show the **SET VS** (Vertical Speed) screen. Here, the pilot may adjust the current climb/descent rate to a different vertical speed as conditions demand.

NOTE: A vertical rate and target altitude may be entered prior to engaging the **V NAV** servo: e.g. prior to takeoff. Once these parameters have been entered, the aircraft will immediately enter a climb when the **V NAV** servo is engaged.

Entering the Current Altitude

For the altitude pre-select function to be accurate, it is important that the system be set to the current local barometric pressure. Just as the primary aircraft altimeter must be adjusted to compensate for barometric pressure changes, the Pro Pilot also provides a means for making such adjustments. While the primary aircraft altimeter is adjusted using a scale calibrated in “inches of mercury” (e.g., 29.92), the Pro Pilot is adjusted to agree with the altitude shown on the corrected primary altimeter.

Barometer Elevation/Altitude Set



If the aircraft is on the ground when the Pro Pilot system is turned on the display screen will show the **BARO SET** display and indicate the assumed field elevations.

The initial **barometric elevation** should be set to be as close to that of the airfield elevation as possible. Any difference will be the result of barometer changes since the system was last used. Rotating the encoder knob will change the baro elevation in 5 foot increments, and it should be set to be as close to the actual airfield elevation as possible, in feet. This will assure that the internal Pro Pilot system altimeter will agree closely with the aircraft altimeter that has also been corrected to airfield elevation.

In practice, during preflight checks the pilot will set the primary aircraft altimeter using a current barometer setting. The aircraft altimeter will then be indicating the current elevation. The Pro Pilot **BARO SET** should be set to agree with the corrected primary aircraft altimeter.



If the aircraft is in flight when the Pro Pilot is first turned on, the screen will again show the **BARO SET** display and indicate the assumed altitude as shown.

If this does not agree with the baro corrected primary aircraft altimeter, rotate the encoder knob to enter the proper altitude. The aircraft should be level (not climbing or descending) so that the aircraft altimeter needles are not moving. The initial altitude will likely be already close to that shown by the aircraft altimeter. Here again, any differences will be the result of barometer changes since the last time it was set. The system is now calibrated and ready to use. Press the encoder knob to exit or wait five seconds for this screen to time out automatically.

Once the altitude has been set, it can be accessed and changed at any time. To see the **BARO SET** screen in flight, press the **V MODE** button repeatedly and the display will increment as follows:

ALT HLD -SET VS - ALT SEL – BARO SET



SET function in this mode.

The **BARO SET** may then be changed by rotating the encoder until the indicated altitude agrees with the aircraft altimeter. The display resolution is in 20 foot increments for the **BARO SET** function in this mode.



In normal flight, unless remarkable barometric changes have been experienced, the inactive **ALT SEL** display should also agree with the current altimeter indication.

Press the **V MODE** button to return to the active screen.

Note: The mechanical aircraft altimeter is subject to small errors at different altitudes and should be calibrated according to FAA guidelines. The Pro Pilot contains an accurate model of the atmosphere but may exhibit small errors attributed to normal manufacturing tolerances of the precision sensors. Such accumulated errors between the two systems will typically be less than 1%. During rapid climbs and descents it may also be observed that the mechanical altimeter “lags” the Pro Pilot altimeter **BARO SET** due to the faster response of the solid state sensors.

Entering a Target Altitude



To enter a target altitude, press the **V MODE** button to toggle to the **ALT SEL** screen and rotate the encoder knob to select the desired altitude.

Let's assume that we wish to climb to 7,500 feet. Rotating the encoder knob will increment the value by 100 ft. per click. Pressing and rotating the knob will increment the value by 1,000 ft. per click.

When the knob is rotated to enter the altitude, the **ALT SEL** LED will illuminate and the screen will show the selected altitude. Once the proper altitude is entered, press the encoder knob to activate the climb to altitude.

NOTE: If a climb/descent rate has previously been set in the **SET VS** screen, the climb/descent to altitude will be at the rate that was entered. If no vertical rate was entered the default rate (specified in the **CONFIGURATION** menu) will be automatically used.

The display screen will briefly show the **BARO SET** screen so the pilot can check the Pro Pilot altimeter against the aircraft altimeter. If the autopilot altimeter does not agree with the aircraft primary altimeter, adjust it to agree by rotating the encoder knob. This display automatically times out 5 seconds after a change is made. Once the timeout occurs (or the encoder switch is pressed again) the climb will begin and the display screen will show the default climb or descent rate, alternating with the destination altitude.

NOTE: During the climb, BOTH the **AS/VS** LED and the **ALT SEL** LED will flash unless otherwise configured. This informs the pilot of the active modes, even if the pilot has pressed the **H MODE** button to view only horizontal navigation information on the screen.

Once at the destination altitude of 7,500 feet, the system will enter the **ALT HOLD** mode and the aircraft will level off and hold that altitude.

- To cancel the pre-selected altitude (but not the vertical rate), press the **V MODE** button until the display shows the **ALT SEL** screen and then press and hold the encoder knob for 3 seconds.

The **ALT SEL** LED will turn off and the destination altitude will be canceled, but the climb or descent will continue at the rate selected. The **AS/VS** LED will continue to flash.

- To cancel both the target altitude and the vertical rate, press and hold the **V MODE** button for 3 seconds.

Both LEDs will turn off and the green **ALT HLD** LED will illuminate as the aircraft maintains that altitude.

Pausing the Climb Example

During the climb to a destination altitude, a controller might ask the pilot to hold at a specific altitude until further advised. The Pro Pilot can easily accommodate such a request.

Example: Assume that a climb has been initiated to a destination altitude of 8,500 feet. The **AS/VS** LED and the **ALT SEL** LED are flashing to indicate the active profile. If it is desired to pause the climb at, say, 6,500 feet the pilot may press the encoder button (while viewing any **V MODE** screen and the display arrow points to the right) when the aircraft reaches 6,500 feet.

At that point, the Pro Pilot will enter the **ALT HLD** mode and the green **ALT HLD** LED will illuminate to inform the pilot that the aircraft is holding at the current altitude. The **AS/VS** LED and the **ALT SEL** LED will stop flashing, but remain illuminated (to indicate that the altitude pre-select system is “armed”).

To resume the climb to 8,500 feet, press the encoder knob to initiate the climb and the **AS/VS** LED and the **ALT SEL** LED will resume flashing. The **ALT HLD** LED will go out.

NOTE: A vertical rate and target altitude may also be entered *prior* to engaging the **V NAV** servo. Once these parameters have been entered, the aircraft will immediately enter a climb or descent to the preselected altitude, if chosen, when the **V NAV** servo is engaged.

Upon reaching 8,500 feet, the aircraft will resume level flight and the **ALT HLD** LED will illuminate.

Assuming that the aircraft was trimmed properly for the climb, the display will begin to display a “**TRIM DN**” alert when the aircraft levels at the “paused” altitude. If the pitch servo is equipped with the optional auto-trim feature it will automatically re-trim the aircraft.

Changing the Destination Altitude

If the pilot wishes to change the destination altitude, once set, prior to initiating the climb or during the climb, it is easily done by repeatedly pressing the **V MODE** button until on the **ALT SEL** screen. Rotating the encoder will then change the destination altitude.

Example: If a controller has cleared the aircraft to climb to 5,500 feet, the pilot might go to the **ALT SEL** screen and enter that altitude. If a specific climb rate was not entered, the Pro Pilot will enter the default climb rate that was chosen in the **CONFIGURATION** menu.

Once in the climb, if the controller then changes the assigned altitude to 7,500 feet the pilot would press the **V MODE** button repeatedly until on the **ALT SEL** screen and then rotate the encoder knob until the destination altitude reads 7,500. It is not necessary to perform any other action to activate that setting.

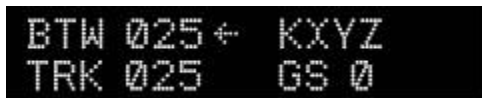
A Vertical Flight Scenario

Let’s assume that we are flying to an airport that is about 50 nm distant. Our home airport is located under Class B airspace with a ceiling of 3,500 ft. Our en route altitude is planned to be 7,500 ft. We have entered the route into our GPS and (if we have a panel mounted GPS) selected the localizer approach at the destination.



When we power up, the Pro Pilot asks us to adjust the **BARO SET** screen so that the internal altimeter agrees with the field elevation.

Rotating the encoder knob will adjust the elevation by 5 ft. per “click”. Once the display altitude agrees with the aircraft altimeter, press the encoder knob and the screen will advance to the **H MODE** displays.



The display indicates that the destination airport is KXYZ and, since we are still motionless on the ground, the groundspeed is zero.



Press the **V MODE** button to advance to the **V MODE** display. The first display screen will show an **ALT HLD** message.



Press the **V MODE** button again to advance to the **SET VS** (set vertical speed) screen. When first entering this screen, the rate will always be “0” unless previously adjusted.



Rotate the encoder knob to set in the desired climb rate – in this case let’s use 800 fpm. Note that the **AS/VS** LED illuminates when a rate has been dialed into the display.



To enter the target altitude, press the **V MODE** button again to advance to the **ALT SEL** screen.



Note that the system has “snapshot” our current altitude and displays it on the screen. Since we are still on the ground, it will show the same field elevation that we had previously adjusted when we first turned the system on.

Rotate the encoder to enter the desired altitude. Each “click” of the encoder will change the altitude by 100 feet. If we press and hold the encoder knob while turning, it will change the altitude by 1,000 feet per “click”.



Select the target altitude of 7,500 feet as shown, and press the encoder knob to enter this value. If the encoder is not pressed, the value will not be entered.

Notice that the **ALT SEL** LED also illuminates as we enter the altitude. Since both LEDs are illuminated it informs us that a climb will be initiated when the **V NAV** servo is engaged and the encoder knob has been pressed while either the **VS SET** or **ALT SEL** screen is displayed

Pressing the **H MODE** button at this point will devote the screen and encoder to the horizontal navigation functions. However, the **V MODE** LEDs will continue to show that values have been entered in the **VS SET** and **ALT SEL** registers (they are now “armed” and ready to execute).

The Pro Pilot is now properly set for the flight. The GPS has a flight plan and the climb rate and target altitude have been entered.

After takeoff, and safely out of the airport traffic pattern, we engage the **H NAV** servo by pressing the **H NAV** button. The Pro Pilot is now controlling the aircraft ailerons and guiding the airplane toward the destination airport.

Assume that we are still close to our departure airport and the class B airspace is still above us. At this point we can engage the vertical profile by pressing the



V NAV button. This engages the pitch servo and the aircraft will begin to climb. Quickly pressing the encoder knob will “pause” the climb so that we remain below the restricted airspace. The **ALT HLD** LED is now illuminated and the other two **V MODE** LEDs are illuminated, not flashing. This tells us that the aircraft is holding altitude and ready to climb to altitude.

Once clear of the class B airspace it is only necessary to press the encoder knob once again to initiate the climb. At this point, the **ALT HLD** LED goes out and the **AS/VS** and **ALT SEL** LEDs begin to flash again, indicating that the climb is underway to the preselected altitude.

A vertical rate and a target altitude may be entered prior to engaging the **V NAV** servo for example, prior to takeoff. Once these parameters have been entered engaging the **V NAV** and pressing the encoder will initiate an immediately climb to the preset altitude while in flight.

If a preselected altitude has *not* been chosen, i.e., only a rate of climb was entered, the encoder button need not be pressed to activate the climb, only the **V NAV** button.

It is now possible to press the **H MODE** button to resume viewing the **H NAV** displays. The **AS/VS** and **ALT SEL** LEDs will continue to flash until the destination altitude is reached.



When the aircraft approaches within 100 feet of the destination altitude, it will slow the ascent to 200 feet per minute for a smooth intercept. When it reaches the destination altitude, it will level the aircraft and enter the **ALT HLD** mode. The **AS/VS** LED and **ALT SEL** LED will extinguish and the **ALT HLD** LED will illuminate.

Note: While in a climb/descent to a target altitude, the display will normally show the **VS** screen indicating the climb or descent rate. As a reminder, at approximately 20 second intervals, the display will briefly show the destination altitude as well.

Here it indicates a climb to 7,500 feet.



Vertical Use of Pilot Command Steering

The Pilot Command Steering (**PCS**) function may be used to set a climb or descent rate. It is employed by pressing and holding the remote disconnect button on the control stick while the **V NAV** pitch servo is engaged.

This will disconnect the pitch servo from the controls and allow the pilot to establish a desired climb or descent. After 3 seconds, the **V NAV** servo LED will begin to flash. This indicates that the servo will re-engage when the button is released and the Pro Pilot will continue the climb/descent at the rate it detected when the button was released.

The pilot may elect to have the **PCS** climb/descent rate controlled by the vertical speed (**VS**) of the aircraft at the time of button release, or the airspeed. The choice between vertical speed (**VS**) or airspeed (**AS**) may be selected in the **CONFIGURATION** menu. If the pilot chooses to employ a **PCS** climb rate based upon airspeed (possibly chosen for best cooling in a climb) the climb will continue at that airspeed but the vertical speed (**VS**) will change with altitude and power settings.

It should also be noted that the **PCS** function (when employed) will affect the **H NAV** mode as well, unless a separate **PCS AH** disconnect button has been installed. As previously described, it will put the Pro Pilot into the **CRS** mode and track the course that the aircraft is on when the button is released.

NOTE: There is a provision in the **CONFIGURATION** menu to incorporate two separate remote disconnect buttons; one for the **H NAV** servo and one for the **V NAV** servo. This setting will also provide independent **PCS** capabilities to each axis.



For safety reasons, the pilot should consider a single remote disconnect button to disconnect both servos with a single click. While provisions has been made for two remote disconnect buttons that will allow separate horizontal and vertical functions (including PCS), this should be employed only when the user has an overriding need for separate control.

In this case, it will be necessary to press EACH button to disconnect the respective servo in an emergency situation.


Chapter 9

GPSS and GPSV Operation

GPSS and GPSV Defined

GPSS and **GPSV** are acronyms for “GPS Steering” and “GPS Vertical steering”. These features use the ARINC 429 data stream provided by some GPS receivers and EFIS systems.

When ARINC signals are available and the Pro Pilot is in the Track (**TRK**) mode, the autopilot follows the roll commands (**GPSS**) and vertical commands (**GPSV**) issued by the originating GPS receiver or EFIS.

 In addition to the ARINC data, the Pro Pilot also requires the AVLINK or NMEA RS-232 data input for other features and functions to operate properly.

The ARINC 429 data signal requires 2 wires for data, as opposed to the RS-232 where the data is carried on one wire (the common power ground provides the return data path).

The Pro Pilot can utilize the ARINC signal from non-WAAS GPS receivers and will accurately track a flight plan, as well as the lateral profile of certain GPS approaches.

GPSS and GPSV Considerations

- Precision GPS approaches (RNAV) require the use of a certified WAAS receiver (such as the Garmin 400W/500W series) to be able to fly the vertical profile of an approach. Garmin WAAS receivers also provide guidance for the Pro Pilot to fly procedure turns and certain holding patterns.
- The IFR approved UPS GX series of GPS receivers have a GPSS type signal interface available on a dedicated RS232 channel into the autopilot, however no vertical (GPSV) capability exists with these receivers.
- When connected to a compatible EFIS (and in the **TRK** mode), the Pro Pilot may also obtain lateral and vertical guidance from the EFIS.
- On some compatible EFIS systems the altitude and heading bugs can also be used to generate the lateral and vertical guidance to the Pro Pilot.

NOTE: The ARINC lateral and vertical guidance is only accepted from the GPS or EFIS when the autopilot is in the **TRK** mode.

If the autopilot is placed in the **CRS** or **INT** modes:

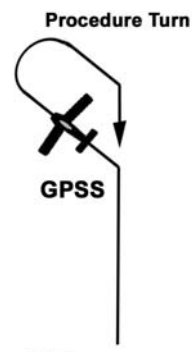
- The ARINC input is disregarded
- The lateral and horizontal flight paths are selected at the autopilot front panel
- Lateral navigation reference is provided via the RS-232 NMEA / AVLINK signal
- Vertical guidance is selectable at the autopilot based on barometric pressure data provided by the autopilot system by selection of the **AS/VS** Mode.

Operation Using Certified WAAS GPS Receivers

Certified panel mounted WAAS GPS receivers have proven accuracy that allows them to be used for precision GPS approaches into airports, as well as en route navigation.

GPSS Guidance

When an approved WAAS enabled GPS receiver (such as the Garmin 400W/500W and 650/750 series) is used, the Pro Pilot will follow the ARINC roll commands to the extent that it will fly complete horizontal flight plans (as entered into the GPS receiver), including procedure turns and some holding patterns.



For GPSS guidance to be active two conditions must be met:

- The **H MODE** selection must be in the **TRK** mode to access the ARINC signal.
- The blue **GPSS LED** must be illuminated (indicating a valid ARINC 429 signal is available) and the autopilot is in the Track (**TRK**) mode.

⚠ When the **GPSS** option is installed the Pro Pilot (while in the **TRK** mode) will always default to the **GPSS** mode when valid data is present.

GPSS LED Indicator

- In the event that the **GPSS** becomes inactive (i.e. on a localizer approach) the **GPSS LED** extinguishes and the Pro Pilot immediately begins to track the Aviation Data (AVLINK or NMEA 0183) signal that it receives on the RS-232 data input line.
- If the pilot presses the **H MODE** button the Pro Pilot will enter the Course (**CRS**) mode, and the blue **GPSS LED** will turn off. This indicates the Pro Pilot is no longer using the ARINC signal for guidance and is now relying on the RS232 signal for the course and intercept functions.



⚠ Since the **GPSV** does not function without the **GPSS**, the **GPSV LED** will also turn off, and vertical guidance will be controlled by the front panel of the Pro Pilot.

NOTE: When valid ARINC guidance is available and the Pro Pilot is in the Course (**CRS**) mode (not using the **GPSS** and **GPSV** functions) the blue LEDs will blink briefly every two seconds to indicate ARINC guidance is present but not being used. Putting the Pro Pilot into the Track (**TRK**) mode will again activate the **GPSS** and **GPSV**.

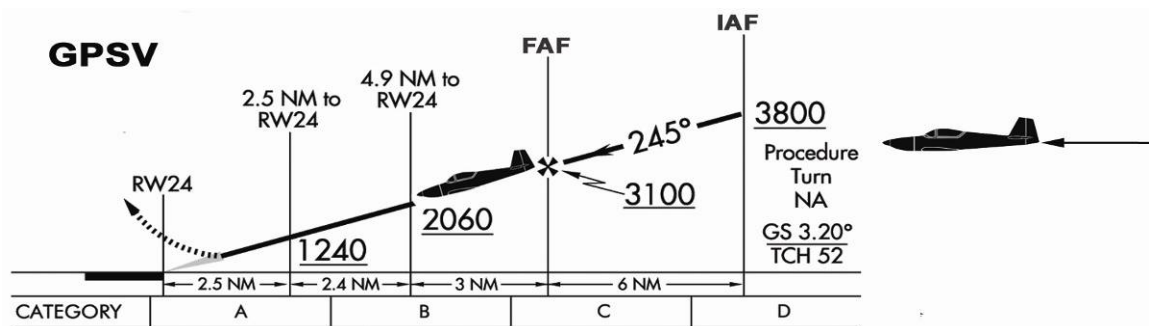
GPSV Guidance

A certified WAAS GPS system allows vertical tracking of RNAV descents into approved airports.

This **GPSV** function will not be active during the en-route portion of a flight plan and becomes active only when the WAAS GPS is configured for the approach and the final approach is initiated. At this point, the receiver recognizes that the approach is valid and provides the proper data signal to the autopilot for vertical navigation.

Approaches

- The approach will normally begin with the Pro Pilot in the **ALT HLD** (Altitude Hold) mode, although the autopilot **VS** mode or externally (EFIS) generated vertical navigation may be active.
- When the vertical data signal becomes valid, the blue **GPSV LED** will blink and the autopilot will be forced automatically to the **ALT HLD** mode. The blinking blue **GPSV LED** indicates that the Pro Pilot has identified the ARINC vertical tracking data.
- At this time, the display screen will show the vertical distance to the descent path into the airport. The screen shown here illustrates that the descent line is just 420 feet above the aircraft as it intercepts. The aircraft will command a “bend over” pitch down just prior to intercept so that it doesn’t overshoot the line.



When the aircraft intercepts the descent line,

- The **GPSV LED** will glow steadily.
- The autopilot **V MODE** indicator will automatically change to the **AS/VS** mode (**AS/VS LED** will illuminate) and begin the descent.
- The display screen will continue to show the vertical and horizontal tracking accuracy.

In most cases, ATC will assign your intercept altitude well below the glideslope descent line. The aircraft flight path will be such that the aircraft intercepts the descent path from below the line.

However, the autopilot will allow as much as a 500 foot above the line intercept condition. In this case the ARINC vertical tracking data will become active when the aircraft is positioned above the descent path. The autopilot will now command an immediate “bend over” to intercept the descent path.

NOTE: If the aircraft path is more than 500 feet above the descent path the approach will be immediately terminated, and the autopilot will flash an abort message and enter **ALT HLD** until the vertical servo is disengaged.

EFIS GPSS and GPSV Guidance

Compatible EFIS systems provide an ARINC 429 data signal that enables the **GPSS** and **GPSV** functions of the Pro Pilot. This allows the EFIS heading and altitude bugs to control the aircraft through the autopilot.

- If the EFIS is sending the appropriate ARINC 429 commands, the blue **GPSS** and **GPSV** LEDs will illuminate.
- If the autopilot is receiving only valid **GPSS** data, only the **GPSS** LED will illuminate.
- The **H MODE** must be set to the **TRK** (Track) mode, and the **TRK LED** must be illuminated for the autopilot to respond to the EFIS commands.
- The EFIS may provide flight plan data for en route navigation as well as approved approaches.

Operational procedures and interface controls on available EFIS systems vary widely. Most will provide means for heading and altitude control as well as GPS navigation. It is therefore necessary for the pilot to become proficient in the operation of the EFIS system before attempting to use it with the autopilot.

- EFIS systems obtain their navigation information from either an external or internal GPS system incorporated into their product. The performance of the autopilot will be directly affected by the quality of the navigation data that it is obtaining from the EFIS.

Often, the aircraft will have more than one navigational signal source available to the Pro Pilot.

- Many EFIS systems get their navigation data from an external GPS receiver. It is advisable to install a means to connect the autopilot data inputs to each alternative signal source provided.
- It is common to have a handheld backup GPS receiver for use in the event that the primary receiver fails.
- In the event that the primary GPS or EFIS failure, the Pro Pilot can be quickly connected to the alternate signal source by use of a simple switch.
- Some example switch arrangements are shown in the wiring chapter.

Unusual Conditions

Although it is impossible to list all the various failure modes that can occur with multiple complex systems, some points are worthy of note.

1. Under any condition, turning off the Pro Pilot servos positively returns control of the aircraft to the pilot. This can be accomplished via the servo buttons on the face of the bezel, the remote autopilot disconnect switch, or by removing power from the autopilot.
2. Selecting the **CRS** or **INT** mode on the autopilot positively disconnects the autopilot from the ARINC inputs, whether sourced from the EFIS or GPS receiver.
3. If there are multiple ARINC or RS-232 sources available, installing a selection switch allows the Pro Pilot to independently access each source. If the primary signal source fails, the pilot can quickly select an alternative such as using the data signal from a portable GPS receiver.

Example Approach Scenario

For purposes of illustration, assume we are cruising in the en-route mode, the Pro Pilot is using the ARINC 429 data for roll steering commands and is in altitude hold mode at 4,500 feet. The destination is Palomar Airport in Carlsbad, California (a sample approach chart is shown below).

In this case we are using a Garmin 400W or 500W series WAAS receiver which is approach certified.

The approach plate shows two possible initial approach fixes (**IAF**), GAYGE and ICUGA. There is an intermediate fix (**IF**) at KANEC intersection and a final approach fix (**FAF**) at JABAL. If we begin our approach at ICUGA, the chart shows that we must not descend below 3800 feet as we transition to KANEC. The chart also stipulates that we must remain above 3100 feet between KANEC and JABAL.

After contacting approach control, we request the RNAV LPV approach using the ICUGA transition and the controller responds with instructions to remain above 4,000 feet until reaching ICUGA.

Approaching ICUGA, we use the Altitude Select (**ALT SEL**) mode on the Pro Pilot to set the target altitude to 4,000 feet, with a descent rate of 500 feet/minute. Once the aircraft reaches 4,000 feet it automatically enters the Altitude Hold (**ALT HLD**) mode and continues the approach at that altitude.

Upon reaching ICUGA the aircraft turns and flies directly to KANEC.

We now slow the aircraft to approach speed. When we arrive at KANEC and begin the turn toward JABAL (still in **ALT HLD**) the **GPSV** LED begins to blink, indicating that the descent signal has become active.

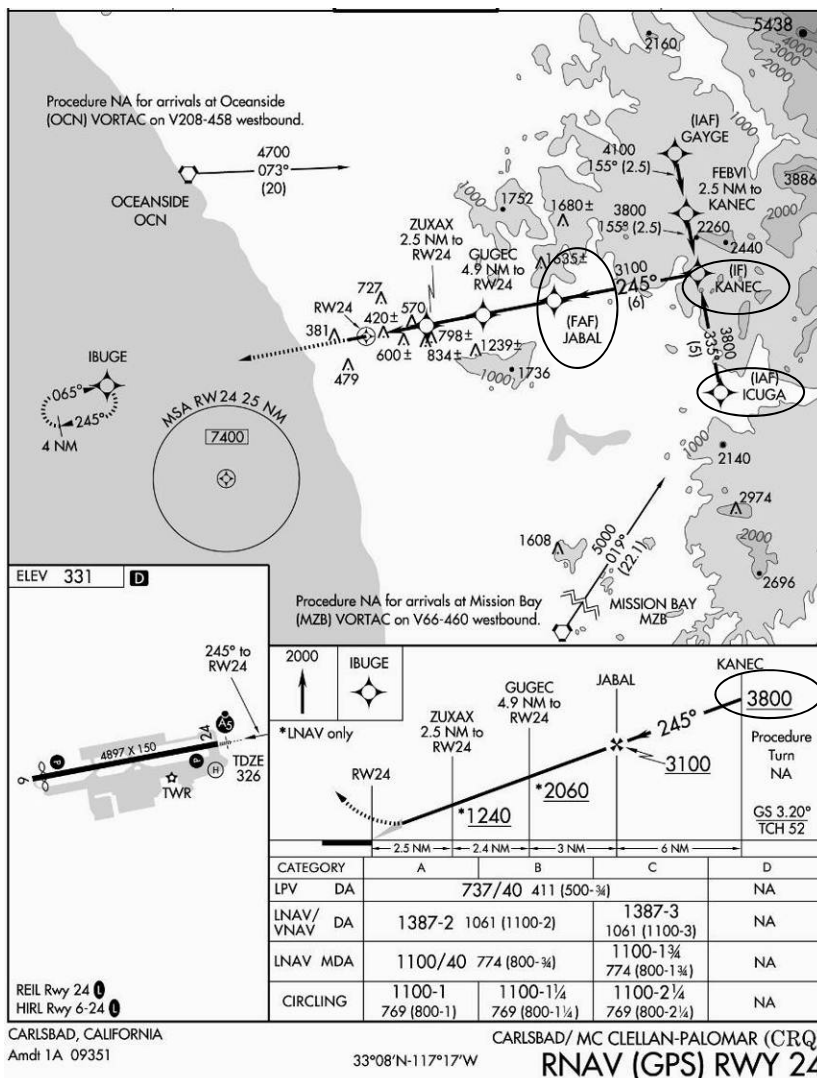
The R/H side of the display screen automatically changes to show the cross track error in the top line of the screen, and the bottom line shows that the descent line is some 800 feet above the aircraft.

The aircraft remains in **ALT HLD** as it continues toward JABAL and the display screen shows that the vertical distance to the descent line is decreasing.

The screen to the right shows the line is now 420 ft. above the aircraft) and is tracking within .01 NM of the horizontal centerline.



The **GPSV** LED continues to blink until the descent line is just a few feet above the aircraft, at which time it begins to glow steadily and the Pro Pilot commands a “bend over” maneuver. The aircraft pitches down and begins to descend. The pilot immediately retards the throttle to remain at approach speed. The Pro Pilot will now direct the aircraft to remain on the lateral/vertical descent path to the airport.



Chapter 10

Fuel Management System Operation

The fuel management option for the Pro Pilot allows the pilot to view multiple fuel parameters. It provides a means to accurately measure fuel flow (in gallons or liters), fuel remaining and fuel used. It employs the GPS data to compute available range and time remaining. This feature requires the installation of a small pushbutton on the panel or control stick.

The fuel flow in **GPH** (gallons per hour) or **LPH** (liters per hour) is always available in the variable data on the bottom right quadrant of the display. Rotating the encoder knob will cycle through the GPS data screens to bring this data into view.



- A small momentary pushbutton, mounted to the instrument panel or control stick allows the pilot to view additional fuel parameters.
- Pressing the remote pushbutton, regardless of what is being shown on the autopilot display screen, will bring up the displays as shown below.
- Each fuel display will remain viewable for a 5 second period before timing out and returning to the normal autopilot display. However, if the button is pressed again during that 5 second period, the screen will advance to the next fuel display.

In this manner, all fuel parameters are always available with the press of a button.

Display Screens

Five screens are available when using the remote pushbutton. The first screen presented is the screen that was on the display when last viewed. In the example below this would be the GPH display

```
BTW 245 FUEL GPH
TRK 244 8.0
```

The first time the button is pressed the right hand side of the screen will show a larger display of the **FUEL GPH**.

```
BTW 245 FUEL REM
TRK 244 31.2 GAL
```

The second press of the button will display the **FUEL REM** (Fuel Remaining) screen.

```
BTW 245 TIME REM
TRK 244 2:46
```

The third press of the button will display the **TIME REM** (Time Remaining) which indicates the time until the tanks are empty.

```
BTW 245 USED
TRK 244 31.2 GAL
```

The fourth press of the button will display **USED** (Fuel Used). This parameter will accumulate until the pilot resets it as described below.

BTW 245 FUEL RNG
TRK 244 237 MI

The fifth press of the button will display **FUEL RNG** (Fuel Range) to advise the pilot how far the aircraft can fly (at the current speed and fuel consumption) until fuel depletion.

LOW FUEL ALARM
8 GAL

The display will also show a flashing warning if the remaining fuel falls below a quantity that was set in the **CONFIGURATION** menu.

NOTE: When this warning is displayed, it will stay on the screen until the pilot acknowledges it by pressing the remote fuel pushbutton, or any other button on the control head. The button must be pressed while the warning is present on the screen. Once it has been acknowledged it will not appear again.

SET FUEL USED TO
ZERO IN 4 SEC

The fuel **USED** will accumulate until reset by the pilot. If desired, it can be left to accumulate for a multi day cross country flight even though fuel has been added multiple times.

FUEL USED = ZERO

The fuel **USED** may be reset to zero by pressing and holding the remote pushbutton for 5 seconds. After one second, the display above will appear, showing a countdown.

- If the switch is held until the countdown reaches "0", the fuel **USED** display will be reset to "0" when the **FUEL USED = ZERO** display appears.
- If the button is released before the display reads **FUEL USED = ZERO**, the fuel **USED** will remain unchanged.

Chapter 11

Configuration Menu

The Pro Pilot provides a quick and easy method to set up certain parameters - some that are normally only changed during installation and some that are commonly accessed in flight. These are divided into two different menus, the “**Configuration Settings Menu**” and the “**Preferences Settings Menu**”.

- The **Configuration Menu** may be accessed by pressing and holding the encoder knob only while turning on the power to the system. These are settings that normally are set up one time and need not be addressed again. Some parameters, such as setting servo direction, are not accessible in flight.
- The **Preferences Menu** is accessed by pressing the encoder knob and holding it in for 3 seconds while in the navigation display. These menus contain settings that the pilot can adjust in flight to optimize the Pro Pilot for current flight conditions.

Using the Configuration Menus

The **Configuration** menu may be accessed in flight in the following manner:

With the power off, press and hold the encoder knob while turning on power to the Pro Pilot.

Once the **CONFIG SETTINGS** screen is observed release the encoder knob.

Paging through the options is accomplished by pressing the encoder knob sequentially to sequence forward, or by rotating the encoder knob to move to the next or previous display.

Once the appropriate screen has been selected, pressing the **H MODE** button will activate the cursor and place the triangular arrow on the screen indicating the display values can be adjusted or changed. Rotating or pressing the encoder will change the screen settings. The screen will not update if the arrow is not present.

To exit a screen, press the **H MODE** button until the arrow is no longer present on the display. This makes it possible to again page through the setup screens using the encoder knob..

To exit the **CONFIGURATION SETTINGS** menu, press and hold the encoder knob for a period of 3 seconds and the screen will return to the navigation functions.

Settings Available In the Configuration Menu

- **MIN AS SET** - Sets the minimum airspeed limit for the autopilot
- **MAX AS SET** - Sets the maximum airspeed limit for the autopilot
- **VNAV SERVO SET** - Allows setting of the VNAV servo direction (* not available in flight)
- **V_TRIM SPEED/DIR** – Allows setting speed and direction of the VNAV trim motor if the auto-trim option is installed
- **HNAV SERVO SET** – Allows setting the HNAV zero position and servo direction (* The direction setting is not available in flight)
- **AS/VS SELECT** – Sets the airspeed capture (AS) or vertical speed capture (VS) option for PCS
- **MAX TURN RATE** – Sets the automatic or manual maximum turn rate
- **CIRCLE LAST WPT?** – Sets the option to circle the last flight plan waypoint or to proceed on prior course thereafter
- **SET_DEFAULT VERT RATE** – Allows selection of the default vertical rate
- **AP DISCONNECT MD** – Allows selection of just the HNAV or VNAV or both on PCS disconnect action if two yoke/stick PCS buttons are installed. A single button should always be AND (both).

- **RESTORE DEFAULTS** - Allows reset of both or either VNAV or LNAV factory settings
- **LED FLASH RATE** – Choose FAST FLASH, SLOW FLASH or NO FLASH for all LED's
- **Custom Startup screen Display setting** – Allows configuration of the custom startup screen
- **Autopilot serial number and firmware version**– Provides the firmware version and the unit serial number for factory reference
- **ZERO FLT DATA ON POWERUP** – When set to “yes” this will reset the flight timers to 0 prior to a flight. When set to “no” it will accumulate data over several flights, until reset manually.

The following paragraphs describe how to select and change the various configuration settings.

Minimum Airspeed Setup

The Pro Pilot is capable of commanding the aircraft to climb and descend at rates up to 2000 feet per minute. It is therefore necessary to assure that the system cannot stall or over-speed the aircraft, even if a pilot enters a command that would precipitate such an event.

The autopilot senses airspeed from the aircraft pitot system and allows the pilot to set minimum and maximum airspeed limits to assure that the airplane will operate in a safe flight regime when the autopilot is operating the control systems.

Minimum and maximum airspeeds are selected by the pilot by manually flying the aircraft to the airspeed desired and then recording the resultant pitot pressure (IAS) into the system. The **V NAV** servo will automatically be turned OFF when this menu is selected.

To enter set the **MINIMUM IAS SET** selection, perform the following steps:

1. Enter the **CONFIGURATION** menu as detailed previously and select the **MINIMUM AS SET** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the left side of the lower line. The **ARMED** message will appear on the bottom line.
3. Fly the airplane to the minimum airspeed you wish to set and stabilize at that airspeed.
4. Once the airspeed has stabilized, press and release the encoder knob
5. Observe that the bottom line displays the "**CAPTURE**" message.
6. Press and release the **HMODE** button.





The **MINIMUM AS SET** procedure is complete and the encoder can now be used to select another menu screen.

Note: In actual use, the dynamics of an aircraft in an ascent will likely allow the airplane to decrease speed somewhat below the limit before the system can effectively increase the speed of the aircraft by lowering the nose. It is therefore best to set the limit with extra margin to allow for this.

Maximum Airspeed Setup

To enter set the **MAXIMUM IAS SET** selection, perform the following steps:

1. Enter the **CONFIGURATION** menu as detailed previously and select the **MAXIMUM AS SET** menu.
2. Press and release the **HMODE** button. The arrow will be placed at the left side of the lower line. The **ARMED** message will appear on the bottom line.
3. Fly the airplane to the maximum airspeed you wish to set and stabilize at that airspeed.
4. Once the airspeed has stabilized, press and release the encoder knob
5. Observe that the bottom line displays the "**CAPTURE**" message.
6. Press and release the **HMODE** button.



MAXIMUM IAS SET
OFF



MAXIMUM IAS SET
▶ARMED



MAXIMUM IAS SET
▶CAPTURE

The **MAXIMUM AS SET** procedure is complete and the encoder can now be used to select another menu screen.

Note: In actual use, the dynamics of an aircraft in a descent will likely allow the airplane to increase speed somewhat beyond the limit before the system can effectively slow the aircraft by raising the nose. It is therefore best to set the limit with extra margin to allow for this.

Testing the MIN/MAX airspeed limits is accomplished by exiting the **CONFIGURATION** menu and returning to the navigations screens (Press and hold the encoder knob for 3 seconds). Engage the **V NAV** servo and note that the system is in **ALT HLD** and the aircraft is level.

Press the **V MODE** button until the **SET VS** screen appears. Then rotate the encoder to specify a climb rate. Press the encoder to initiate the climb. Once the aircraft is established in the climb, slowly retard the throttle until the airspeed decays to the minimum airspeed that you have previously set. The display should flash the message "**MIN AS LIMIT**".

Check to be sure that the system lowers the nose of the aircraft so that the airspeed settles out at the minimum airspeed that you have set. The screen will then display "**MIN AS CAPT**" as the autopilot continually adjusts the elevator control to keep the speed at this limit.

The pilot should then check the maximum airspeed alarm limit by re-entering the **SET VS mode** and dialing in an appropriate descent rate. When the maximum airspeed limit is achieved the display should flash the message **MAX AS LIMIT** and the system should raise the nose of the aircraft to slow it to the prescribed limit. Here again, as the speed slows, the display will show a **MAX AS CAPT** message after the speed has decreased to the maximum airspeed setting. The autopilot will then adjust the elevator to maintain a speed at the set limit.

Exiting from either minimum or maximum airspeed alarm indicators requires a press of any of the quadrant buttons. The **H NAV** and **V NAV** servos will be disconnected and it will be necessary to control the aircraft manually. Once airspeed is reestablished to normal flight parameters, the **H NAV** and **V NAV** servos may be engaged. **TRK** and **ALT HLD** will be resumed.

Initial Setup of the Vertical Navigation Servo

Depending upon how the servos were mounted, the proper direction of rotation of the crank arm must be assured.

VNAV SERVO SET menu screen allows setting the direction of rotation of the **V NAV** servo. Initially the screen will appear



VNAV SERVO SET
POS -44.5 DIR=NM

as shown.

To set the servo direction, perform the following steps:

1. Select the **CONFIGURATION SETTINGS** menus as detailed previously
2. Press and release the **H MODE** button. The arrow will be placed at the polarity field (**NM** or **RV**)
3. Press and release the **V NAV** servo button. The servo will drive to it's zero position
4. Rotate the encoder knob clockwise. Observe that the elevators move in a direction that will cause the airplane to climb.
5. If this is correct, proceed to step 7. If not, continue
6. Press and release the encoder knob. Observe that the servo drives back to center and the **DIR** field changes to the opposite polarity **RV(NM)**. Repeat steps 4 and 5
7. Press and release the **H MODE** button. Record the polarity for future reference.



VNAV SERVO SET
POS -44.5 DIR NM



VNAV SERVO SET
POS -44.5 DIR RV

The **VNAV SERVO SET** is complete and the encoder can now be used to select another menu screen. Press the **H MODE** button to remove the arrow.

Once the servo direction is set correctly, the result is stored in non-volatile memory and need not be adjusted again.

NOTE: As a safeguard, the servo direction cannot be set while airborne. Some parameters in the **CONFIGURATION** menu cannot be accessed when there is airspeed or GPS groundspeed present.

Initial Setup of the Horizontal Navigation Servo

The **HNAV SERVO SET** menu screen allows setting both the servo zero position and the direction of rotation of the **H NAV** servo. The proper direction of rotation of the servo and the initial zero point must be assured

Initially the screen will appear as shown. 7500 is a reference number denoting the servo center position. Limits of these reference only numbers are 6000 to 9000.




HNAV SERVO SET
POS 7500 DIR=NM

To set the **H NAV** servo zero position and direction, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus as detailed previously and select the **HNAV SERVO SET** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the direction
3. Press and release the **HNAV** servo button. The servo will now drive to its mechanical zero position and the display will read the factory setting of 7500.
4. Rotate the encoder knob clockwise. Observe that the **H NAV** servo moves in a direction that will cause the airplane to turn to the right.
5. If this is correct, proceed to step 7. If not, continue
6. Press and release the encoder knob. Observe the direction field changes to the opposite polarity **RV(NM)**. Repeat steps 4 and 5
7. Rotate the encoder to a setting that puts the ailerons in their normal, in-flight neutral position. Record this number and the polarity for future reference.
8. Press and release the **H MODE** button.

The **HNAV SERVO SET** procedure is complete and the encoder can now be used to select another menu screen. Once these servo directions are set, the result is stored in non-volatile memory and need not be adjusted again.

NOTE: As a safeguard, the servo direction cannot be set while airborne. When airspeed or GPS groundspeed is present, the **NORM** and **REV** messages do not appear and this function is disabled.

 If the aileron center number is near the extremes, it might be necessary to check the mechanical servo linkage. With the ailerons centered the number should be near somewhere near 7500.

Selecting Airspeed or Vertical Speed for PCS

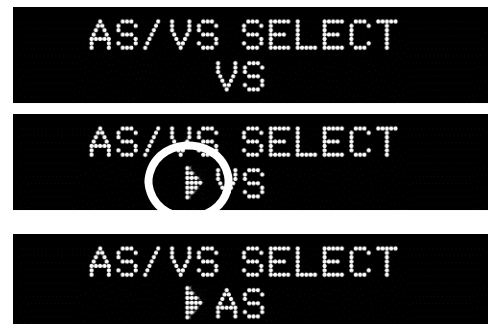
The AS (airspeed)/VS (vertical speed) select screen allows setting of the mode of the PCS steering function.

When the PCS mode is activated (by pressing and holding the servo disconnect switch for greater than 5 seconds while the servos are active) the autopilot could be placed into one of three different modes.

- If the selection is to **VS** and the vertical rate is in excess of 200 feet per minute, either up or down, then the autopilot will capture the current vertical rate.
- If the selection is to **AS**, and the vertical rate is in excess of 200 feet per minute, either up or down, and the then the autopilot will capture and maintain the current indicated *airspeed*. *This is useful for maintaining a constant airspeed for engine cooling in a prolonged high power climb condition.
- If the vertical rate is less than 200 feet per minute in either selection, then the **ALTITUDE HOLD** mode will become active.

To set the **AS** or **VS** selection, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus as detailed previously and select the **AS/VS SELECT** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the **AS(VS)** field
3. Rotate, or press the encoder to change the selection
4. Press and release the **H MODE** button.



The **AS/VS SELECT** procedure is complete and the encoder can now be used to select another menu screen.

Setting Maximum Turn Rate

A “standard rate turn” of 3 degrees per second may result in a comfortable bank angle at 130 knots, but as speed increases the bank angle must be increased to achieve the standard rate of turn.

In faster aircraft this steeper bank may be uncomfortable to some pilots and, indeed, may exceed the capability of an altitude hold system to maintain altitude properly in the turn. To remedy this, the Pro Pilot has a means whereby the users can adjust the maximum rate of turn to their personal satisfaction.

When shipped, the Pro Pilot is defaulted to an “automatic” mode where the actual turn rate is automatically adjusted based on groundspeed (as measured by your GPS) to limit the bank angle to approximately 15 to 20 degrees. For aircraft cruising at groundspeeds of 140 knots or greater the automatic mode will decrease the allowable turn rate to keep the aircraft bank angle at a comfortable maximum of approximately 15 degrees. Slower speeds will allow a standard rate turn of 3 degrees per second.

Alternatively, if your cruise groundspeed is typically less than 150 knots, or if you do not mind the higher bank angles at the higher groundspeeds, you may want to select the **MANUAL** mode. In the **MANUAL** mode you can set the maximum turn rate to a fixed limit. It is adjustable from 1 degree/sec to as high as 3 degree/sec, in increments of 1/10th degree/sec.

To set the **TURN RATE** selection, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus as detailed previously and select the **MAX TURN RATE** menu.
2. Press and release the **HMODE** button. The arrow will be placed at the **AUTO (MAN)** field
3. Rotate, or press the encoder to change the selection between **AUTO** and **MAN**
4. If a manual rate is desired, select the **MAN** field and then press and release the **HMODE** button. You may take this number as low as 1 degree/sec, but be advised that this will result in very slow turns and autopilot performance may be unacceptably sluggish. If **AUTO** is desired, select **AUTO** then proceed to step 6
5. With the arrow selecting the manual rate, rotate the encoder to select the desired rate
6. Press and release the **HMODE** button.



The **MAN TURN RATE** procedure is complete and the encoder can now be used to select another menu screen.

Circle Last Waypoint Setting

This selection allows you to either home to the last waypoint in a flight plan or GOTO waypoint, or to track outbound from the last waypoint.

- If the option is set to **NO**, the Pro Pilot will track directly outbound from the last waypoint in a flight plan, or the GOTO waypoint. The waypoint identifier will be placed in the lower left display line upon waypoint passage and will flash for 10 seconds to indicate passage.
- If the option is set to **YES**, the Pro Pilot will turn the aircraft to effectively "home" to this last waypoint. Both modes remain in their respective states until the **HNAV** mode of the Pro Pilot is changed, or a new waypoint is selected.

To set the **CIRCLE LAST WPT** selection, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus as detailed previously and select the **CIRCLE LAST WPT?** screen.
2. Press and release the **H MODE** button. The arrow will be placed at the **YES (NO)** field
3. Rotate, or press the encoder to change the selection
4. Press and release the **H MODE** button.



The **CIRCLE LAST WPT?** procedure is complete and the encoder can now be used to select another menu screen.

Vertical Navigation Servo Deadband

The **VNAV** servo deadband may be tailored to optimize vertical tracking performance for the particular airplane. The factory setting of 6 is normally optimal for most application. Lowering this number will increase the tracking resolution of the system, while raising the number will have the opposite effect.

Care must be taken not to lower the deadband setting below a value that causes servo oscillation in-flight or during ramp operation with the servo engaged.

To set the **VNAV SERVO DB** selection, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus as detailed previously and select the **VNAV SERVO DB** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the setting field
3. Rotate the encoder to change the selection.
4. Press and release the **H MODE** button.



VNAV SERVO DB
6



VNAV SERVO DB
▶ 6

The **VNAV SERVO DB** procedure is complete and the encoder can now be used to select another menu screen.

Set Default Vertical Speed Rate

Upon activation of the altitude preselect function, either the vertical rate set into the **VS SET** display, or a default vertical rate will become active. If no vertical rate is set when the altitude preselect function is activated, the vertical default rate will be used for either the climb or descent to the desired altitude. The following procedure sets that default vertical rate.

To set the **SET DEFAULT VERT RATE** selection, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus and select the **SET DEFAULT VERT RATE** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the rate setting field
3. Rotate the encoder to change the selection.
4. Press and release the **H MODE** button.



SET DEFAULT VERT
RATE = 500



SET DEFAULT VERT
RATE ▶ 800

The **VNAV SERVO DB** procedure is complete. The encoder may be used to select another screen.

Autopilot Disconnect Mode

The Pro Pilot is designed to accommodate either separate **V NAV** and **H NAV** remote autopilot disconnect switches or the use of a single switch to control both functions. This menu allows the selection of using either switch to separately activate the disconnect function separately for the respective axis, or have either switch activate the disconnect function for both axes.

- If the setting is "**OR**", then the switches act independently.
- If the setting is "**AND**", then a single switch input is used for both the **V NAV** and **H NAV** disconnect functions.

To set the **AP DISCONNECT MODE** selection, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus and select the **AP DISCONNECT MODE**
2. Press and release the **H MODE** button. The arrow will be placed at the setting field
3. Rotate or press the encoder to change the selection.
4. Press and release the **H MODE** button.



AP DISCONNECT MD
HNAV AND VNAV



AP DISCONNECT MD
▶ HNAV OR VNAV



For safety reasons, the pilot should consider a single remote disconnect button to disconnect both servos with a single click: (**AND**). While provision has been made for two remote disconnect buttons that will allow separate horizontal and vertical functions (including PCS), this

should be employed only when the user has an overriding need for separate control.

The **AP DISCONNECT MODE** procedure is complete and the encoder can now be used to select another menu screen.

Restore Defaults

Several of the variables used to optimize Pro Pilot performance including the servo zero and direction settings are captured to EEPROM (non volatile memory) during initial setup. Further, tracking gains that are set for differing flight conditions are also maintained in system EEPROM.

On rare occasion these values may become corrupt if a power transient occurs during an EEPROM write procedure, or the pilot may inadvertently change settings that cause poor autopilot performance. The restore default procedure allows a quick method to restore all these values back to their factory settings.



It is good practice to record all the variable settings you change from the factory settings so these may be replaced after the restore defaults procedure.

The **RESTORE DEFAULTS** procedure allows either one or both **HNAV** or **VNAV** parameters to be reset.

To perform the **RESTORE DEFAULTS** procedure, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus as detailed previously and select the **RESTORE DEFAULTS** mode.
2. Press and release the **H MODE** button. The arrow will be placed at the "ALL" setting field. Press the encoder knob to activate the restore. The display will flash when the function is complete.
3. If it is desired to reset only the **H NAV** defaults, Press and release the **H MODE** button to position the cursor adjacent to **HNAV**. Press the encoder to activate. The **HNAV** display will flash when the function is complete.
4. If it is desired to reset only the **VNAV** defaults, Press and release the **H MODE** button again to position the cursor adjacent to **VNAV**. Press the encoder to activate. The **VNAV** display will flash when the function is complete.
5. Press the **H MODE** button until the right arrow is absent from the display



The **RESTORE DEFAULTS** procedure is complete and the encoder can now be used to select another menu screen.

Setting LED Flash Rate

The **AS/VS** and **ALT SEL** LEDs are set at the factory to flash only when an active climb/descent is underway. Experiments with a number of test pilots have shown a variety of opinions and preferences regarding flashing lights in the cockpit.



Therefore, the user has the choice of selecting three configurations for the LEDs. – **SLOW FLASH**, **FAST FLASH** or **NO FLASH**.



When on the screen, press the **H MODE** button to bring the cursor up on the bottom left hand side of the screen.

Once the cursor is visible, rotate the encoder knob to change the flash rate or select **NO FLASH**.



Press the **H MODE** button again to remove the cursor and save the setting into non-volatile memory.

The **LED FLASH RATE** procedure is complete and the encoder can now be used to select another menu screen.

Custom Startup Display Screen

This screen is designed to provide a message of your choosing at power up. There are two lines of 16 characters each available for custom programming. The screen may show a Trio Avionics logo and firmware number, but this may be changed by the user.



Typically, most Pro Pilot customers place their name on the top line of the display and the aircraft model and tail number on the second line. This display can be changed at any time to any configuration desired.



Press the **H** or **V MODE** button to position a flashing cursor at the first character position. The front panel switches function as follows:

- **Rotary Encoder** - Selects the displayed character from a set of available characters.
- **Encoder Pushbutton** - Selects the cursor position. The cursor will wrap around from the last character position on line 2 to the first character position on line 1.
- **H or V MODE button** - Terminates writing to the screen and removes the cursor from the screen.

NOTE: The characters are written to non-volatile memory as each character is changed. If you accidentally sequence out of this screen (or turn off power) whatever information that was present on the screen at that time will be retained in memory.

Zero Flt Data on Power Up

This **CONFIGURATION** menu selection allows automatic reset of the **FLIGHT TIME** and **FLIGHT DISTANCE** on each power up sequence. The factory default is "**NO**", but if the user wishes to have this reset automatically for each flight, it should be set to "**YES**".

The selection is enabled by pressing the **HMODE** button which places an arrow next to the variable field (**YES/NO**). Rotating or pressing the **ENCODER** changes the "**YES/NO**" variable. The selection is exited by pressing the **HMODE** button which erases the arrow and returns the encoder function to display selection.

To prevent a momentary loss of power (while in flight) from resetting the values, the autopilot monitors airspeed and will not allow an automatic reset while in flight.

Note: The **TOTAL TIME** and **TOTAL DISTANCE** values are not affected if this option is enabled.

Chapter 12

Autopilot Preferences Menu

The Preferences Settings menus are designed to allow setting of various parameters while the autopilot is being used in flight. For example, the **HNAV** fine tracking gains may be adjusted for optimal navigation tracking performance for a particular airplane and GPS. Setting of the trim speeds for the **VNAV** servo is another example of in-flight adjustments

Using the Preferences Menu

To enter the Preferences Menu, press and hold the encoder knob for a period of 3 seconds while in the navigation display. The navigation display will be replaced by the setup screens. Paging through the setup screens is accomplished by repeatedly pressing the encoder knob or by rotating the encoder knob.

Once the appropriate screen has been selected, press the **H MODE** button to activate the cursor and place the triangular arrow next to the value that is to be adjusted. Once the cursor is in place, rotate the encoder or, in some cases, press the encoder to change the value. The value will not change if the triangular arrow is not present on the display screen.

To exit that screen, press the **H MODE** button until the cursor is no longer present on the display. It is now possible to use the encoder to page through the setup screens.

To exit the menu, press and hold the encoder knob for a period of 3 seconds and the screen will return to the navigation functions.

Settings Available In the Preferences Settings Menu

- **BACKLIGHT and DISPLAY SET** – Sets the brightness levels if the remote dim isn't used
- **CONTRAST ADJUST** – Sets the contrast for the LCD display
- **DISPLAY BRIGHT SET** – Sets the display brightness for the OLED display screen
- **FL DIST, FL TIME** – Displays re-settable flight distance and flight time
- **TOT DIS, TOT TIME** – Display non-resettable total distance and total time
- **SET HNAV GAINS** – Adjusts horizontal **H NAV** fine tracking gains
- **SET H SERVO GAIN** – Adjusts **H NAV** servo response gain
- **VNAV GAIN SETS** – Adjusts gain for the altitude hold and vertical speed modes
- **VNAV SERVO DB** – Optimizes the **V NAV** servo dead-band setting

Backlight Set and Display Brightness Set (OLED Model Only)

This display screen that is shown on this menu item will depend upon which display module has been installed in the Pro Pilot – OLED or LCD.

The **BACKLIGHT SET** applies to both the LCD and OLED models and controls the backlighting of the indicators, LED's and buttons. The **BACKLIGHT SET** also controls the backlighting of the LCD screen (but not the OLED screen which has its own separate lighting menu). It allows setting the level of the display if the remote analog dim (panel dimmer) interface is not being used. The **BACKLIGHT SET** setting has nine levels of intensity with a setting of 1 being the dimmest setting.

The DISPLAY BRT value adjusts the brightness of the characters that appear on the OLED screen. This setting also has nine levels of intensity with a setting of 1 being the dimmest setting. **NOTE:** When the external dimming feature is employed (using the aircraft panel dimmer) a maximum of 8 levels is available.

To enter the **BACKLIGHT SET** and **DISPLAY BRT** selections perform the following steps:

1. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **BACKLIGHT SET** and **DISPLAY BRT** menu.
2. Press and release the **H MODE** button. The arrow will be placed to the left of the **BACKLIGHT SET** value.
3. Rotate the encoder to change the value.
4. Press and release the **H MODE** button to advance the cursor to the **DISPLAY BRT** value.
5. Rotate the encoder to adjust the brightness of the OLED display screen
6. Press and release the **H MODE** button again to remove the cursor from the screen.



The procedure is complete and the encoder can now be used to select another menu screen.

Backlight Set and Contrast Set (LCD Display only)

The **CONTRAST SET** menu allows setting the contrast level for the LCD display. The polarizer lens on the LCD display can cause an apparent lack of contrast in an off-angle viewing of the display. The contrast adjustment can be used to improve the readability of the display for these off angle viewing installations. This menu is not available for the OLED display as it is not required.

To enter the **CONTRAST ADJUST** election, perform the following steps:

1. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **BACKLIGHT SET** and **CONTRAST SET** menu.
2. Press and release the **H MODE** button. The arrow will be placed to the left of the **BACKLIGHT SET** value.
3. Rotate the encoder to change the value.
4. Press and release the **H MODE** button to advance the cursor to the **CONTRAST SET** value.
5. Rotate the encoder to change the contrast setting for best view ability.
6. Press and release the **H MODE** button. The cursor arrow will disappear.



The **CONTRAST ADJUST** procedure is complete. The encoder can now be used to select another menu screen.

Flight Distance and Flight Time

The flight distance and flight time (**FL DIST**, **FL TIME**) displays accumulate flight time and flight distance when a speed of 45 knots or above is maintained. These counters can be individually reset to zero at any time by selecting the appropriate display line and then pressing the encoder button to perform the zeroing.

For these timers to operate, the host GPS must be on and have achieved satellite lock. The time and distance information is saved in non-volatile memory once per minute so that, if power is lost momentarily, a maximum of only 1 minute of time and distance information will be lost.

The flight distance counter measures actual distance flown, including excursions from the programmed flight plan. For example, if you flew a 50 mile detour between two waypoints 200 miles apart, the actual distance added to the distance counter will be 250 miles.

All distance measurements are based on nautical miles so it is recommended the host GPS receiver be programmed to measure the distance in nautical miles vs. statute miles or kilometers.

The flight time counter measures actual flight time when the airspeed exceeds approximately 45 knots, as measured by the GPS.

The flight time or distance may be zeroed using the procedure below.

1. To enter the **FL DIST, FL TIME** selection, perform the following steps:
2. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **FL DIST, FL TIME** menu.
3. Press and release the **H MODE** button. The arrow will be placed at the FL DIST setting value. To zero this value, press and release the encoder knob.
4. Press and release the **H MODE** button. The arrow will be placed at the FL TIME setting value. To zero this value, press and release the encoder knob.
5. Press and release the **H MODE** to exit this function.



FL DIST▶ 212.3
FL TIME 02.15

The **FL DIST, FL TIME** procedure is complete and the encoder can now be used to select another menu screen.

Accumulated Total Distance, Total Flight Time

This display shows the total accumulated flight time and total accumulated flight distance (**TOT DIS, TOT TIME**) in nautical miles. It is informational only and cannot be reset. The values are saved once each minute during flight in nonvolatile memory.



TOT DIS 1880.3
TOT TIME 17.2

Horizontal Navigation Gain Setting

- See Chapters 11 and 12

Vertical Navigation Gain Settings

- See Chapters 11 and 14

Vertical Navigation Servo Deadband

The **V NAV** servo deadband may be tailored to optimize vertical tracking performance for the particular airplane. The factory setting of 6 is normally optimal for most applications. Lowering this number will increase the tracking resolution of the system, while raising the number will have the opposite effect.

Care must be taken not to lower the deadband setting below a value which causes servo oscillation in-flight or during ramp operation with the servo engaged.

To set the **VNAV SERVO DB** selection, perform the following steps:

1. Enter the **PREFERENCES SETTINGS** menu as detailed previously and select the **VNAV SERVO DB** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the setting field
3. Rotate the encoder to change the selection.
4. Press and release the **H MODE** button.



VNAV SERVO DB
6



VNAV SERVO DB
▶6

The **VNAV SERVO DB** procedure is complete and the encoder can now be used to select another menu screen.

Vertical Trim Motor Speed / Direction

If the option vertical trim has been purchased the Vertical Trim Speed and Direction menu screen shown below will be visible. This option allows setting both the trim motor speed and the direction of rotation of the user supplied trim motor.



```
TL=10 TH=04 D=N
LAS=040 HAS=170
```

This screen allows adjustment of the trim motor speed depending on the speed of the aircraft. Typically, pilots prefer a faster trim movement at the lower airspeed range and slower trim movement at a higher airspeed. The trim speed and direction menu selection allow customizing the trim speed to your particular aircraft.


The screen acronyms and their meaning is as follows:

TL = Speed of trim movement at or below the Low Airspeed Setting
TH = Speed of the trim movement at or above the High Airspeed Setting
D = Trim direction setting (“N”, normal, “R”, reverse)
LAS = Low Airspeed Setting (range 40 to 240 kts)
HAS = High Airspeed Setting (range 40 to 240 kts)

The following limitations must be observed to prevent abnormal trim operation:

- 1.) If the **TL** setting is set below “4” the Trio Pro trim function is disabled.
- 2.) **TL** setting must be equal or greater than the **TH** setting
- 3.) **LAS** setting must be less than the **HAS** setting.
- 4.) Depending upon how the trim motor is wired and mechanically linked, the proper direction of rotation of the trim servo must be assured.

To set the speed of the trim movement and direction, perform the following steps:

1. Enter the **CONFIGURATION SETTINGS** menus as detailed previously and select the trim menu shown
2. Press and release the **H MODE** button. The arrow will be placed at the **TL** speed setting field.

```
TL→10 TH=04 D=N
LAS=040 HAS=170
```

 - Adjust trim movement for low speed flight. A lower number will allow for a slower response (speed of trim movement) to trim errors or pilot input. A higher number will allow a faster response to pitch trim errors or pilot input.
3. Press and release the **H MODE** button. The arrow will be placed at the **TH** speed setting field.
 - Adjust trim movement for high speed flight. A lower number will allow for a slower response (speed of trim movement) to trim errors or pilot input. A higher number will allow a faster response to pitch trim errors or pilot input.
4. Press and release the **H MODE** button. The arrow will be placed at the Trim Direction (**D**) setting field.
 - Toggle the trim motor direction normal (**N**) or reverse (**R**) by momentarily pressing the **ENCODER** button.
 - Turning the **ENCODER** while on this display field will cause movement of the trim motor in the selected direction for verification of proper movement. Rotating the encoder clockwise should induce “up” trim and counter-clockwise should induce “down” trim.

NOTE: The trim direction selection is locked if the aircraft is in a flight condition to prevent reversing this setting in flight. Ensure this setting is accomplished on the ground prior to flight.

-
5. Press and release the **H MODE** button. The arrow will be placed at the **LAS** (low airspeed) setting field.
 - Set the lower airspeed for the corresponding **TL** setting.
 6. Press and release the **H MODE** button The arrow will be placed at the **HAS** (high airspeed) setting field.
 - Set the airspeed corresponding to the low trim speed (**TH**) setting.

The **V-TRIM SPEED/DIR** is complete and the encoder can now be used to select another menu screen.

Trim Setting Example:

The pilot desires a fast trim movement an airspeed of 100 kts for since the trim is less effective at slower airspeeds and a slower trim movement at greater than 150 kts since the trim movement is more sensitive at higher airspeeds.

In this example the pilot enters:

- A trim movement (**TL**) of 18 (very fast trim response)
- The low air speed (**LAS**) setting 100 kts
- A trim movement high (**TH**) of 6 (very slow trim response)
- The high air speed (**HAS**) setting of 150 kts

NOTE: Between an airspeeds setpoints of 100 and 150 kts (**LAS** and **HAS**) the trim movement speed is linearly interpolated between the **TL** and the **TH** settings. In this case, an airspeed halfway between 100 and 150 kts (or 125 kts) would result in the speed of trim movement half way between the **TL** and **TH** setting, in this case 12.

When adjusting the trim values it will be noted that the firmware has been designed to prevent any “crossover” in the settings. That is, the **HAS** can never be lower than the **LAS**, and vice versa. The same is true for the **TL** and **TH** settings.

Chapter 13

Fuel Preferences Menu

Changing Fuel Levels

When fuel is added to the tanks the pilot will use the **PREFERENCES** menu to enter the appropriate amount.

There are three parameters that allow setting the exact amount of fuel on board.

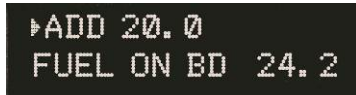


```
ADD TOP REM
FUEL ON BD 24.2
```

- **ADD** allows the user to enter the fuel that was added
- **TOP** will enter the preset amount for full tanks (see **CONFIGURATION** menu)
- **REM** will allow the user to enter the actual amount of fuel that is currently in the tanks.

To use any of these three functions, press the **H MODE** button repeatedly to sequentially change functions. Use only one of the functions (the one you prefer) to adjust the fuel remaining quantity.

Adding Fuel

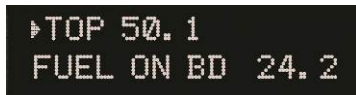


```
▶ADD 20.0
FUEL ON BD 24.2
```

Pressing the **H MODE** button the first time will show the **ADD** function. Rotating the encoder will allow the user to enter the amount of fuel that was added to the tanks (Rotate the encoder for 0.1 increments. Press and rotate for 1.0 increments). The example screen shows that 20

gallons were added. Pressing the encoder will update the **FUEL ON BD** amount by adding 20 gallons to the total.

Topping Fuel Tanks



```
▶TOP 50.1
FUEL ON BD 24.2
```

Pressing the **H MODE** button again will allow the user to quickly enter the amount for full fuel. Pressing the encoder will immediately enter the amount for full tanks. The amount that is entered for the **TOP** quantity is adjustable in the **CONFIGURATION** menu, and should be initialized for

your particular airplane to accurately reflect the amount of fuel when the tanks are full.

Adjusting Remaining Fuel



```
▶REM 24.2
FUEL ON BD 24.2
```

If the user wishes to adjust the amount of actual fuel on board, pressing the **H MODE** button again bring up the **REM** (Remaining Fuel) display. Rotate the encoder to enter the total amount of fuel on board.

NOTE: Remember to press the encoder button to record the amount into memory and exit the screen.

Configuration Menu

The fuel management system may be configured and calibrated in the **CONFIGURATION** menu. Enter this menu by pressing the encoder knob and holding it in while turning the power switch “**ON**”.

Adjusting K FACTOR

The **K FACTOR** determines the accuracy of the fuel readings. The fuel flow transducers are characterized at the factory and the Pro Pilot will be set to the calibrated number, as shown here.

However, because a number of factors in the fuel system installation can affect this, the **K FACTOR** may be calibrated to a more precise number. The adjustment range of the **K FACTOR** also allows various selected fuel flow transducers to be used.



The calibration may be tested by filling the tanks and flying the aircraft until the remaining fuel is down to 25% or less. This will assure a large enough sample to determine accuracy. If it appears that the fuel remaining is not the correct amount (it will likely be very close) The **K FACTOR** may then be adjusted up or down to improve the accuracy.

- Rotate the encoder to bypass all menu items until reaching the screen that displays “ENTER K FACTOR”.
- Press the **H MODE** button to replace the “=” sign with an arrow. Rotate the encoder to change the value of the first digit. Press encoder to advance to next digit. Press **H MODE** to exit.

A more precise method of calibration can be used to accurately determine the **K FACTOR** for factory supplied or other manufactures of fuel flow transducers. If you need to calibrate the **K FACTOR** use the following procedure:

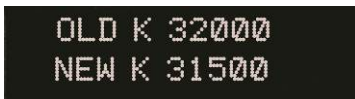


- Fill the tanks to a known level (full tanks are usually the best).
- Zero the **FUEL USED** on the appropriate screen (this will also zero **FUEL USED** on the **CAL K FACTOR** screen shown below).
- Fly the aircraft until most of the fuel has been used.

The **FUEL USED** field on this screen will now show the amount that the computer believes was consumed. Then fill the tanks again and note the exact amount of fuel that was added.

- If it disagrees with the display, press the **H MODE** button to display the arrow instead of the “=” sign and rotate the encoder knob to enter the amount of fuel that was actually used
- Then press the encoder button which will sequence to the screen shown below.

This process will re-compute the **K FACTOR** and the system will now be accurately calibrated.



When the **K FACTOR** computation is complete, the display will show the original **K FACTOR** and the new one that was calculated by using the method described above. This value will be retained in non-volatile memory and should never need to be changed again.

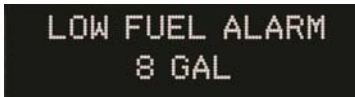
This screen can be exited by rotating or pressing the encoder.

Setting Maximum Fuel Level



The **TOP OFF SETTING** requires the user to enter a value that is equal to the amount of fuel when the tanks are completely full. This assures that the Fuel Remaining readings will always be correct when the pilot employs the **TOP OFF** feature after filling the tanks.

Setting Low Fuel Alarm



The **LOW FUEL ALARM** sets the fuel level at which the alarm will occur. This should typically be a value that will allow at least 45 minutes of continued flight. Setting this value to “0” will disable the alarm.

Changing Units (Gal or Liters)



GALS OR LITERS
GAL

The **GALS OR LITERS** screen allows the user to set the units of fuel measurement to their preference.

Flight timers and fuel values default settings require that the user manually reset them to zero. The autopilot now has an option that saves this data only for the current flight - i.e. it automatically resets them to zero at the beginning of each flight (on power up). The **CONFIGURATION** menu now gives the user the ability to choose either option.

Zero Flt Fuel On Power Up

If the fuel option is present in the autopilot this **CONFIGURATION** menu selection now also allows automatic reset of the **FUEL USED** on each power up sequence.



ZERO FLT FUEL ON
POWER UP = NO

The selection is enabled by pressing the **HMODE** button which places an arrow next to the variable field (**YES/NO**). Rotating or pressing the **ENCODER** changes the selection. The selection is exited by pressing the **HMODE** button which erases the arrow and returns the encoder function to display selection.

The **TOTAL FUEL USED** value that is used to calibrate the K Factor is not affected by this setting. Note that the **PREFERENCES** menu **ZERO FUEL USED** menu will still zero both the **FLT FUEL USED** and the **TOTAL FUEL USED**. Also, holding the remote fuel display button will allow clearing of both the **FLT FUEL USED** and the **TOTAL FUEL USED** values if activated.

To prevent a momentary loss of power (while in flight) from resetting the values, the autopilot monitors airspeed and will not allow an automatic reset while in flight.

Fuel Display Timeout

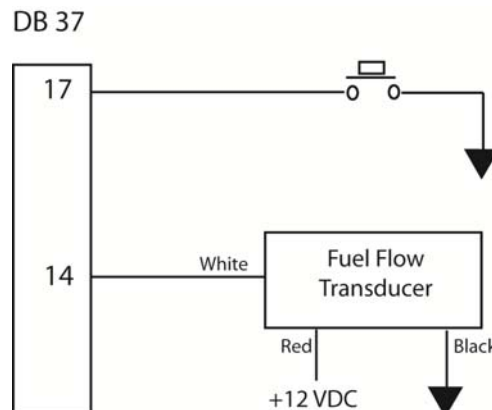


FUEL DISPLAY
TIMEOUT = 5 SEC

The default setting (**5 SEC**) will cause the remote button to present fuel parameters for 5 seconds and then return to the navigation displays. This **CONFIGURATION** menu selection allows (when set to **NEVER**) the reading to stay on screen until the user presses the **HMODE** or **VMODE** button, or the **ENCODER** is rotated.

The selection is enabled by pressing the **HMODE** button which places an arrow next to the variable field. Rotating or pressing the **ENCODER** changes the selection. The selection is exited by pressing the **HMODE** button which erases the arrow and returns the encoder function to display selection.

Fuel Sensor Connections



Chapter 14

Horizontal and Vertical Gain

Horizontal Navigation Gain

The response of the aircraft to horizontal navigation system commands can vary considerably depending upon a number of factors. The mass of the airplane, the sensitivity to control movement, and the way the control surfaces are rigged can affect aircraft response to control movement.

In most cases, the factory default settings will be satisfactory, however, fine adjustments to tune the response to a particular installation are provided to ensure optimum tracking performance.

The Pro Pilot allows the pilot to adjust three system parameters to achieve optimum horizontal navigation performance. Adjustment may be needed if the aircraft wanders more than +/- 1 or 2 degrees in the **CRS** mode, or in the **TRK** mode, if the **XTK** value displayed on the autopilot tends to exceed .03nm for long periods, or there is excessive hunting around the desired track.

For instance, assume that you are flying in the **CRS** mode (in smooth air) and you find that the aircraft “wanders” a few degrees to the left and right. You may wish to enter the calibration screens to adjust the **CRS** gain to lessen the deviations.

Additional gain may improve the performance, but be aware that too much or too little gain may also cause oscillations. You should adjust it to find the “sweet spot” for your aircraft where it holds the course best. These settings are saved in non volatile memory and need not be adjusted again.

The three adjustable parameters that are available to the pilot for horizontal response are:

1. **CRS Gain:** Fine course quality. This adjustment controls sensitivity to course commands when in the Course (**CRS**) and Track (**TRK**) modes, and within 5 degrees of the desired course and .07 nm of the desired track (**DTK**). It has no effect outside of 5 degrees of the selected course heading or greater than .07 nm of the **DTK**.
2. **TRK Gain:** Fine track quality. This adjustment controls how sensitive the system is to commands when in the Track (**TRK**) mode, and within .07 miles of the track centerline. It has no effect outside of .07 miles.
3. **PULL IN:** Pull In controls system response when the aircraft is outside of the .07 miles cross track error or showing greater than 5 degrees of error to the selected course. This is essentially a coarse gain used to bring the system within range of the fine tracking gain settings.

These settings should normally have to be set up only once, during your first test flight.

Changing Horizontal Navigation Gains

To enter the **SET HNAV GAINS** selection, perform the following steps:

1. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **SET HNAV GAINS** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the **CRS** setting value. Adjust this setting only while in the CRS mode. To change this value, rotate the encoder to the desired setting.



```
SET HNAV GAINS
CRS=2 TRK=3 PI=9
```



```
SET HNAV GAINS
CRS 2 TRK=3 PI=9
```

Usually, an increase or decrease of 1 unit is sufficient to tune the **CRS** mode tracking to a particular aircraft and GPS system. After changing the value, or if you want to bypass this setting, proceed to step 3.

3. Press and release the **H MODE** button. The arrow will be placed at the **TRK** setting value.



Adjust this setting only while in the TRK mode To change this value, rotate the encoder to the desired setting. Usually, an increase or decrease of 1 or 2 units is sufficient to tune the **TRK** mode tracking to a particular aircraft / GPS system. After setting the change, or if you want to bypass this setting, proceed to step 4.

4. Press and release the **H MODE** button. The arrow will be placed at the **PI** (pull in) setting value. This setting can be adjusted in either the **TRK** or **CRS** mode, but is only used when entering or recovering from a commanded turn in excess of seven degrees.
5. To change this value, rotate the encoder to the desired setting. Usually, an increase or decrease of 1 or 2 units is sufficient to tune the **PI** term to a particular aircraft / GPS system. After setting the change, or if you want to bypass this setting, proceed to step 6.
6. Press and release the **H MODE** button.



The **SET HNAV GAINS** procedure is complete and the encoder can now be used to select another menu screen.

NOTE: While viewing the calibration screens, you cannot change from the “Track” mode to the “Course” mode or visa versa. This is because the **HMODE** switch is devoted to gain adjustment while in the calibration screens. Therefore it is necessary to select the **MODE** you wish the autopilot to fly (Track or Course) before entering the **PREFERENCES** function.

Vertical Navigation Gain

The **V NAV** system gain settings optimize the Pro Pilot altitude control system vertical tracking performance. This adjustment allows the Pro Pilot to be tailored to your individual airplane. The factory setting is a nominal value which should give good performance in most airplanes. However, to achieve best performance in your airplane the **VNAV GAIN SETS** adjustment should be optimized.

A gain that is set too high can result in unstable performance (i.e. “porpoising”). A gain that is set too low will decrease the responsiveness of the system, especially in turbulence.

There are three gain settings on the **VNAV GAIN SETS** screen.

- The **ALT HLD** parameter controls the stability of the aircraft when in the **ALT HLD** mode. It will determine how aggressive the system responds to turbulence and how tightly it will hold altitude in a turn.
- The **VS** (Vertical Speed) parameter is a separate gain value that may be used to assure that the aircraft achieves the commanded vertical rate in a climb or descent.
- The **AS** (Airspeed) parameter allows gain to be adjusted for smooth operation in a commanded airspeed climb or descent.



Changing Vertical Navigation Gains

To enter the **VNAV GAIN SETS** selection, perform the following steps:

1. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **VNAV GAIN SETS** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the **ALT HOLD** gain value. To adjust this value, rotate the encoder to increase or decrease the displayed value, otherwise continue with step 3.
3. Press and release the **H MODE** button. The arrow will be placed at the **VS** (vertical speed) gain value. To adjust this value, rotate the encoder to increase or decrease the displayed value, otherwise continue with step 4.
4. Press and release the **H MODE** button. The arrow will be placed at the **AS** (Airspeed) gain value. To adjust this value, rotate the encoder to increase or decrease the displayed value, otherwise continue with step 5.
5. Press and release the **H MODE** button.



VNAV GAIN SETS
AH▶30 VS=35 AS=50



VNAV GAIN SETS
AH=30 VS▶35 AS=50



VNAV GAIN SETS
AH=30 VS=35 AS▶50

The setup of the vertical navigation gains is complete and the encoder can now be used to select another menu screen.

Chapter 15

In Flight Adjustment of Horizontal Gain

Setting Course Mode (CRS) Gain

1. With the **H NAV** servo on, select the **CRS** mode and allow the airplane to stabilize on the selected course for a few minutes.
2. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **SET HNAV GAINS** menu
3. Use the **H MODE** button to select the **CRS** parameter.
4. Rotate the encoder to increase this number one count.
5. Exit the calibration screens (press and hold encoder knob until the normal navigation screen returns).
6. Observe tracking performance. If the oscillation increases return to step 2 and lower the **CRS** setting by two counts (original count minus one).
7. Repeat steps 2 to 6 until best tracking is obtained. Normally the Pro Pilot will hold the ground track within +/- 1 degree in smooth air



```
SET HNAV GAINS
CRS=2 TRK=3 PI=9
```

You should then adjust the **TRK** gain for best performance while in the Track mode. To do this you must first exit the calibrations screens, returning back to the normal autopilot functions.

Here you should place the autopilot in the Track (**TRK**) mode by pressing the **H MODE** button sequentially to illuminate the **TRK** LED and allow the aircraft to stabilize on the track that you have selected on your GPS flight plan.

Once the aircraft is stabilized track gain can be set. Use the following procedure:

Setting Track (TRK) Gain

1. With the **H NAV** servo on, select the **TRK** mode and fly to a waypoint about 50 miles or greater distance.
2. Allow the airplane to stabilize on the track centerline. Normal smooth air performance is 0.0+/- 0.03 miles either side of track, and typically you will see 0.00 to 0.01 most of the time.
3. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **SET HNAV GAINS** menu.
4. Use the **H** or **V MODE** button to select the **TRK** parameter.
5. Increase or decrease this number one count at a time.
6. Exit the calibration screens (press and hold encoder knob until the normal navigation screen returns).
7. Observe tracking performance. If variation around track centerline increases return to step 3 and lower the **TRK** setting by two counts (original count minus one)
8. Repeat steps 2 to 7 until best tracking is obtained.



```
SET HNAV GAINS
CRS=2 TRK=3 PI=9
```

Setting Pull-In Gain

Press the **H MODE** switch again to position the cursor adjacent to the **PI** (Pull-In) value.

The **PULL-IN** gain may be adjusted if you feel the aircraft is not responding appropriately when you request large course changes.

As an example, assume that you are in the course mode and you use the encoder switch to program a 90 degree course change. Initially, the aircraft will establish a constant turn rate which will decrease as it approaches the correct course. If you feel that the “pull in” after the turn shallows is too slow, you might wish to increase the **PI** gain. If it is overshooting the new course, you may wish to lower the **PI** gain.

1. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **SET HNAV GAINS** menu.
2. Use the **H** or **V MODE** button to select the **PI** parameter.
3. Increase this number one count.
4. Exit the calibration screens (press and hold encoder knob until the normal navigation screen returns).



SET HNAV GAINS
CRS=2 TRK=3 PI▶9

Setting the Overall Horizontal Servo Gain

The **H NAV** system gain setting optimizes the **overall** Pro Pilot altitude control system horizontal tracking performance. This adjustment allows the Pro Pilot to be tailored to your individual airplane. The factory setting is a nominal value which should give good performance in most airplanes.

The **HNAV** servo gain is used to increase or decrease the overall response of the **HNAV** servo and its control of **CRS**, **TRK** and **PI**. In some installations the lever arms cannot be mechanically adjusted to accommodate the required range of travel or linking to the control system. In some airplanes the control systems are so sensitive that the factory preset servo gain is a little high for that particular installation, The **HNAV** servo gain adjustment procedure is made available to accommodate these variations.

NOTE: After a change in the **H NAV** servo gain, the **CRS**, **TRK** and **PI** adjustments may need to be readjusted. Please contact Trio Avionics if you think you may need to change this adjustment from factory settings.

To enter the **SET H SERVO GAIN** selection, perform the following steps:

1. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **SET H SERVO GAIN** menu.
2. Press and release the **H MODE** button. The arrow will be placed at the **HNAV** servo gain value. To adjust this value, rotate the encoder to increase or decrease the displayed value, otherwise continue with step 3.
3. Press and release the **H MODE** button.

The **SET H SERVO GAIN** procedure is complete and the encoder can now be used to select another menu screen.

Chapter 16

In Flight Adjustment of Vertical Gain

Altitude Hold Gain Tuning

To optimize the **ALT HLD** gain setting in your airplane, perform the following steps:

1. With the **V NAV** servo on, enter the **ALT HLD** mode in smooth air at your normal cruise speed after verifying the pitch trim is properly adjusted for level flight.
2. Enter the **PREFERENCES SETTINGS** menus and select the **VNAV GAIN SETS** screen.
3. With the aircraft initially straight and level and the **H NAV** servo OFF, manually execute a turn at a bank angle of approximately 15 degrees.
4. If the altitude sags more than 30 feet after entering the turn the system gain needs to be increased. Perform step 4.
5. Increase the **ALT HLD** gain by 5 units, then repeat step 3.



```
VNAV GAIN SETS
AH▶30 VS=35 AS=50
```

NOTE: This gain setting is for smooth air tracking. If you enter turbulent conditions and the altitude excursions are more than what you will accept, you may increase the gain (clockwise rotation) to limit the altitude excursion. A setting of between 40 and 60 has been shown to be optimum for most aircraft tested during flight evaluation. Your settings should be similar.

Vertical Speed Gain Tuning

The **VS** gain setting will be adjusted while the aircraft is in an autopilot commanded climb. A good starting point for this setting is to use the factory gain setting and increase it by five (5) units.

If a climb rate of, say, 800 fpm is chosen and the autopilot is stabilized and only climbing at 500 fpm, the **VS** gain should be increased. If the system has the auto-trim option it may present excessive out-of-trim messages during the climb or descent, again indicating that the gain may need to be adjusted.

NOTE: If Auto Trim is installed, set the **TRIM SPEED** setting at zero for this procedure. This will prevent the auto-trim from actuating during this testing. Manually trim the aircraft for a reasonable amount of trim error. "Reasonable" here means that if you disconnected the **V NAV** servo, the climb or dive resulting from a trim error would not cause a sharp, excessive transition to a rate of climb or descent.

To tune the **VS** gain, perform the following steps: (Should be done in smooth air)

1. With the **V NAV** servo on, enter the **ALT HLD** mode in smooth air at your normal cruise speed after verifying the pitch trim is properly adjusted for level flight. Press the **V MODE** button to get to the **SET VS** screen.
2. Enter a climb rate of 500 fpm and press the encoder knob to initiate the climb. Allow the climb to stabilize. If the aircraft is not achieving the 500 fpm rate, proceed to step 3.
3. Enter the **PREFERENCES SETTINGS** menus as detailed previously and select the **VNAV GAIN SETS** screen.
4. Rotate the encoder to get to the **SET VNAV GAINS** screen.
5. Press the **H MODE** button to move the arrow to the **VS** field.
6. Increase the **VS** gain by 5 unit increments until satisfactory performance is obtained. The lowest gain setting that will give satisfactory performance is the best setting.
7. If the gain is set too high, there may be excessive excursions when engaging the VS mode while in a high rate of ascent/descent climb/dive.



```
VNAV GAIN SETS
AH=30 VS▶35 AS=50
```

Chapter 17

Trim and Auto-Trim

Autopilots love a well trimmed aircraft. If an airplane is out of trim, the autopilot servo must constantly fight the controls to keep the plane in a proper attitude. If the out of trim condition is severe, autopilot performance may deteriorate significantly.

This is especially true for the elevator control. In the Altitude Hold (**ALT HLD**) mode, improper trim may cause the aircraft to “hunt” vertically (i.e. experience small repetitive vertical excursions). If the autopilot is commanding a climb or descent (**AS/VS** mode), improper trim may prevent it from achieving the proper climb or descent rate.

The Pro Pilot will issue trim alerts to the pilot. If the elevator servo is equipped with the Auto-Trim option it will automatically operate the existing aircraft electric trim to remove trim errors.

No trim messages are provided for aileron trim.

Manual Elevator Trim

Aircraft are generally equipped with a manual trim that requires the pilot to adjust a mechanical trim control to change the trim of the aircraft. Some airplanes employ an electric motor or “trim servo” to allow the pilot to adjust trim by means of an electrical switch that might be positioned on the control stick or instrument panel.

Trim Messages

With the autopilot active, when the elevator is out of trim a small flashing arrow will appear in the bottom R/H corner of the display to indicate that the pilot should adjust the aircraft pitch trim. The direction of the arrow will indicate if the trim adjustment should be up or down.



```
BTW 025 +XTK<0.02
TRK 025 GS 200 ▲
```

If this subtle trim message is ignored, after a short interval the message “**TRIM UP REQD**” or “**TRIM DN REQD**” will be displayed.



```
BTW 025 +TRIM UP
TRK 025 REQD
```

In either case, the pilot should adjust the trim until the trim alert no longer appears. This may be done in two ways:

- Leave the autopilot engaged and adjust the trim in small increments. Make minor adjustments and wait 5 to 10 seconds before making further adjustments. This will allow the system to recognize that the adjustment has been made. Continue to adjust until the message no longer appears.
- Momentarily press the **V NAV** button to disconnect the vertical servo and observe if the aircraft tends to climb or descend. Trim the elevator until level flight is achieved. Press the **V NAV** button to re-engage the pitch servo.

Automatic Elevator Trim

The automatic trim is an optional feature that allows the altitude hold system to automatically adjust the aircraft electric trim motor to keep the elevator forces balanced. The pilot may then change engine power settings and command climbs and descents without the necessity to manually re-trim the aircraft.

Trim Motors

The trim servo/motor is not provided by Trio as a part of the automatic trim system. It is usually specified or provided by the aircraft builder / kit provider.

It is a common complaint that electric trim operation is often “too fast” and difficult to adjust properly. To address this, the Pro Pilot offers an effective means to adjust the speed at which the elevator trim motor runs. Adjusting the trim speed is covered in the **PREFERENCES MENU** – Chapter 13

The drive to the trim motor originates within the Trio Gold Standard (GS) servo. It provides the drive signal to the trim motor through the 6 pin connector on the GS servo. Pins 5 and 6 are reserved for this purpose, as shown on the Pro Pilot wiring schematic at the back of this manual.

An electrical switch is generally provided to allow the pilot to adjust the aircraft trim manually when the altitude hold system is not engaged. It is also a necessary safety feature to allow the pilot to override the servo trim function if required.

In aircraft that have the Auto-Trim feature, when the servo is engaged the electric trim motor will be adjusted automatically. If the servo is **NOT** engaged the electric trim may be manually adjusted by rotating the encoder knob.

Auto-Trim Operation

When the altitude control system is engaged and commanding the Auto-Trim to run the electric trim motor, it will display a small flashing triangle on the lower right side of display indicating the direction of the trim correction. This will appear only when the motor is running.



The image shows a digital display with two lines of text. The first line reads "BTW 025 +XTK<0.02" and the second line reads "TRK 025 GS 200" followed by a small upward-pointing triangle icon.

Even when the **V NAV** pitch servo is disengaged, and if the Auto-Trim option has been installed, rotation of the **ENCODER** knob will still allow manual adjustment of the trim motor servo. “Clicking” the knob position will result in a very fine adjustment of the trim servo position, while rapid rotation the **ENCODER** knob will result in larger changes of the trim servo position. The display screen will appear as shown.

The speed at which the trim motor is driven is managed in the **CONFIGURATION** or **PREFERENCES** setup menus using the **TRIM SPEED** parameter. (See Chapters 12 and 13)

Switching Between Manual Trim and Auto-Trim

On page 79, there are diagrams showing two methods that allow switching between aircraft’s electric trim system and Gold Standard Servo’s automatic trim operation.

- Option 1:** Is a manually operated toggle switch that can be positioned in either the “Manual” or “Auto” position. In the Manual position, there will be no automatic trim available, and in the “Auto” position there will be no manual trim available. It will require that the pilot remember to reposition the switch when the altitude hold system is not engaged.
- Option 2:** Shows a method that disengages the automatic trim circuit from the GS servo whenever the manual trim switch is operated.

Chapter 18

The Servos

Servo Installation and Setup



The servo unit incorporates important safety features:

- The internal gears are pulled into the engaged position by an electric solenoid. When the gears are not engaged, the output crank arm rotates freely and the aircraft controls can be operated normally without friction. When the servo is engaged, the solenoid pulls the gears into place so the servo positions the control surfaces. Disengaging the servo allows free movement of the controls.
- The roll and pitch servos are engaged and disengaged by pressing **H NAV** and **V NAV** buttons respectively. We also recommend installing a remote **SERVO DISCONNECT** switch on the control stick (or other remote location). Installation of a remote switch (or dual switches) is highly recommended, as it allows an immediate way to disengage the servos - even in heavy turbulence, when it may be difficult to operate the individual **H NAV** or **V NAV** button. In addition, such a switch(s) will allow for the **PILOT COMMAND STEERING** feature and the **VS** (vertical speed) and **AS** (airspeed) capture features.
- The servos also employ a clutch, which allows the pilot to override the servos by applying moderate force to the control stick. Even though the solenoid will hold the gears in place, the clutch will then slip and allow the control surfaces to move. In the event of strong turbulence, conflicting traffic or an altitude anomaly, the pilot can thus override the servos to control the airplane. In such an instance, the servos should normally be disengaged as soon as possible.

NOTE: The clutch function does not rely on a shear pin failure mechanism as is employed on some other popular autopilot servos. Activation of the “clutch” function in no way damages the servo drive system although prolonged operation in this condition should be avoided.

Installing a Servo

Begin by looking for a point on your aircraft bell crank, control pushrod or cable where pushing or pulling the aileron or elevator control linkage a distance of 1.5 to 2.4 inches will do the job. Then find a place to mount the servo nearby to accomplish this by means of the pushrod.

You will mount the servo and pushrod so that the control surface is in a neutral position when the servo crank arm is at mid position. That's it, aside from carefully checking that **the required range of control movement is available within the limits of the servo travel range, and that no "over center" condition can exist. Also, assure that the aircraft control system hits its "stops" before the servo crank arm hits its "stops"**.

OVER-CENTER TESTING

An over-center condition will result in a complete locking of the control system during operation. The result of this is that you will lose all control of the airplane.

When installing the servo, ensure that under **any** flight conditions, including inverted flight, control system flexing, airframe flexing, extreme turbulence or any other abnormal flight conditions,

IT IS CRITICAL TO ENSURE NO POSSIBILITY THAT AN OVERCENTER CONDITION CAN OCCUR.

Close is not good enough in this case. If you have any questions of doubts, please consult a qualified technical counselor or call Trio Avionics for consultation.

The servo crank arm uses a pushrod terminated by rod end bearings to link the servo arm to the aircraft control system. The pushrod provided in the installation kit should be trimmed to the correct length for your particular installation.

The servo must be mounted on a solid platform that will not buckle or "oilcan" and attached to a firm existing support. It is recommended that the servo platform not be mounted to the aircraft "skin" without a doublers and some other additional support. **Rigidity of the servo mount is critical to proper servo operation.** If you do not have the experience required to fabricate the required bracket please contact Trio Avionics for guidance.

When shipped, the crank arm and screws are not attached to the servo. This allows easy installation of the crank arm for each particular installation. The appropriate Loctite compound is pre-applied to the screws accompanying the crank arm.

In your installation, it may be more convenient to rotate the crank arm to a new orientation that will give a neutral (servo center position) at +/- 90 degrees or 180 degrees from that as supplied from the factory. The servo crank arm is secured to a flange by four machine screws that can be removed for indexing the crank arm in 90 degree increments.

If the screws need to be removed to reposition the crank arm, after repositioning, Loctite Number 222 must be reapplied (very sparingly) to prevent loosening of the screws.



Note: It is important to assure that the proper direction of travel is preserved when modifying the crank arm orientation. Changing the crank arm mounting by 180 degrees will essentially reverse the direction of travel for the servo arm. In such a case the Pro Pilot must be programmed to reverse the drive signal. In the event unusual pitch changes occur in the first flight, the first check on the ground should be to be certain the servo direction of travel is correct.



Choose an operating radius on the servo crank arm that allows full elevator movement (control stop to control stop) without driving the servo crank arm into its limits. Most aircraft get best performance in the

outermost hole. In the event the servo rotation is insufficient, the servo mechanical stops may be removed. Contact Trio Avionics if this appears to be necessary.

Servo Mounting Hardware

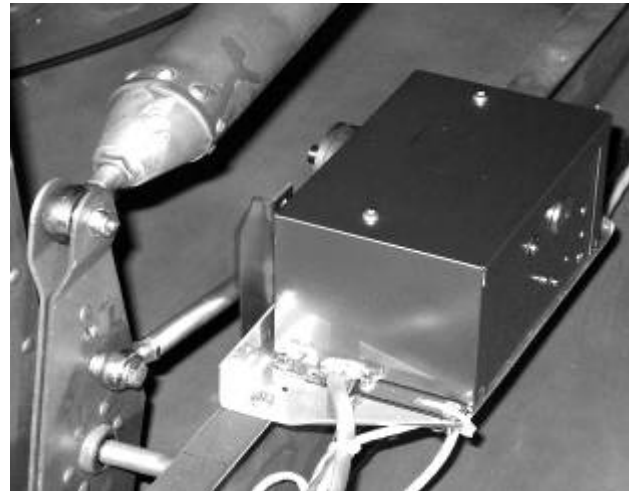
The following picture shows the electrical and mechanical installation kit that is provided for the servos. A pushrod is provided for each servo, along with two rod end bearings. Typically, one of these connects to the servo crank arm and the other is connected to the aileron or elevator bell crank. When the servo is connected to the control system it should be installed so that the servo crank arm is at a right angle to the control rod. This mechanically centers the servo mechanism to the control system so that there is *equal displacement in either direction* when the servo is actuated.



Selecting a Site for the Servo

For most aircraft, it's relatively easy to find a suitable site for locating the crank arm servo. The length of the pushrod and the angle it makes with the driven element are user selectable.

The rod end bearing allows some misalignment, typically about 8 degrees, between the servo pushrod and the plane of rotation of the crank arm. This limit on angular displacement often determines the minimum pushrod length. Any side-to-side movement must not jam the rod end bearing. A suitable hard point must be found, or built, for mounting the servo. The mounting place needs to be as accessible as possible, and there must be a means of linking to the control system. (The photo above shows an elevator servo installation in a RV-6).



Note: The controls must travel from control stop to control stop within the range of movement allowed by the servo stops which limit crank arm rotation.



When the above conditions are met, the system usually performs best when the pushrod is attached to the outermost hole in the servo crank arm. If your aircraft employs a control system bell crank, you should ideally attach the pushrod to the bell crank at a distance from its pivot point that allows full control system travel along with maximum travel of the crank arm without contacting the servo mechanical stops.

Never allow the servo to limit aircraft control travel

The servo mounting location must be strong and rigid. If, for example, you need to mount the servo on the skin of an airplane, it will be necessary to use additional bracing or a “doubler” to provide appropriate rigidity. You do not want the movement (rocking) of the servo to fatigue the mounting structure.



When mounting the servo, be careful not to drill mounting holes into critical load bearing members. It may be best to construct a mounting plate, place and bond machine screws so that they will interface with the case mounting holes, and then secure the assembly into place. For a composite aircraft installation, the bottom of the plate (shown) should be flocked and the holes in the plate filled with flock before applying fiberglass layers over it to secure it to the fiberglass structure.

NOTE : It is important that the servo mounting plate surface be flat and smooth. If it is not, this can distort the servo frame when the servo is secured to the mounting plate.

Usually the servo pushrod will terminate on a control pushrod or a bell crank. If you are connecting to a pushrod **care should be taken to keep the pushrod from being free to rotate.** (To repeat, the pushrod should **NOT** rotate.)

The reasoning for this is that as the pushrod rotates there is “lost motion” in the system, i.e., movement of the crank arm does not result in movement of the control system. **The control movements are so small that it takes very little slop in the system to make the airplane not track properly.**

It will simplify installation adjustments if there is enough overhead clearance to allow removal and replacement of the servo lid with the servo remaining in place (for instance, you will possibly want to adjust the slip clutch). The servo lid is secured by two screws on the top of the servo.

Positioning the Servo Crank Arm

The crank arm is not attached to the servo when shipped. To suit your particular installation, you will need to position the servo crank arm to get the correct geometry to drive the control system. It can be installed in one of 4 positions, in 90 degree increments. The screws that are supplied have Loctite® applied to the threads. Once these screw are tightened, they will be very difficult to remove – so be sure that the crank arm orientation is correct.

Should it be necessary to remove the screws, once installed, it is required to apply heat with a heat gun before attempting to loosen the four screws. The heat should be applied for at least one minute to allow the Loctite® to soften. Failure to heat the assembly will more than likely cause the screws to break off when being removed.

If it is necessary to reposition the servo Crank Arm, perform the following steps:

1. Use a #2 Phillips screwdriver to remove the screws. Ensure sufficient pressure is used to prevent slippage of the screwdriver and subsequent rounding of the screw heads.
2. Rotate the crank arm to the correct position for your installation.
3. When satisfied with the positioning, apply a small amount of Loctite® 222 to the screws, reinsert and tighten the screws.

Install the Servo Pushrod

Cut the pushrod to the proper length so that, when the servo is at neutral, or centered in its full rotation stop to stop, the aircraft aileron or elevator is also neutral (see note).

Choose the longest possible crank arm radius that accommodates a pushrod range of movement equal to or exceeding that required for full aileron or elevator travel.

Be sure that the rod end bearings never jam due to misalignment as the pushrod angle is varied by different combinations of control system input. Push the control stick (or control wheel) in all four corners to test this.

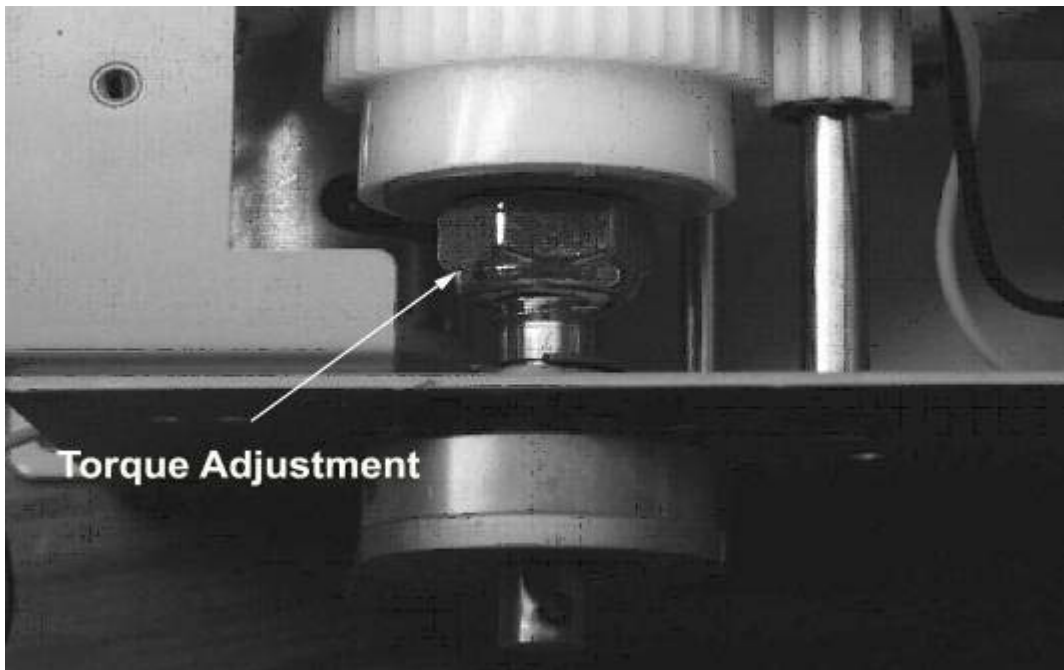
NOTE: The crank arm neutral position for your control systems will be dependent on the particular aircraft design.

For instance, many designs require more throw of the control system from the neutral position to the full stick back position (elevator up) than the other direction.

In this case when the elevators are positioned at their neutral position, the crank arm will not be at its centered (exact vertical or horizontal) position. This is not of concern during operation of the system as the servo design compensates for this offset automatically during operation. Again, the important thing to remember is that the control system must contact its mechanical stops before the servo contacts its mechanical stops.

When attaching the servo pushrod to a control bell crank, it is important to keep the two lever arms equal. Measure the distance from the servo crank arm pivot point to the outermost hole in the crank arm. Then drill an attach point in the bell crank that is the same distance from its pivot point. This will assure proper servo operation.

Setting Servo Override Force (Slip Clutch)



WARNING

The only authorized field adjustment to the servo is the clutch torque adjustment as described in this section. Any other adjustments without factory authorization and consultation is prohibited and can result in degradation of flight performance or unsafe flight control inputs while under autopilot control.

The servo Torque Control nut (the adjustment nut inside the servo on the output shaft) sets the override force - the force you will feel at the stick when the servo clutch begins to slip.

Engage the servo by pressing the appropriate **H NAV** or **V NAV** switch. You should hear the solenoid operate inside the servo housing and the servo crank arm should become firmly held in place by the gear train. Then push the control stick hard enough to override the servo. Using an 11/16 " or 17mm open end wrench set the override force to a value that will give good control authority, but not so strong as to be difficult to override with the control stick.

WARNING

When setting servo force override adjustment on the pitch servo, be aware of the consequence of a pitch servo disconnect in a moderate to extreme out-of-trim condition. Newer, light aircraft designs can be extremely pitch sensitive. A servo disconnect while in an out of trim condition could result in an abrupt change in pitch attitude and in extreme cases it is possible to cause structural damage. In order to mitigate this risk it is recommended that the clutch be set at a very low force level initially. Flight testing should then be conducted to determine an appropriate adjustment point for your particular aircraft at the operational airspeeds. A recommended adjustment scenario is as follows:

1. Prior to flight, using a spring scale on the control stick, set the clutch force so that a stick pressure of about 2 lbs results in a clutch slip. On some aircraft it may be necessary to balance the elevator so that there is no initial load force on the servo. To do this, place the elevator in a flight neutral position and engage the servo in the **ALTITUDE HOLD** mode.
2. Perform a low speed flight test. During this test the aircraft should be placed in a neutral pitch trim condition and then the servo engaged in the **ALTITUDE HOLD** mode. While in the **ALTITUDE HOLD** mode, the aircraft should be slightly mis-trimmed. While in this condition the autopilot display should be observed for a **CLUTCH SLIP** message. If no **CLUTCH SLIP** message appears after 15 seconds, the pilot should disconnect the servo while maintaining manual pitch control during the release.
3. If the **CLUTCH SLIP** message does not appear and the pitch excursion is excessive on release, then the clutch force should be reduced and the test re-run until the **CLUTCH SLIP** message occurs at a point where the aircraft excursion at release is not excessive.
4. The objective of this test is to have a **CLUTCH SLIP** message occur at a servo force override level that will not cause an excessive pitch excursion when the servo is released. Once this setting is obtained at the low flight speed, testing should be accomplished at progressively higher flight speeds to ensure a release at any operational airspeed will not result in a significant pitch excursion when the servo is disconnected with an out-of-trim condition.

Adjustment of Servo Rotation Direction

After installation wiring is complete the system servo direction check must be accomplished. This is a "one time" setting that must be accomplished while the aircraft is on the ground. Once done, it should never have to be changed unless you replace a control head, or perform a "default reset" that returns all settings to the factory defaults.



NOTE: This is a **CRITICAL** setting and **MUST** be verified before flight. If the command direction to the servo motor is not correct the aircraft will be forced into a divergent maneuver when the system is engaged.

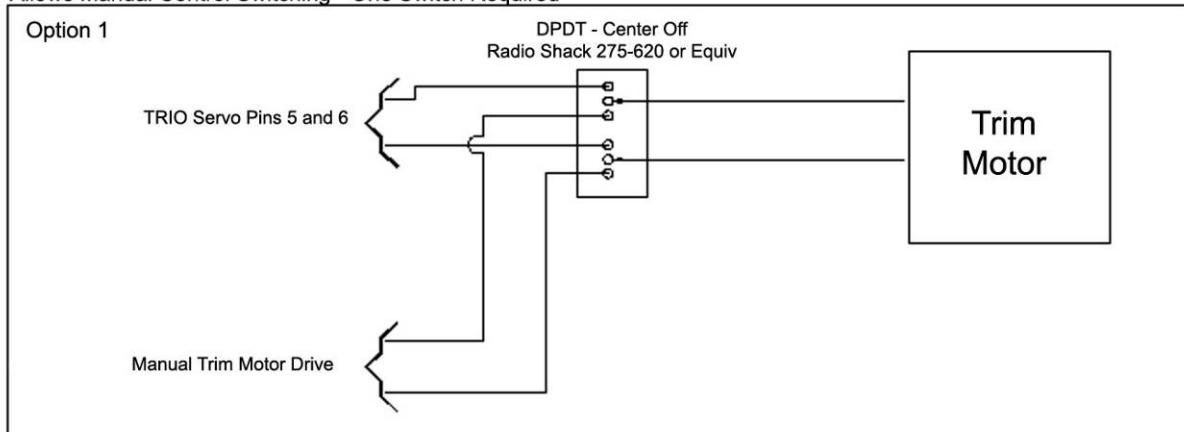
- The **V NAV** servo is self centering due to the ability to provide its angular position back to the control electronics.
- The **H NAV** servo will be centered manually in the steps below to facilitate the automatic roll trim error compensation.

Setting the proper rotation direction of the **H NAV** and **V NAV** servos is detailed in the **CONFIGURATION SETTINGS** menu, previously described in Chapter 11.

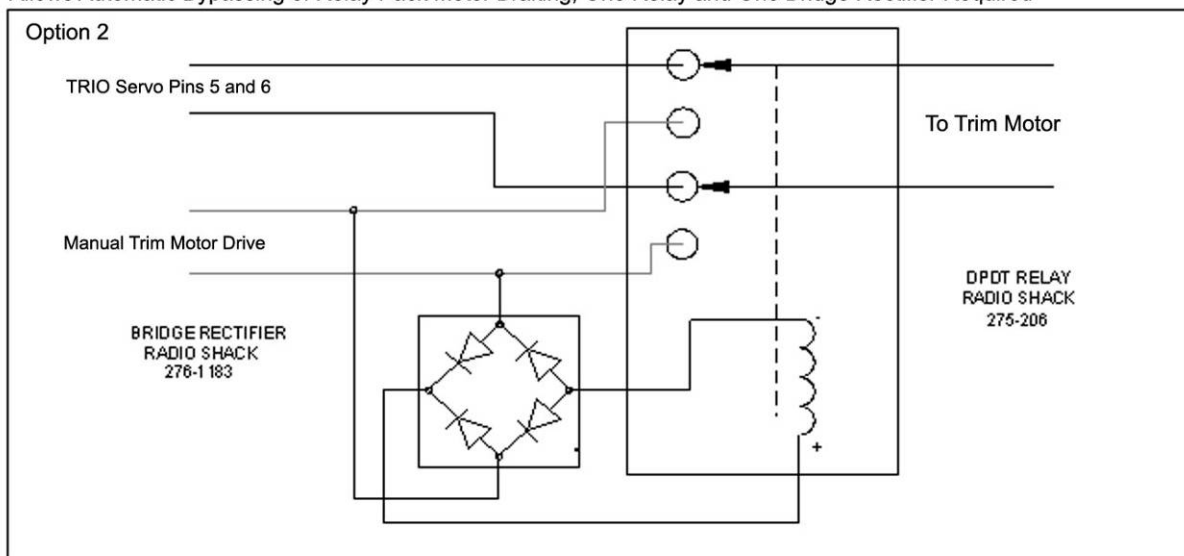
IMPORTANT

Prior to performing this step the system must be powered up for a full 5 minute period to allow the inertial components to bias to their zero position. For **H NAV** settings, if the aileron center number in the **H NAV** setup configuration is near the extremes of 6000 or 9000, it might be necessary to check the pushrod length servo linkage. Ideal level flight should occur near the 7500 center but small deviations are acceptable.

Allows Manual Control Switching - One Switch Required



Allows Automatic Bypassing of Relay Pack Motor Braking, One Relay and One Bridge Rectifier Required



Note: The Radio Shack switches specified are for reference only. Radio Shack changes their parts and suppliers often. They, or other suppliers, will have equivalent switches.

Chapter 19

Alerts, Warnings and Alarms

The Pro Pilot employs a number of sensors to monitor proper operation in the control electronics and the servos. When it detects a possible problem it will notify the pilot via messages on the display screen and, if appropriate, via an audible alarm.

Alerts

Alerts notify the pilot when a non-critical event has occurred.

- **Servo Disconnect** – Sounds a three-beep- tone whenever the servo is disconnected intentionally or unintentionally.
- **BARO SET** – Requests the pilot to confirm the correct baro altitude before beginning a climb or descent.
- **Arrival at a Destination Altitude** – Sounds a single-beep tone and displays the message “**ALT CAPTURE**” for 5 seconds. The display then reads **ALT HLD**.
- **Trim Messages** – The display will present **TRIM UP REQD** or **TRIM DN REQD** when the autopilot is engaged and the aircraft is out of trim. The pilot should adjust the aircraft trim.
- **VS ERR** - The Vertical Speed error will appear when there is conflict between the Vertical Speed direction and the Altitude that has been selected. For instance, if the pilot dials in a 500 foot per minute descent but enters a destination altitude above the current altitude the servo will not engage and the error message will appear.

Warnings

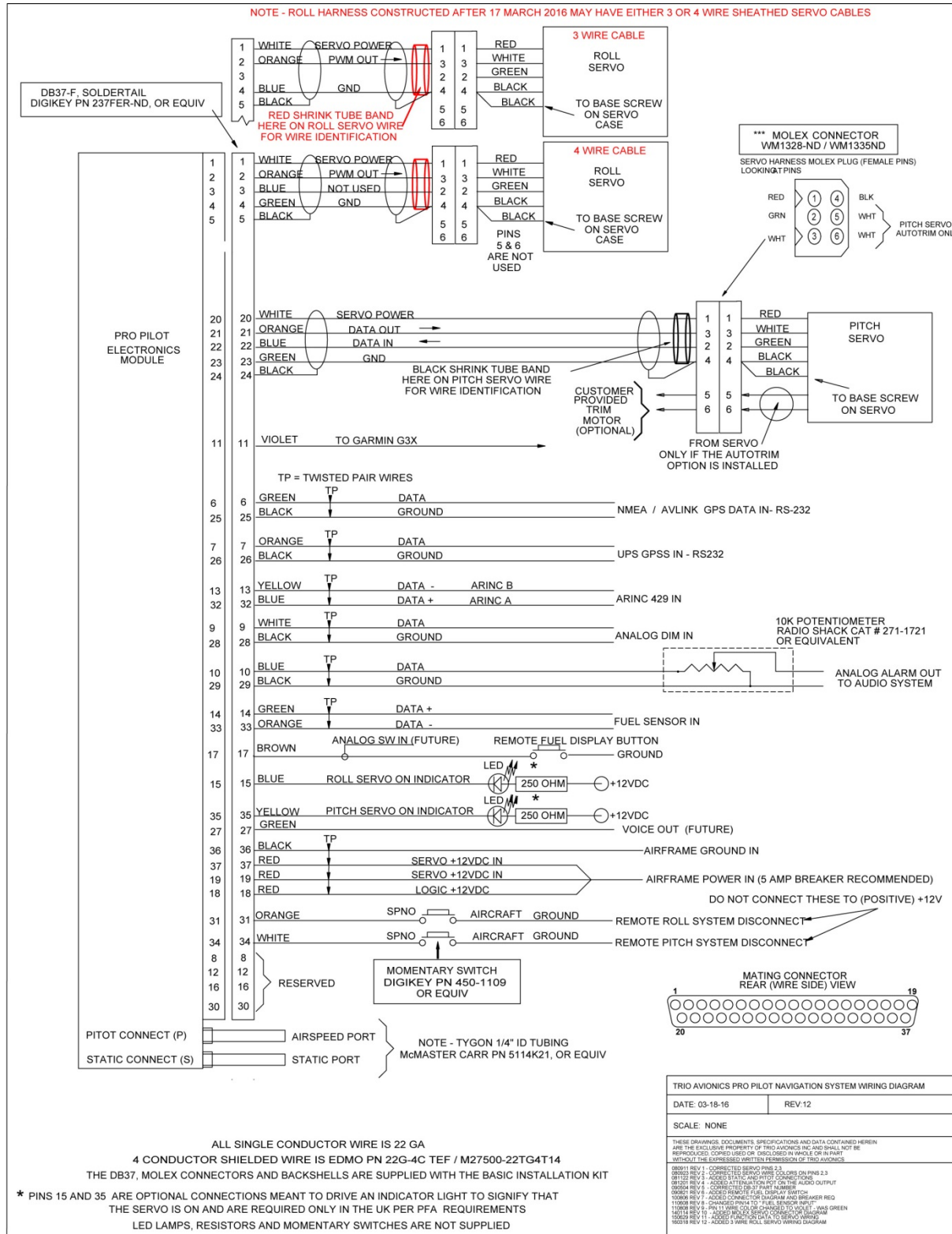
Warnings alert the pilot of potential problems that may require action

- **NO GPS** – Indicates that the GPS signal has been lost. In this instance, the Pro Pilot will continue to keep the wings level, and continue using the barometric data for altitude control, but has no lateral navigation information.
- **NO FLT PLN** – GPS is available but no flight plan or GOTO has been entered. The Pro Pilot will enter the Course (**CRS**) mode and will fly a pilot selected course over the ground.
- **CLUTCH SLIP** - If the clutch slips for more than 3 seconds the message **CLUTCH SLIP** will appear. This warning may appear in severe turbulence, or in extreme out-of-trim conditions, if the servo must pull hard enough on the elevator that it causes the clutch to slip. If this happens frequently in more benign conditions, it suggests that the operator should consider tightening the servo slip clutch.

Alarms

- **G FORCE LIMIT** – The system has detected that the aircraft has experienced a “G” force of +/- 1 G deviation beyond the normal gravitational constant. Displays a flashing **G FORCE LIMIT** message, sounds a three-beep tone and the servos will disconnect.
- **I/O ERROR** – This indicates a communication problem in the system, usually caused by a wiring error or a component failure. The servos will disconnect and a three beep tone will sound.
- **SERVO CW LIM** – This will occur if the pilot pulls hard on the controls to slip the pitch servo clutch and force the servo crank arm to its clockwise limit. It will also occur if the servo is engaged while the elevator is in an extreme position. The servos will disconnect and an alarm will sound.
- **SERVO CCW LIM** – Same as above, but occurs when the servo crank arm is forced to its counterclockwise limit.

Chapter 20 Wiring Diagram



Chapter 21

ARINC 429

ARINC 429 WIRING

It is recommended that the ARINC 429 and RS232 data lines be wired to the Pro Pilot through a 3 pole switch (toggle or rotary) generally available at various electronics supply companies.

This will allow the selection of a backup GPS receiver in the event that the primary GPS receiver or EFIS becomes inoperative.

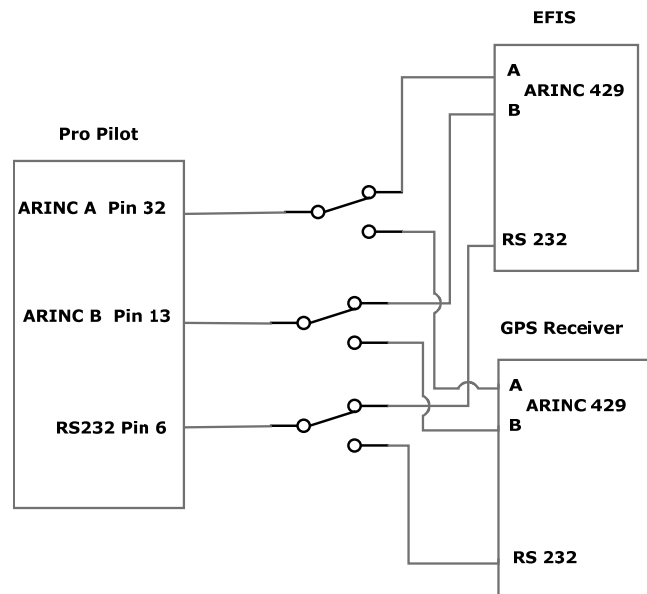
Installation 1

The diagram to the right shows an installation that might have two independent sources of ARINC and RS232 data (an EFIS and a GPS receiver).

The switch is positioned so that the Pro Pilot is obtaining the navigation information from the EFIS.

Alternatively, the switch may be positioned to get the navigation data from the GPS receiver.

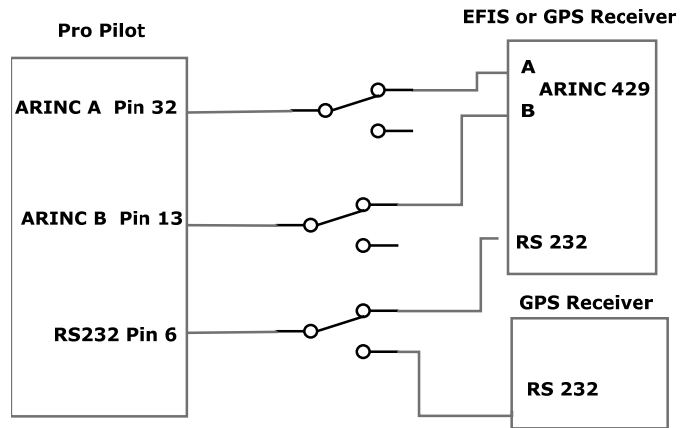
When the switch is changed, it may take up to 3 seconds for the Pro Pilot to identify and lock to the new data source.



Installation 2

In an installation which only has one ARINC source and a backup GPS receiver (such as a handheld that provides only RS232 data) a secondary ARINC signals are not available. If the EFIS should fail, changing the position of the switch will provide access to the alternate source of RS232 data (AVLINK or NMEA 0183). The Pro Pilot will automatically detect the absence of ARINC data and would then track the horizontal flight plan in the backup GPS receiver. In this case, the **GPSS** and **GPSV** LEDs will not be lit (no ARINC data), and the Pro Pilot defaults back to normal operation and front controls will be used for horizontal and vertical navigation.

Note: Do not allow a wiring or switch configuration that allows the Pro Pilot to be simultaneously connected to two different systems (i.e. ARINC wired to one data source and RS232 connected to an alternate source).



This diagram clearly shows that the ARINC connections to the EFIS are not connected when the backup GPS receiver is chosen as the data source.

NOTE: The diagrams above show just two examples of many possible equipment configurations. You may get additional information about other arrangements by contacting Trio Avionics.