



Operating Handbook  
For  
**FD PILOT SERIES AUTOPILOTS**



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# General Introduction

The TruTrak autopilot can be defined as being an orthogonal rate system. This means that gyroscopic rate sensors are installed so as to sense motion about each of the major axes (roll, yaw, and pitch). These sensors generate the fast signal responses necessary to create an autopilot with the best possible dynamic performance.

To fly an aircraft well about the axis controlled by the ailerons, velocity of aileron movement must be directly proportional to the rate of roll for small movement. This means that aileron position corrections do not lag behind motion of the craft about the roll axis. Aileron control systems that use a turn coordinator, which senses twice as much azimuth as roll rate, cannot do this. Instead, in turbulence, yaw disturbances cause undesired aileron movement. In some aircraft this effect is so severe that the controls may even move momentarily in the wrong direction.

The challenge at TruTrak is to create, beyond question, systems with the very best dynamic performance available—systems that need not be disengaged in turbulence, but instead provide function when most needed.

The complete TruTrak flight control system combines within a single panel-mounted programmer/computer package which includes all the electronic and sensing elements needed for the roll and pitch functions and interfaces to a rate-gyro-controlled yaw damper.

Basic directional control is provided by digital selection of a GPS track to be flown. This replaces heading selection on the DG, and eliminates drift as well as crosswind correction. In the GPS steering mode of operation, the system responds to digital guidance information so as to fly a complex navigation program.

The vertical portion of the system contains a pressure signal source for altitude and vertical speed information, an airspeed signal source, and a high performance pitch rate gyro. These signals are combined to provide performance equal to that of the most expensive autopilots. Also by having airspeed information the system is stall proof. It is expected that other systems will soon be coming out with this same feature.

For any set of features all TruTrak computers are identical. Servos likewise are identical in velocity response. Servos do differ according to total torque required. By providing setup functions in the programmer for system activity and torque, one TruTrak programmer-servo combination can fly any aircraft.

As a starting point in understanding how to operate the TruTrak system, the following describes the presentation of data, the operating controls, and the procedures for selecting modes of operation.

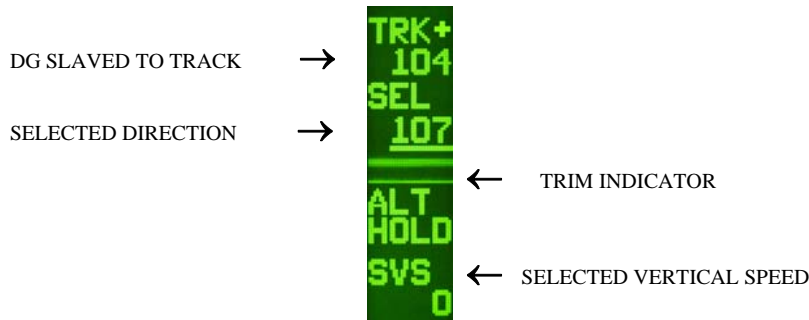
## POWER UP—AIRCRAFT STATIONARY

### Mode and Data Display

This display normally shows operating modes and associated numerical data. It is also used to display setup mode screens and the setting of associated numerical data. When displaying operating modes, the upper portion shows lateral data and the lower portion shows vertical data. (See figure below.) The upper left display labeled TRK shows the electronic DG slaved to GPS track. When the GPS track is not available TRK will be replaced by NO GPS, which means the autopilot now uses an internal gyro source for bank control. Below TRK, the display is labeled SEL. This shows the selected direction of flight. In the FD Pilot II and II VS, the lower portion shows whether or not the unit is in the altitude hold mode. The bottom of the display shows whether the autopilot is on or off with the FD Pilot II VS selected vertical speed. The horizontal

space between the upper and lower display area is used to show pitch trim. This display consists of two horizontal bars spaced vertically as the rungs on a ladder. These bars will move up or down to indicate an out of trim condition.

In the upper right where direction is shown, a flashing indicator is present next to TRK or NO GPS. When there is GPS serial data present but no position fix, this will be a flashing period. Once GPS position data becomes valid this will be a flashing asterisk. If GPS flight plan information (GPS NAV) is being received or if the programmer is a FD Pilot IIVSG and GPS Steering (GPSS) information is being received, a flashing plus sign will be displayed. An underline is shown beneath the SEL numerals, indicating that this value can be set by turning the encoder knob.



## Controls

The FD Pilot II series autopilot uses the simplest controls available. All programming is done via a rotary encoder knob and two buttons labeled MODE and ALT. The MODE button toggles between the default (TRK) mode and the GPSS mode (or GPS NAV mode if GPS steering is not available). The ALT button engages altitude hold or moves the cursor to the SVS numerals. Both buttons are also used to enter the setup modes as well as maneuver



through the setup screens. Engaging the autopilot can be done by either pushing and releasing the encoder knob on the programmer or by pushing and holding the switch located on the control wheel or stick for more than two seconds and then releasing. Disengaging can be done either of two ways: by pushing and holding the encoder knob on the programmer for approximately three seconds and then releasing the knob, OR by momentarily pushing and releasing the switch located on the control wheel or stick. This switch provides the Control Wheel

Steering function. This function allows the autopilot to synchronize to both the current direction and vertical speed

## Initializing the Autopilot

The autopilot master switch should be in the off position when the engine is started. Aircraft electrical systems can generate voltage transients during an engine start, and like other avionics systems, the autopilot should not be unnecessarily subjected to these conditions. After the engine is started, turn on the autopilot master switch and hold the aircraft stationary as the internal gyros are initialized. The model and software version will be displayed briefly. For approximately ten seconds afterward, the display will show the words **PWR UP** in the lower display. When initializing is complete **PWR UP** will change to **AP OFF**



## GPS Acquisition

Next to the word **NO** a flashing period • will appear each time the GPS sends a message to the autopilot (once per second). This indicates the GPS is working but has not yet obtained a position fix. As long as the period is shown, the **NO**

GPS display cannot transition to the **TRK** mode. When the GPS does obtain a fix, the period will be replaced by an asterisk \*. **NO GPS** will be replaced by **TRK** when approximately ten knots ground speed is achieved. This can even occur at rapid taxi speeds.

## FD Pilot II

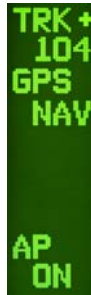
### Lateral Modes

When the autopilot is engaged it will be in the basic lateral mode and will synchronize to the current ground track. The number following **SEL** (Selected direction) will be underlined and rotating the encoder knob will select a new heading. Rotation of the knob will give 5° steps of **SEL**, and 1° steps when the knob is depressed.



TRK+  
104  
SEL  
104  
AP  
ON

If a GPS flight plan has been entered into the GPS, pushing the **MODE** will engage the **GPS NAV** mode and a flashing plus sign will be shown. In the **GPS NAV** mode, the autopilot will follow a flight plan programmed into the GPS. However, the autopilot must over-fly each



TRK+  
104  
GPS  
NAV  
AP  
ON

way point prior to turning and intercepting the next course line.

If the **GPSS** option has been added, pushing the **MODE** button will engage the **GPS Steering**. In the **GPSS** mode the autopilot follows lateral steering or bank commands generated by a navigation system (**EFIS** or **GPS**).



TRK+  
093  
GPSS  
AP  
ON

### Gyro Back-Up Mode

The lateral modes previously described are based on **GPS** track being present. When **GPS** is lost, the autopilot uses its internal gyros for bank control, and **TRK** is replaced with **BANK**. This mode is only a backup and would seldom be needed; however, it does provide a



NO  
GPS  
BANK  
0°  
AP  
ON

means of selecting a desired bank angle, and a means of adjustment if the aircraft turns when zero bank is selected. If the GPSS or GPSV signal source is functional, the **GPSS** and **GPSV** modes will also be functional. When in the gyro backup mode the number displayed below **BANK** is the selected bank angle. Rotating the encoder knob will move the selected bank angle one degree at a time up to five degrees, the bank angle is then selectable in five degree steps up to 30 degrees.

If the aircraft continues to turn when a bank angle of zero degrees has been selected, push in on the encoder and the display changes to show a **TRIM** adjustment. This adjustment is selectable in increments of 0.2 degrees per minute up to ten degrees per minute in either direction. Every time the trim is adjusted it will add the displayed number to the current trim adjustment.

NO  
GPS  
TRIM  
0.0  
AP  
ON

### Altitude Hold Mode

When the autopilot is engaged it will be in the basic lateral mode, the pitch servo will not be engaged at this time. To engage the altitude hold the aircraft must be at the desired altitude and be trimmed for

level flight. After trimming the aircraft, simply press and release the ALT button. If an altitude change is desired, it is necessary to turn off the altitude hold. To do this, press and release the ALT button.

TRK+  
103  
SEL  
103  
ALT  
HOLD  
AP  
ON

### Minimum and Maximum Airspeed

The CT Pilot series autopilots have a minimum and maximum airspeed feature.

These are added only for safety. If the autopilot is in altitude hold and the pilot reduces power to a point at which the airspeed falls below the minimum airspeed set in the autopilot, the autopilot will allow the aircraft to begin a descent and flash **MIN AS** on the display.

TRK+  
104  
SEL  
104  
MIN  
AS  
AP  
ON

Likewise if the autopilot is in altitude hold and the pilot adds power to a point at which the airspeed reaches the maximum airspeed, the autopilot will allow the aircraft to climb and will flash **MAX AS** on the display.

TRK+  
104  
SEL  
104  
MAX  
AS  
AP  
ON

## Gyro Set

The gyros will center automatically during the autopilot power up sequence. A manual gyro set can be performed, if desired. This procedure should be performed with the aircraft stationary on the runway and the autopilot disengaged. Press and hold the encoder knob for approximately three seconds. During this time, the words GYRO SET will be displayed. Continue holding the knob for 10 seconds to center the gyros.

A vertical rectangular display with a black background and green text. The top line reads 'NO' and the second line reads 'GPS'. The bottom two lines read 'GYRO' and 'SET'.

## Power Loss

If there is a momentary loss of electrical power, the autopilot will disengage. The autopilot gyros will need to be manually re-initialized using the gyro set operation. Do not re-engage the autopilot until the gyros have been set using the gyro set procedure. Manually fly the aircraft in a straight line, as steadily as possible, while holding in the knob for at least ten seconds. After releasing the knob, the autopilot may be re-engaged, and any residual gyro offset will be slaved away automatically.

A vertical rectangular display with a black background and green text. The top two lines read 'TRK+' and '104'. The bottom two lines read 'GYRO' and 'SET'.

## FD Pilot II VS

### Lateral Modes

When engaged, the autopilot will be in the basic lateral mode, and it will synchronize to both the current direction and vertical speed being flown. The number following SEL (Selected direction) is underlined and rotating the encoder will select a heading. Rotation

A vertical rectangular display with a black background and green text. The top two lines read 'TRK+' and '103'. The next two lines read 'SEL' and '103'. The bottom two lines read 'ALT HOLD' and 'SVS 0'.

of the knob will cause 5° steps of SEL and when it is depressed the steps will be 1°.

If a GPS flight plan has been entered into the GPS, pushing the MODE button will engage the GPS NAV mode and a flashing plus sign will show. In the GPS NAV mode the autopilot will follow a flight plan programmed into the GPS. The autopilot

A vertical rectangular display with a black background and green text. The top two lines read 'TRK+' and '104'. The next two lines read 'GPS' and 'NAV'. The bottom two lines read 'ALT HOLD' and 'SVS 0'.

must, however, over-fly each waypoint prior to turning and intercepting the next course line.

If the GPSS option has been added, pushing the MODE button will engage the GPS steering. In the GPSS mode the autopilot follows lateral steering or bank commands generated by a navigation system (EFIS or GPS). This feature will only be available when coupled to certain EFIS systems or a GPS with GPS steering outputs.



TRK+  
093  
GPSS  
ALT  
HOLD  
SVS  
0

### Gyro Back-Up Mode

The lateral modes previously described are based on GPS track being present. When GPS is lost, the autopilot uses its internal gyros for bank control, and **TRK** is replaced with **BANK**. This mode is only a backup and would seldom be needed; however, it does provide a means of selecting a desired bank angle, and a means of adjustment if the aircraft turns when zero bank is selected. If the GPSS signal source is functional, the **GPSS** modes will also be functional. When in the gyro backup mode the number displayed below **BANK** is the



NO  
GPS  
BANK  
0°  
ALT  
HOLD  
AP  
ON

selected bank angle. Rotating the encoder knob will move the selected bank angle one degree at a time up to five degrees, the bank angle is then selectable in five degree steps up to 30 degrees.

If the aircraft continues to turn when a bank angle of zero degrees has been selected, push in on the encoder and the display changes to show a **TRIM** adjustment. This adjustment is selectable in increments of 0.2 degrees per minute up to ten degrees per minute in either direction. Every time the trim is adjusted it will add the displayed number to the current trim adjustment.

## Vertical Modes

When the autopilot is engaged it will synchronize to the direction and vertical speed being flown at the time, the lower right section of the display shows SVS (selected vertical speed). To enter altitude hold at any time, push and release the ALT button two times.

TRK+  
103  
SEL  
103  
ALT  
HOLD  
SVS  
0

If an altitude change is desired, momentarily push and release the ALT button and the cursor will move over to the selected vertical speed. Rotation of the encoder knob will now change the selected vertical speed. If the cursor is under the SVS number a single click of the ALT button will select zero vertical speed. If the selected vertical speed is set to zero, the display will show ALT HOLD.

TRK+  
104  
GPS  
NAV  
ALT  
HOLD  
SVS  
0

Once the desired vertical speed has been selected, momentarily pushing and releasing the MODE button will move the cursor back to SEL, or after approximately seven seconds without moving the encoder, the cursor will move back to SEL.

## Setting Pitch Trim

The pitch servo contains a torque sensor that sends a signal to the computer when an out of trim condition is detected for more than a preset length of time. This is displayed with three moving horizontal bars in the center of the display. These bars will move according to the direction in which trim is required. The pilot is then required to operate the trim control (electric or manual) so as to bring the system to neutral trim. With mechanical trim this is easily done, but with electric systems it may be necessary to develop a technique. If the trim is slow enough, the pilot has plenty of time to react when the bars disappear before the trim condition is reversed. With a fast trim it will be necessary to tap or pulse the trim button so that it will be slow enough to turn it off before going too far. When a reversal takes place, a slight tap in the opposite direction may be required to get the bars to stay off. The bars can be ignored if they reappear after adjusting the trim and the aircraft is known to be close to the neutral trim position.

## Minimum and Maximum Airspeed

The CT Pilot II series autopilots have a minimum and maximum airspeed feature. These are added only for safety. This feature is easier described using the CT Pilot IIVS model as an example. If the pilot commands a vertical speed climb in which the aircraft slows to the minimum airspeed, the aircraft will maintain that airspeed and will flash **MIN AS** on the display.



TRK+  
104  
SEL  
100  
MIN  
AS  
SVS↑  
2000

Likewise if the pilot commands a vertical speed descent in which the aircraft accelerates to the maximum airspeed, the autopilot will not fly the selected vertical speed, but will maintain the maximum airspeed and flash **MAX AS**.



TRK+  
104  
SEL  
100  
MAX  
AS  
SVS↓  
1000

## Gyro Set

The gyros will center automatically during the autopilot power up sequence. A manual gyro set can be performed, if desired. This procedure should be performed with the aircraft stationary on the runway and the autopilot disengaged. Press and hold the encoder knob for approximately three seconds, the words **GYRO SET** will be displayed.



TRK+  
104  
GYRO  
SET

## Power Loss

If there is a momentary loss of electrical power, the autopilot will disengage. The autopilot gyros will need to be manually re-initialized using the gyro set operation. Do not re-engage the autopilot until the gyros have been set using the gyro set procedure. Manually fly the aircraft in a straight line, as steadily as possible, while holding in the knob for at least ten seconds. After releasing the knob, the autopilot may be re-engaged, and any residual gyro offset will be slaved away automatically.

## FD PILOT Setup Procedure

The setup consists of setting activity, torque, serial baud rate, bank angle setting, micro activity, minimum airspeed, maximum airspeed and static lag. To enter the lateral setup mode, press and hold the MODE button for approximately 3 seconds until the first setup screen appears. The first setup screen shows the current value for the activity of the aileron servo, with an underline under the present setting of activity. A typical screen might show:

The underlined number is set by rotating the encoder knob. Turn this knob to set the activity level to the desired value for the particular aircraft. Any value between 0 and 24 may be chosen. In this example, the value of 3 will be selected.

```

LAT  ACTIVITY
    3
EXIT NEXT
  
```

Activity should be set so as to not be excessive in turbulence and yet sufficient to fly without hunting in still air. (Any lost motion or play between the servo and the control surface can cause hunting in still air).

After the activity has been set to the desired value, press and release the ALT button to advance to the next setup screen.

In a manner similar to activity, use the encoder knob to select the desired value of roll servo torque. This value should be between 7 and 12. A default value is set at the factory but may need to be modified to suit a particular aircraft. The value chosen should be sufficient to fly the aircraft, but not so much that it is difficult to override the autopilot if necessary.

```

LAT  TORQUE
    12
EXIT NEXT
PREV
  
```

After selecting the desired torque level, press and release the ALT button to advance to the next setup screen.

The value shown represents the speed of the primary RS-232 interface to the external GPS unit. By default at the factory it is set to 9600 baud. However, it may be set to any of 600, 1200, 2400, 4800, or 9600 baud. Consult the manual for the GPS unit and follow its setup instructions to determine its setting and set the baud rate of the autopilot to the same value. The autopilot will recognize NMEA-0183 protocol or Apollo

```

BAUD
9600
EXIT NEXT
PREV
  
```

GX50/GX60 protocol (moving map output).

Once the desired baud rate or Garmin protocol has been selected, use the ALT button to advance to the next screen.

The bank angle setting can be adjusted to suit the pilot. This setting controls how much bank the autopilot will command when in a turn. A LOW setting will bank the aircraft about 12.5°, MED about 19°, and HIGH about 25°. This will not change the flight dynamics of the system and any of the three settings will fly the aircraft equally well. Once the desired bank angle setting is selected, advance to the next screen. The unit will now show:



The micro activity setting in most aircraft will be left at zero (0). Micro activity is used only in aircraft in which a slow wing rock has been observed in very still air. Sometimes there will be a small amount of lost motion in an aircraft's control system, and the micro activity setting is a way to compensate



for the lost motion. Set the micro activity as needed and advance to the next screen.

This setup screen is used to increase the bank angle that the autopilot will fly in GPS Steering mode. Increase the value to increase the allowable bank angle. Press and release the ALT button to advance to the next setup screen, which is shown below:



Set the Yaw Damper? to Y if there is a yaw damper installed and N if there is not a yaw damper installed. Use the ALT button to advance to the final setup screen. Press and release the knob to finish the setup for the lateral axis. This concludes the lateral setup procedure.



To configure the pitch portion of the autopilot push and hold the ALT button for 3 seconds. The first setup screen if a CT Pilot IIVS allows the pitch axis to be turned on or off. The default of on will always be selected after a power cycle.



To turn the pitch axis off, select off, and click the knob to exit. To advance to the next setup screen, press and release the ALT button, the next setup screen is shown below:

Turn the encoder knob to set the activity level to the desired value. Any value between 0 and 24 may be chosen. In this example, the value of 3 will be selected.



Once activity is set to the desired value, press and release the ALT button to advance to the next setup screen:

In a manner similar to activity, use the encoder knob to select the desired value of pitch servo torque. This value should be between 7 and 12. A default value is set at the factory

but may need to be modified to suit the aircraft. The value chosen should be sufficient to fly the aircraft, but not so much that it is difficult to override the autopilot if necessary.



After selecting the desired torque value, advance to the next screen.

Use the encoder knob to select the minimum airspeed at which the autopilot will fly the aircraft. This speed should be a safe margin above a stall. Press the ALT button to advance to the next setup screen. The next screen will show:



The maximum airspeed value is the fastest indicated airspeed the autopilot will fly, independent of what it is commanded to do. Rotate the knob to adjust this airspeed to a value safely below the red line airspeed, but above the normal cruise speed. Select the desired value, and then press the ALT button to



advance to the next setup screen.

The next screen in the setup procedure is the static lag setup screen. This setting should only be changed if the autopilot tends to have a slow oscillation in pitch during altitude hold due to lag in the static system. The display will show:



A green monochrome display showing the text 'STATIC LAG' at the top, a horizontal line with the number '0' below it, and the words 'EXIT', 'PREV', and 'NEXT' arranged vertically at the bottom.

Rotating the encoder knob will change the number as in previous setup screens. After selecting the desired value, press the ALT button to advance to the next setup screen.

As before in the lateral setup mode, the micro activity setting in most aircraft will be left at zero (0). Micro activity is used only in aircraft in which a slow oscillation has been observed while in altitude hold, in very still air. Sometimes there will be a small amount of lost motion in an aircraft's control system, and the micro activity setting is a way to compensate for the lost motion. Press and release the ALT button to advance to the final setup screen.



A green monochrome display showing the text 'MICRO ACTIVITY' at the top, a horizontal line with the number '0' below it, and the words 'EXIT', 'PREV', and 'NEXT' arranged vertically at the bottom.

This setting in most cases will not need to be changed. If the half step setting is set to Y (yes), then the pitch servo will now have higher resolution, and take smaller steps. While this setting will make the servo take smaller steps, it will decrease the amount of available torque. This setting should be left at N (No), unless it is observed that the nose moves up and down very slightly while in altitude hold in very still air. Press and release the knob and the display will return to the normal flight screen.



A green monochrome display showing the text 'HALF STEP' at the top, a horizontal line with the letter 'N' below it, and the words 'EXIT', 'PREV', and 'NEXT' arranged vertically at the bottom.

## Contrast Adjustment

The FD Pilot II contrast should only be adjusted while on the ground. To enter the contrast adjust mode, with the autopilot powered off, push and hold the encoder knob in. Turn on the power to the autopilot, and after 1 second release the knob. The display will show the current contrast setting. Rotate the knob to select the desired contrast ratio. Too low of a number and the words will fade out on the display. Too high of a number the background will become dark, and the text unreadable. To exit the contrast adjustment screen, press and release the encoder knob.



TruTrak Flight Systems, Inc.

(07/08)  
Printed in U.S.A.