

# EZ PILOT



## Operation and Installation Manual

Trio Avionics Corporation

Rev 2.3

## Notice and Warnings

**Warning: Any failure to comply with the following warnings can lead to property damage and serious injury, including death.**

**Although** Trio Avionics has taken reasonable steps to test its product, the final determination of safe operation lies with you, the installer and pilot. Your workmanship in installing, cabling, and testing the autopilot in your airplane is critical to safety. If you are not the original builder of your aircraft, and do not hold a valid "Repairman's Certificate" for your aircraft, you must have the installation done by a qualified A&P aircraft mechanic or the original builder. You must comply with all current FAA regulations regarding installation of this device in your airplane.

**This product** is to be used on homebuilt, experimental aircraft only. It is not approved for, nor is it legal to install it in, certified aircraft. It is not approved by any governmental or non-governmental agency.

**Prior** to installing or flying this autopilot, read the manual completely. If you have any questions about the installation or operation of the system, **STOP** and then call or email Trio Avionics for clarification.

**The servo** that is a part of this autopilot system is attached directly to your aileron control system. It is possible to install or adjust it in a manner that may result in improper or unexpected aileron movement that could result in dangerous aircraft maneuvers. Install it only after you have read and understand the installation instructions. You must thoroughly inspect and test your installation prior to flight. Mistakes in any modification to your aircraft can be life threatening!

**Each homebuilt aircraft** is individual in its construction, maintenance and flying characteristics. Therefore, while Trio Avionics has tested the product in a variety of aircraft, we do not represent or warrant that it is appropriate or suitable for use in your particular aircraft. Only you can make that determination and ultimately only you are responsible for its safe installation and use.

**This product** is designed for use as an en route navigation aid only, and only at safe altitudes in unobstructed airspace. It must not be relied upon for any other purpose. It is not to be used for flight in instrument meteorological conditions (IFR), or approaches into airports in either IFR or visual (VFR) conditions. Power to the servo must be turned "off" for takeoffs and landings.

**In operation**, this product relies upon data provided by a GPS receiver. Always keep in mind that GPS signals are not totally reliable. They may be disrupted by electromagnetic interference, improper placement of antennas, satellite unavailability and other problems. You must provide data signals from a reliable and properly installed GPS receiver. The GPS antenna must have a clear "view" of the sky to assure uninterrupted, safe operation. External antennas are strongly recommended.

**When flying** an aircraft with this, or any, autopilot enabled, you must be constantly vigilant for any sign of improper operation of the autopilot. When there is even a suspicion that the autopilot or the GPS receiver is not operating properly, you must immediately disable the autopilot by any of the various methods detailed in this manual. Do not fly the autopilot without incorporating the remote servo disconnect switch that is described in this manual.

**There may be** a tendency to concentrate on the instrument display when test flying this or any other new system in your aircraft. Do not allow it to distract you from the need to "see and avoid" other aircraft.

**The safe practice** of aviation demands the consistent exercise of pilot skill, knowledge of airmanship and weather, judgment and focused attention at a level which is appropriate to the demands of each individual situation. Pilots who do not possess or exercise the required knowledge, skills and judgment are frequently injured or killed. Therefore, although an autopilot can serve as a useful navigation aid, no autopilot can be relied upon and you must be at full attention at all times while flying any aircraft.

***If you do not agree to comply with any of the warnings or notices above, do not install or fly this autopilot system in your aircraft. Call Trio Avionics for a Return Material Authorization (RMA) and return the unused system for a full refund.***

# Table of Contents

	Page
<b>Introduction</b> .....	1
<b>2.0 General Information</b> .....	2
Track Mode (TRK).....	2
Course Mode (CRS).....	3
Intercept Mode (INT) .....	3
<b>3.0 Control and Display Unit</b> .....	4
<b>3.1 Switch Function and Operation</b> .....	4
<b>3.1.1 On/Off Switch</b> .....	4
<b>3.1.2 Mode Switch</b> .....	4
<b>3.1.3 Servo Power Switch</b> .....	5
<b>3.1.4 Display Switch</b> .....	5
<b>3.1.5 Left or Right (L/R) Switch</b> .....	6
<b>3.2 Display Information</b> .....	7
<b>3.2.1 Power Up Display</b> .....	7
<b>3.2.2 Initial Logo Screen</b> .....	7
<b>3.2.3 NO GPS Screen</b> .....	7
<b>3.2.4 GPS Active, Normal Power-Up Display</b> .....	8
<b>3.2.5 TRK Mode, GPS Signals Present</b> .....	8
<b>3.2.6 TRK Mode, BTW (Bearing to Waypoint field)</b> .....	8
<b>3.2.7 Variable Field, Top Line</b> .....	8
<b>3.2.7.1 XTK (Cross Track Error Field)</b> .....	8
<b>3.2.8 TRK (Groundtrack Field)</b> .....	9
<b>3.2.9 Variable Fields, Bottom Line</b> .....	9
<b>3.2.9.1 GS (Groundspeed)</b> .....	9
<b>3.2.9.2 ETE (Estimated Time En-route, HH:MM)</b> .....	9
<b>3.2.9.3 ETe (Estimated Time En-route, MM:SS)</b> .....	10
<b>3.2.9.4 RNG (Range to Waypoint)</b> .....	10
<b>3.2.9.5 Waypoint</b> .....	10
<b>3.2.9.6 Digital Turn Coordinator Display</b> .....	10
<b>3.2.9.7 DIS?</b> .....	10
<b>3.2.9.8 TRN?</b> .....	11
<b>3.2.9.9 SPD?</b> .....	11
<b>3.2.10 CRS (Course) Mode</b> .....	11
<b>3.2.11 INT (Intercept) Mode</b> .....	12
<b>3.2.12 TOP (Track Offset Position)</b> .....	12
<b>3.2.13 Automatic Course Reversal</b> .....	13
<b>3.2.14 Variable Display Field – Upper Line</b> .....	14
<b>3.2.15 Other Display Presentations</b> .....	14
<b>4.0 Setup Screens</b> .....	14
<b>4.1 Contrast Setting (LCD model only)</b> .....	15
<b>4.2 Initial Servo Position and SERVO direction</b> .....	15
<b>4.3 Max Turn Rate selection</b> .....	15
<b>4.4 IO = Dim or Mode? Screen</b> .....	16
<b>4.5 Circle Last WPT? Screen</b> .....	16
<b>4.6 Turn Rate Display selection</b> .....	17
<b>4.7 Custom Screen Setup</b> .....	17
<b>4.8 Software Configuration and Serial Number</b> .....	17
<b>5.0 Ground Operation and Flight Example</b> .....	17
<b>5.1 Power Up and Initial Settings</b> .....	17
<b>5.2 Flying to a Courseline or GOTO Waypoint</b> .....	19
<b>5.3 Loss of GPS</b> .....	19

	5.4 CRS Mode Operation .....	20
	5.5 INT Mode Operation .....	21
	5.6 Pilot Controlled Steering (PCS) .....	21
6.0	<b>Installing the Control Head</b> .....	23
	6.1 Your GPS .....	23
7.0	<b>Servo</b> .....	25
	7.1 Installing the Servo .....	25
	7.2 Servo Mounting Hardware .....	26
	7.3 Selecting a Site for the Servo .....	27
	7.4 Install the Servo Pushrod.....	28
	7.5 Setting Servo Override Force (Slip Clutch).....	28
	7.6 Adjustment of Servo Rotation Direction and Servo Neutral.....	29
	7.6.1 Setup Mode Entry .....	29
	7.6.2 Servo Rotation Testing .....	30
	7.6.3 Servo Direction Reversal .....	30
	7.6.4 Servo Neutral Setting.....	30
	7.7 In Flight Adjustment of Servo Neutral .....	30
	7.8 Repositioning the Servo Crank Arm.....	31
	7.9 System Optimization, Flight Time, Distance Counters and Totalizers.....	31
	7.9.1 System Optimization .....	31
	7.9.2 Flight Time, Distance and Totalizer Counters.....	34
	7.9.2.1 Flight Time and Distance Counters .....	34
	7.9.2.2 Flight Time and Distance Totalizer Displays.....	34
8.0	<b>Electrical Requirements</b> .....	34
	8.1 Primary Input Power.....	34
	8.2 Servo Power.....	35
	8.3 GPS Data Input.....	35
	8.4 Remote Display Brightness.....	35
	8.5 Autopilot Servo Disconnect.....	35
	8.6 Wiring Diagram .....	36
	8.7 J1 Connector Pin Mapping Chart.....	36
9.0	<b>Glossary of Terms</b> .....	37
10.0	<b>Contact Information</b> .....	37

# EZ Pilot

## 1.0 Introduction

Congratulations on choosing the EZ Pilot autopilot. It is designed to enhance the navigational capabilities of your experimental aircraft and offers many innovative features.

While the EZ Pilot is inherently simple to use, this manual will serve as a guide to understanding its basic functions and employing its many advanced features. The EZ Pilot is so feature-rich that mastering it all might seem intimidating at first. Be assured that the advanced features are not necessary for out-of-the-box utilization of the autopilot and that, except for the fine gain settings and the servo position adjustment, all of the additional parameters are for increased utilization and enjoyment of your autopilot. **Operation is as simple as entering a flight plan into your GPS and pressing the SERVO button.** The sections on installation and adjustment are placed toward the back of the manual, as you will not normally need to refer to them once your installation and test flights are complete.

**Section 2** examines the elements of operation employed by the EZ Pilot. Here you will get a feel of what the unit will do for you, and how to employ its three basic modes of navigation.

**Section 3** is a detailed description of the Control and Display unit, which will familiarize you with switch functions and the wealth of information available to you on the alphanumeric display.

**Section 4** is a detailed description of the Setup Screens available to you to configure the autopilot to meet your preferences and the flight dynamics of your aircraft. This is “must read” information for the initial set up of the EZ Pilot autopilot.

**Section 5** takes you along on a flight, with the EZ Pilot handling the navigational duties. As the flight progresses, you will begin to employ additional features of the autopilot.

**Section 6** describes the installation of the Control Head and some initial tests for proper operation.

**Section 7** is devoted to the installation and operation of the Servo. Because the servo is connected to your ailerons, be sure you read and thoroughly understand this section before installing the servo. **Paragraph 7.8** describes how to adjust the autopilot so that it is “fine tuned” to your particular aircraft.

**Section 8** covers the electrical requirements and wiring of the EZ Pilot system.

**Section 9** is a glossary of terms and acronyms that are used in this manual.

**Section 10** provides contact information for those wishing to communicate with Trio Avionics

## 2.0 General Information

**The EZ Pilot is a small, solid state aircraft autopilot system designed exclusively for experimental aircraft and is to be used for VFR operations only. This autopilot is not certified and is not suitable or approved for installation in a normally certificated aircraft.**

The EZ Pilot is a single axis autopilot that controls the roll axis for aircraft attitude correction (wing leveling) and provides area navigation using signals provided by an external GPS receiver. It is composed of two units, the control/display unit and the roll servo.

The EZ Pilot does not contain a built-in GPS or other navigation data source. You must supply an appropriate host GPS source and be correctly connected to the Display Head at the time of installation. (See the Installation Instructions later in this manual.)

The EZ 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.

**Note:** The EZ 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 and inherent sensor drift and noise errors. The EZ Pilot has a flash based EEPROM memory that is updated automatically with the most current dynamic calibration information during each flight.

While the EZ Pilot is an excellent “wing leveler,” it finds its greatest strength following a flight plan that is active on a host GPS. This can be as simple as a “GOTO” command on the GPS, or a complex, multi-segment flight plan.

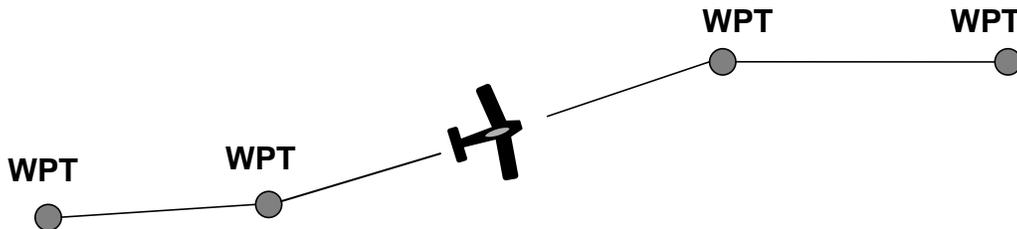
### Important Warning

**Do not use the autopilot to attempt GPS approaches, even though your GPS may provide this feature. The EZ Pilot is intended to be an aid to en route navigation only.**

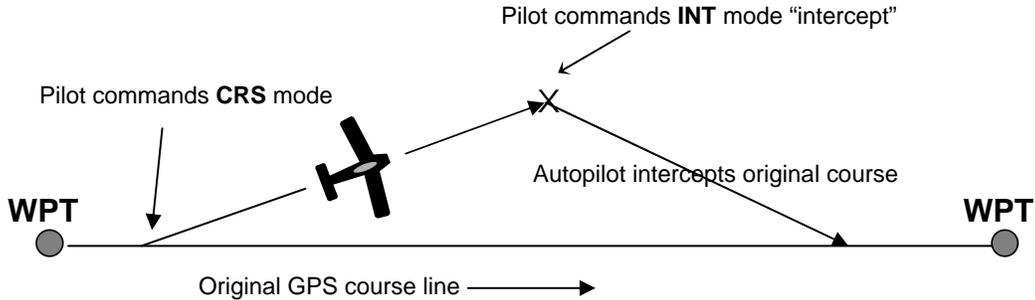
**The Servo should always be disengaged when initiating the landing checklist at altitude.**

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

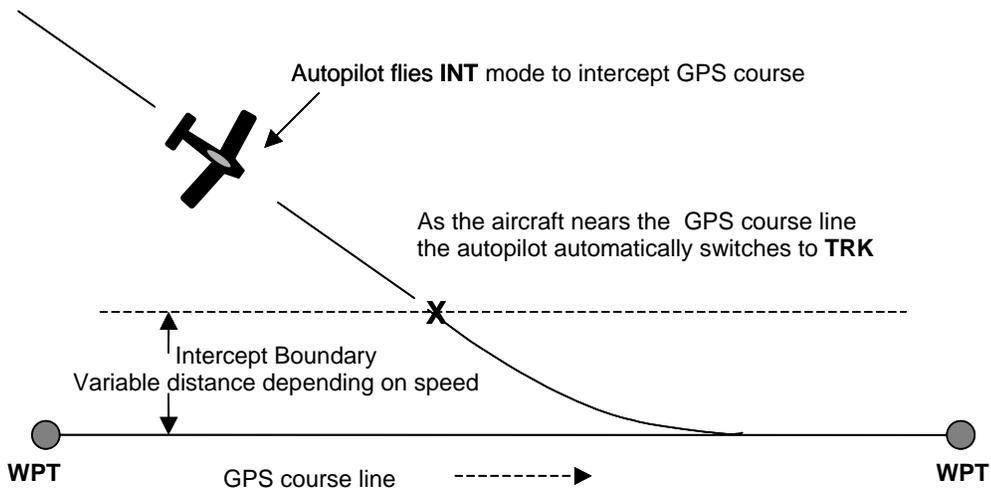
- 1. Track mode (TRK)** – used for area navigation tracking a host GPS flight plan (or GOTO data).



**2. Course mode (CRS)** – provides vector navigation as illustrated below. **CRS** also allows tracking an autopilot-selected course when the host GPS route function is not in use. **CRS** mode uses the GPS signal to provide the aircraft groundtrack. This mode can be useful for avoiding restricted airspace, weather and oncoming air traffic.



**3. Intercept mode (INT)** – used to intercept a predefined GPS desired track (**DTK**) as illustrated below. The **INT** mode also uses the GPS signal to provide the aircraft groundtrack. This mode is useful to regain the original flight plan track after circumnavigating the previously mentioned flight obstacles.



In both the **CRS** and **INT** modes the ground track to be followed may be selected by the pilot, using either the L/R switch or the PCS steering mode of operation

The EZ Pilot will automatically switch from the **INT** mode to the **TRK** mode as it nears the intercept boundary.

### 3. Control and Display Unit

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 3 inch clearance behind the instrument panel. The unit is powered from the airframe +12V DC system. All controls are located on the front panel.

This unit contains all of the controls and displays that are required for **autopilot mode** selection, **display data** selection, **servo power** control, setting **CRS** direction and **INT** angle selection.

#### 3.1 Switch Function and Operation

##### 3.1.1 ON/OFF Switch

The **ON/OFF** switch controls application of aircraft power to the EZ Pilot. In the **OFF** position the EZ Pilot is completely disconnected from the aircraft control system. On power up the display presents a logo and the current EZ Pilot firmware code version (or a customized screen) and sets several default conditions as follows:

Upon power up the **TRK** 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. In this condition the autopilot may still be used to provide a wing leveler function and the **L-R** switch can be used to initiate turns to the left or right. Once GPS data is present and validated, full navigation function is available.

Servo power is initially off on power up. The **Servo Power Switch** must be pressed momentarily to activate the system servo for either normal navigation or wing leveler functions. When the **SERVO POWER LED** is not illuminated the servo motor is completely disconnected from the aircraft control system.

##### 3.1.2 Mode Switch

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

Pressing the **MODE** switch momentarily advances the mode from **TRK** ---> **CRS** ---> **INT** and then back to **TRK**. The appropriate LED illuminates in each mode.

The **MODE** switch also provides the "AUTOMATIC COURSE REVERSAL" feature which does an automatic servo engage and ground track reversal. Please paragraph 3.2.12 for operation instructions for this feature.

Also, the **MODE** switch function may be connected to an external switch (in lieu of the display dimming function) to provide a remote method of changing the EZ Pilot mode setting. See paragraph 4.0 for additional details.

The automatic transition from the **INT** mode to the **TRK** mode is a function of the



crosstrack error (**XTK**) magnitude. The unit will sequence automatically 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** on the upper right data field when the **INT** mode is selected. Also, sequencing the mode from **CRS** to **INT** is not possible if the track error is below this variable limit. (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 **MODE** switch.)

### 3.1.3 Servo Power Switch

The servo power switch controls power application to the EZ Pilot servo. When the **SERVO LED** is unlighted servo power is interrupted. This power interruption disconnects the EZ Pilot completely from the control system. When the LED is illuminated the EZ Pilot is providing servo power and control signals to the autopilot servo. The servo is turned on or off (disconnected) by pressing this switch momentarily. A remote Servo disconnect switch should also be mounted on the aircraft control stick (strongly recommended). When implemented, this switch will provide important additional functionality (PCS mode steering).



### 3.1.4 Display Switch

The Display Switch performs 6 functions, as follows:

#### 1 - Display Data Fields

The **DISPLAY** switch selects what data is presented on the variable fields of the display. Momentarily pressing (“bumping”) the display switch advances the **lower right** line variable display field through the available selections. Pressing and holding the display button then toggling the **L-R** switch advances the **upper right** variable display field through its display selections (see function 5 below). The displays available are described in section 3.2.14.

#### 2 - Display Brightness Control

Display brightness control is also accomplished using the front panel **DISPLAY** switch or a remote display dimming switch. Pressing the front panel switch and holding it approximately one second, then releasing the switch, will change the display brightness level. The **DISPLAY** switch should be momentarily released after the next dimming setting is obtained to prevent cycling to the calibration mode (**Function 3** below). The remote display dimming switch, however, steps the display through the dimming levels each time it is pressed and will initiate the display scanning mode. (There is an option to reassign the remote dimming switch to **MODE** switching but the **DISPLAY** switch on the front panel will still perform the dimming function and start or stop the scanning mode.)

#### 3 - Entering “Calibration Mode”

Pressing and holding the **DISPLAY** switch for more than five seconds causes entry into

the **CALIBRATION MODE** for fine tuning of the autopilot tracking algorithms (all models) and displaying the **FLIGHT TIMERS** and **TOTAL TIME AND DISTANCE** counters.

#### 4 - Scan Mode Entry

Pressing the **DISPLAY** 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,” providing a rotating 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 data field indicating the **SCAN** mode is active

#### 5 - Top Line Data Selection

Using the **DISPLAY** switch in conjunction with the **L-R** switch allows selection of the data being displayed in the right side of the top display line.

#### 6 - Setup Screen Entry

If the **DISPLAY** button is pressed when power is applied, the EZ Pilot will go into the **SETUP** mode function. In this mode the following screens and operating parameters can be changed:

- Contrast adjust (LCD model only),
- Servo position
- Remote dim or mode setting
- Turn rate selection (AUTO, or a fixed turn rate from 1 to 3 deg / sec)
- Last waypoint circle
- Rate of turn display (LARGE or SMALL)
- Start up screen programming (user programmable)
- System Configuration screen (factory software version and serial number)

#### 3.1.5 Left or Right (L- R) Switch

The **L-R** switch has 4 functions depending on the EZ Pilot mode.

##### 1 – TOP control

In the **TRK** mode the **L-R** switch is used to change the Track Offset Position (TOP) setting.

##### 2 - Groundtrack Adjustment

In either the **CRS** or the **INT** modes the **L-R** switch is used to select the groundtrack that the autopilot is commanded to follow. Momentarily moving the **L-R** switch to the left slews the commanded groundtrack to the left in one-degree increments. Momentarily moving the **L-R** switch to the right causes the commanded groundtrack to be moved to the right by one degree. Holding the switch in either the left or right position for more than one second will cause the commanded groundtrack to move right or left at a faster rate until released.

### 3 – Drift Correction (NO GPS mode)

Pressing this switch momentarily 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.* If the switch is held for longer than 1 second in either the right or left position the trim bias count is shifted right or left at a significantly faster rate until the switch is released. 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 switch is released. If the GPS data to the EZ Pilot is unavailable, as indicated by a NO GPS warning, the **L-R** switch provides a method to turn the airplane to a new heading or stabilize the aircraft in a straight and level attitude.

### 4 – Changing various parameters

The L-R switch is used in conjunction with the **MODE** and **DISPLAY** switches in the setup and calibration modes to change the various settings. These will be described in the setup procedures (Section 4) of the manual.

## 3.2 Display Information



Pilot information for navigation is provided on a high contrast, bright Polymer LED (PLED), or an optional transfective LCD (backlighted). 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. The display example shows the normal power up default display with GPS data present.

### 3.2.1 Power up Display

When the EZ 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) If GPS signals are present on the EZ 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.

### 3.2.2 Initial Logo Screen



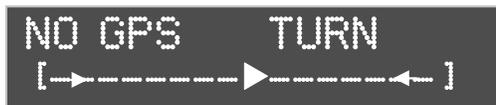
The initial factory logo screen shows the product information including the firmware revision level and unit serial number in the extreme right part of the display (represented by the X's).



Optionally, the purchaser may program their own 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 setup menu screens (Section 4.7).

### 3.2.3 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 five seconds. In all cases the navigation display will return to

normal automatically when the GPS signals are reacquired. Note that 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 made active and the EZ Pilot will go into the wing leveler mode following a "straight and level" course on the last commanded groundtrack. In this mode, manual corrections to the dead reckoning track can be made using the electronic trim feature. (See paragraph 3.1.5)

### 3.2.4 GPS Active, Normal Power Up Display

On power up, the EZ Pilot defaults to the **TRK** mode of operation. Once GPS signals become active on the interface, and a flight plan is entered, the display illustrated below is presented to the pilot. This display is the power up default presentation. It is possible to have the displays shown in paragraph 3.2.9.7 (**DIS?**), paragraph 3.2.9.8 (**TRN?**) or paragraph 3.2.9.9 (**SPD?**) if the conditions noted below are present at that time.

### 3.2.5 TRK Mode, GPS Signals Present

The diagram on the next page shows the EZ Pilot display immediately after power up with a good GPS signal present, and flight plan entered. Note that the SERVO POWER LED is not illuminated. Although the unit is fully capable of providing area navigation, the **SERVO** pushbutton must be manually pressed (connected) before the EZ Pilot will take control of the roll axis of the aircraft.

### 3.2.6 TRK Mode, BTW (Bearing To Waypoint Field)

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 EZ pilot is refreshed, normally once every one or two seconds, depending on the GPS interface data rate. (A GPS with NEMA data output normally 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. Please note that 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).



### 3.2.7 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 (see section 3.2.9) or an electronic rate of turn display. The factory default display is to present the information shown below, but the user may wish to otherwise configure this segment. See section 3.1 for details on setting the data to be displayed in this field.

#### 3.2.7.1 XTK (Cross Track Error Field)



The 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. Conversely, if the apex is to the right (>) the autopilot will fly to the right to eliminate the error. 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**.

### 3.2.8 TRK (Groundtrack Field)



The groundtrack (**TRK**) field is located on the line directly below the "Bearing to Waypoint" (**BTW**) field on the extreme left side. The **TRK** field is the current track over the earth based

on the GPS updates every one or two seconds.

### 3.2.9 Variable Fields, Bottom Line

The bottom 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

\* no associated label field displayed

Each field above except the **DIS?**, **TRN?** and **SPD?** fields is selected by pressing the **DISPLAY** switch momentarily. The **DIS?**, **TRN?** and **SPD?** fields are automatically displayed to indicate GPS data anomalies as described below. 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).

#### 3.2.9.1 GS (Groundspeed)



The **GS** (groundspeed) field indicates the aircraft speed over the ground in the units (miles per hour or knots) as selected on the host GPS system.

This field is limited to a maximum value of 999 miles/knots per hour.

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



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) depending on the results of **RNG/GS** (distance/closing velocity) calculation.

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



This field is identical to the **ETE** field except the format is **MM:SS**. This format is automatically displayed when the **RNG/ CLOSING**

**VELOCITY** calculation indicates the time to the next waypoint is less than 60 minutes from the current time.

### 3.2.9.4 RNG (Range to Waypoint)



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 miles (nautical or statute, depending upon how you have set your GPS). This field is limited to a maximum value of 999 miles.

### 3.2.9.5 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 PPS rate for approximately 10 seconds when past the last waypoint in the route or past the last GOTO waypoint.

### 3.2.9.6 Digital Rate of Turn Display



A digital graphic representing the current yaw rate is presented to the pilot when this field is selected. On the EZ Pilot the pilot has the setup

option of using either the small rate of turn display, or the large rate of turn display. The limit on this rate is approximately  $\pm 4.5$  degrees per second full scale. A three degree per second turn rate is realized when the digital graphic on the small display is at the last horizontal segment in either direction. On the large display the 3 deg / sec rate is denoted by the tip of the arrow presented in the display line.

### 3.2.9.7 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.

### 3.2.9.8 TRN?



The **TRN?** warning is displayed in this field when the EZ Pilot detects a negative closing velocity (going away from the “TO” waypoint). This usually occurs when a waypoint greater than  $\pm 90$  degrees from the current waypoint is selected. **No pilot action is required.**

### 3.2.9.9 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.

### 3.2.9.10 Variable Field Scan Mode – Lower Right Line

If the DISPLAY button is momentarily pressed two times in quick succession (double-clicked) the variable field will enter or exit the “Scan Mode”. In this mode the waypoint designator, RNG, GS, XTK, TOP and ETE(e) fields are sequenced in the display at a 2.5 second rate. This can be useful for sequentially monitoring all the parameters put out by the GPS without having to manually select each parameter.

## 3.2.10 CRS (Course) Mode

Assuming the **TRK** mode is currently selected, the **CRS** (course) mode is entered by pressing the **MODE** pushbutton momentarily. The mode is announced when the **TRK** LED is no longer illuminated and the **CRS** LED is illuminated.

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 commanded groundtrack and are a snapshot from the current groundtrack when the mode is entered. For example, if the **TRK** mode groundtrack is 010 degrees when the **CRS** mode is entered the commanded course will be initialized to 010 degrees. The **TRK** field in line 2 is followed by a left or right pointing apex (< or >), which shows which direction the airplane needs to fly to get back on the commanded track (**CRS**). The pilot now has a clear display of the actual across-the-ground track (**TRK**) in line 2 and the current commanded track (**CRS**) in line 1.



**NOTE:** If **SERVO POWER** is turned on (cycled) while in the **CRS** mode, the current track over the ground is automatically entered as the commanded **CRS**.

In the **CRS** mode the **L-R** switch allows the pilot to adjust the commanded course by one degree increments either right or left of its current value. Again, "bumping" this switch will cause the commanded course to change by one degree, while holding the switch in either off-center position results in a two degree per second change until released. The distance right or left of the **DTK** is preserved as the **XTK** data, although, since we are in the **CRS** mode, it will not affect the autopilot tracking. The **CRS** mode is exited by pressing the mode button until the desired mode (**INT**, **TRK**) is selected. Note that 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 in paragraph 5.6.

### 3.2.11 INT (Intercept) Mode

The **INT** mode is designed to bring the aircraft back onto the desired track after a vector navigation operation. It is activated by pressing the **MODE** switch (to sequence from the **TRK** or the **CRS** mode) until the **INT** LED is illuminated.

It is important to note again, the **INT** mode cannot be entered if the **XTK** error is less than the computed distance from the desired track line. *This variable distance is computed as a function of the turn rate and groundspeed.* The automatic switch from the **INT** to **TRK** mode occurs at this distance. If the **XTK** is greater than the computed distance then the **INT** mode can be entered. See paragraph 5.5 for a detailed description of this feature.

The **INT** mode automatically establishes an approximate 25 degree intercept angle (default setting) toward **DTK**. The commanded intercept course can be adjusted in the same manner as in the **CRS** mode using the **L-R** switch or the **PCS** mode. The **INT** mode is automatically cancelled and the **TRK** mode is entered when the aircraft crosses the intercept boundary line.

**NOTE:** If **SERVO POWER** is turned on (cycled) while in the **INT** mode, the current track over the ground is automatically entered as the commanded intercept angle.

### 3.2.12 TOP (Track Offset Position)

With the advent of highly accurate GPS navigation and coupled autopilots, aircraft are tracking more and more closely to the airway centerlines on designated airways (the EZ 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 EZ Pilot incorporates a feature heretofore found only in high end Flight Management Systems – **Track Offset Position (TOP)**.

**Track Offset Position** allows the pilot to fly a groundtrack which is offset by up to one mile from the centerline between the waypoints (desired track, or **DTK**). To enable this feature, do the following:

In the **TRK** mode (only) Move the **L-R** switch to the left or right 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 1/10<sup>th</sup> mile increments.

The **TOP** function is deactivated by setting the **TOP** field to 0.0 using the **L-R** switch, or by simply cycling power to the EZ Pilot using the **POWER** switch.



BTW ◆ 175 TOP > 0.3  
TRK > 176 XTK ► 0.31

When activated, note that 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.

### 3.2.13 Automatic Course Reversal

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

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.*

The procedure is simple and straightforward. Press and hold the **MODE** button for three seconds. **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
- A 175 degree **right** course reversal will be executed.



CRS 175 TRN 180  
TRK > 000 < --- ◆ --- >

The display screen will change as shown. (The turn coordinator will occupy the entire lower line if it was set to LARGE). The reversed groundtrack will remain in

effect until cancelled by selecting another mode (or using the **PCS** mode) .

If a left course reversal is desired, then hold the **L-R** switch to the left while pressing the **MODE** switch. A left 175 degree left course reversal will then be executed.

**Note:** You are undoubtedly wondering why the turn is limited to 175 degrees instead of 180 degrees. It is to assure a predictable outcome in an emergency situation. In normal operation, when a course reversal is commanded by the GPS (invert flight plan) the autopilot will turn the shortest arc distance. For instance, if the plane is pointed even a fraction of a degree to the left of course, the turn will be to the left, and vice-versa. Additionally, small gyro disturbances and GPS update irregularities could cause ambiguity in turn direction. Therefore, a five degree “buffer” is introduced to absolutely assure that the aircraft will always turn right (or left, if so commanded by the pilot). This guarantees a predictable result in a possible emergency situation

### 3.2.14 Variable Display Field – Upper 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 using a combination of the **DISPLAY** button and the **L-R** switch. To change the displayed parameter, do the following:

1. Press and hold the **DISPLAY** button
2. Momentarily “bump” the **L-R** switch until the desired parameter is displayed
3. Release the **DISPLAY** button after the desired parameter is selected

You may bump the L-R switch either direction to change the displayed field.

Note that this function can only be used in the **TRK** mode since the **L-R** switch is used in the **CRS** and **INT** modes to adjust the course-to-track or intercept angle.

### 3.2.15 Other Display Presentations

On occasion, when a new waypoint is manually selected on the GPS, the data in the GPS input stream might be corrupted momentarily. The EZ 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 EZ Pilot. **No pilot action is required.** Normal **TRK** mode tracking computations are inhibited until the GPS data integrity is restored

## 4.0 Setup Screens

The EZ Pilot provides a quick and easy method to set up certain parameters that are normally only changed at installation. The setup mode allows adjustment of the following items:

1. LCD contrast (LCD model only)
2. Setting of the initial servo position (mechanical zero)
3. Selection of the servo rotation direction
4. Selection of a manual or automatic (bank angle limited) turn rate
5. Selection of a programmable input / output signal for remote dimming or remote mode selection
6. Selection to circle a last waypoint or proceed outbound from a last waypoint.
7. Selection of a large or small format rate electronic rate of turn indicator
8. Setup of a custom startup screen
9. Display of the EZ Pilot software configuration and serial number

#### To enter the Setup Mode:

1. Turn off power.
2. Press and hold the **DISPLAY** button
3. Turn on power
4. Release the display button.

#### NOTE

The **MODE** button is used to sequence through the available settings on a selected screen and to sequence to the next available screen. All settings are saved immediately after the change is made, so to do a quick exit from the **SETUP** mode you can turn the unit **OFF** and then back **ON**, or rapidly press the **MODE** button to sequence through the various screens back to the **TRK** mode of operation

#### 4.1 CONTRAST SETTING (LCD model only)



CONTRAST ADJUST  
L=DECR R=INCR

The first screen presented is the CONTRAST ADJUST screen. To increase the contrast, move the L-R switch to the RIGHT. To decrease contrast, move the switch to the left. This is a slowly varying adjustment so it will require holding the switch in the LEFT or RIGHT position for several seconds to cause a visible change on the screen.

#### 4.2 INITIAL SERVO POSITION and SERVO direction

Press the **MODE** button to sequence to this screen. If this is a PLED equipped unit this will be the first screen presented.



SERVO POSITION  
SERVO=NORM

To change the servo position, use the L-R switch to increase or decrease the displayed value. Setting of the servo position is covered in Sections 7.6 and 7.7

To sequence to the **SERVO: NORM or REV** setting, press the **MODE** button momentarily. The arrow indicator will now be before the **NORM** or **REV** indicator.

#### NOTE

This setting will only appear if the GPS is not locked. The autopilot locks out this function in flight. See sections 7.6.2 and 7.6.3 for proper setting of the **SERVO** direction.

To change the setting, move the L-R switch to either selection. Release the switch when the desired direction is obtained.

#### 4.3 MAX TURN RATE Selection

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 EZ Pilot has a means whereby the users can adjust the maximum rate of turn to their personal satisfaction.

When shipped, the EZ 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 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 1/10<sup>th</sup> degree/sec. When this screen is displayed the arrow is preset to select the **MAN** or **AUTO** field. Use the L-R switch to change between the **MAN** and **AUTO** options.

To adjust the **MAN** turn rate press the **MODE BUTTON** one time until the arrow is in front of the turn rate value. The L-R switch can now be used to change this setting as desired. If you do not wish to change this, simply push the **MODE** button until the normal navigation screen is displayed or recycle



MAX TURN RATE  
▶AUTO

power to the EZ Pilot



To change from **AUTO** (automatic) to **MAN** (manual), move the **L-R** switch to the left or right and you will see the screen shown here. (Repeated use of the **L-R** switch will alternate between **AUTO** and

**MAN**.) You have now instructed the autopilot to observe a fixed maximum turn rate. This is initially set to 3 degrees/sec. If you wish to set the autopilot so that it will have a lower maximum turn rate, press the **MODE** button only once and you will see the following screen:



The arrow (▶) has now moved to the number field that indicates the maximum turn rate that will be allowed in the **MAN** mode that you have selected. You may now use the **L-R** switch to change this

number, in 1/10<sup>th</sup> degree increments, to your desired maximum turn rate.

For instance, if you wish to set you the maximum turn rate to 2 degrees/sec, press the **L-R** switch to the left until the readout indicates 2.0 as shown.



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. Pressing the switch to the right will increment this number up to the maximum of 3.0 degrees/sec.

Once you have achieved the maximum turn rate that you desire, simply press the **MODE** switch again to select the next setup screen

#### 4.4 IO = DIM or MODE? Screen

There is provision for a remote **DIM** or remote **MODE** to be employed with the EZ Pilot. The factory default is to use this button as a **REMOTE DIM** function to adjust the display brightness.

The user has the option to select the J1, Pin 1 input as either a **REMOTE DIM** function or as a **REMOTE MODE SELECT** function. If the **REMOTE MODE SELECT** is employed, the button will perform the same function as the **MODE** button on the control head. Pressing it repeatedly will sequence the autopilot from the **TRK** to **CRS**, to **INT** (if qualified – greater than .5 miles from track line), and then back to the **TRK** mode.

If you want to change this selection, momentarily push the **L-R** switch to either the left or right position. The displayed function will change to **MODE**. Pressing the **L-R** switch repeatedly will continue to alternate between these two settings.

#### 4.5 CIRCLE LAST WPT? Screen



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 it is set to **NO**, the EZ 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 EZ pilot will turn the aircraft to effectively "home" to this last waypoint. Both modes remain in their respective states until the mode of the EZ Pilot is changed, or a new waypoint is selected.

Press the **MODE** button to sequence to this screen. The arrow will be before the **NO** or **YES** field. Use the **L-R** switch to select either **NO** or **YES**.

#### 4.6 TURN RATE DISPLAY Selection



Use the **L / R** switch to change the selection from **LARGE** (full width display) to **SMALL** or vice versa. Pressing the mode switch will advance to the next display

#### 4.7 CUSTOM SCREEN SETUP



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. Typically, most EZ 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.

When the display is first selected there will be a flashing cursor at the first character position. The front panel switches function as follows:

**LEFT / RIGHT switch** Selects the displayed character from a set of available characters.

**DISPLAY switch** 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.

**MODE switch** Terminates writing to the screen and advances to the next display 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.

#### 4.8 Software Configuration and Serial Number



This screen defines the factory configuration for this particular unit and contains the Trio banner along with the software configuration and EZ Pilot serial number.

This screen is permanently written into program memory and cannot be changed without reprogramming the entire unit. If you need to contact Trio regarding this particular product please note this number in your contact information

Pressing the **MODE** button while on this screen sequences the EZ Pilot to the navigation mode.

### 5.0 Ground Operation and Flight Example

This section discusses what must be accomplished on the first “power up” of the EZ Pilot, items to be checked and adjusted, and a flight example

#### 5.1 Power Up and Initial Settings

On power up the EZ Pilot will display the logo screen. Note that the **TRK** LED is illuminated and the **SERVO** power is off (**SERVO LED** is not illuminated). The aircraft roll control (ailerons) should be free and clear indicating the servo is disconnected from the control system.

**Note: If the adjustment of servo rotation direction and servo neutral (section 7.6) has not yet been accomplished, it must be done now, before flight.**

A preflight check on the EZ Pilot at this point would be to engage the servo by pressing the **SERVO POWER** pushbutton momentarily and noting that the **SERVO POWER LED** illuminates. The servo is now locked to the control system. The pilot should intentionally force the ailerons to their extreme positions to verify the slip clutch on the servo will allow the pilot to continue to fly the airplane in the event the servo malfunctions (Section 7.5). **If this is not possible the aircraft should be grounded until this discrepancy is resolved.** If this check is satisfactory the **SERVO POWER** 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.

<p><b>Important: If all of the above actions cannot be properly achieved, turn the EZ 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.</b></p>
--

Since the GPS is not yet powered up, after about 7 seconds the display shows the **NO GPS** message. The pilot now applies power to the GPS unit that is connected to the EZ Pilot and programs the GPS flight plan. On GPS power up, the display on the EZ 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 EZ 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 kts). In this case either the "NO GPS" message or the "NO FPLAN" mode will be displayed.

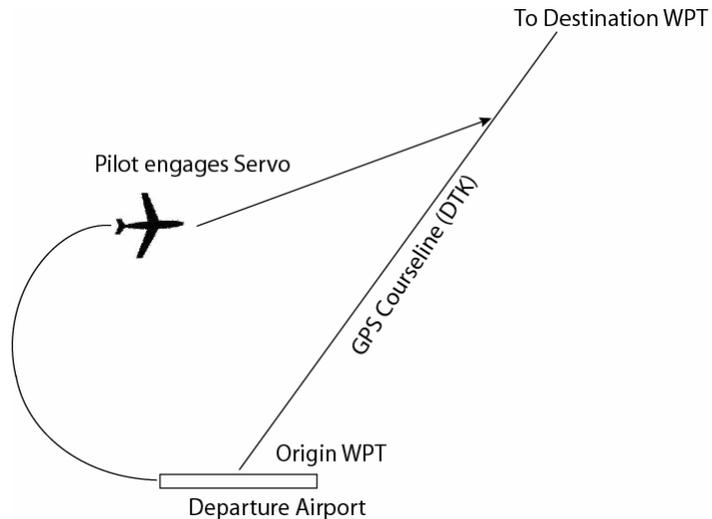
Some GPS receivers' output data are capable of providing groundtrack and groundspeed information to the EZ pilot after satellite lock, even before a flight plan is entered. The EZ pilot will detect this and provide the pilot with a modified **CRS** mode capability. In this mode, manual transition to 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 to fly a selected groundtrack. 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 EZ 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 EZ Pilot and the host GPS system.

## 5.2 Flying to a Courseline (DTK) or GOTO Waypoint

**If this is the first flight with the EZ Pilot, the in-flight adjustment of Servo Neutral must be accomplished (see section 7.7).**

**Note:** As a safety feature, during the takeoff roll, the EZ Pilot checks the status of the servo. At 25 knots GPS groundspeed, it will automatically disconnect the servo, allowing free movement of the ailerons. This is a backup feature only and should not be relied upon to replace a necessary preflight checklist item. This feature relies on a proper GPS signal being received and will not function properly if the GPS is not active and providing data to the autopilot.



After take off, and at a safe altitude, select the flight plan on your GPS and press the **SERVO POWER** pushbutton momentarily.

Note that the **SERVO LED** is now on and the autopilot has control of the aircraft.

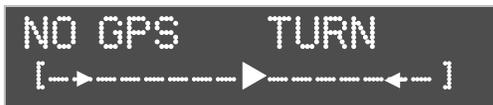
One of the design features of the EZ Pilot is its ability to find the desired course (**DTK**) and track to it regardless of where the airplane is heading when the autopilot is engaged. In an extreme example, the plane might be flying 180 degrees away from the GPS routing and the EZ Pilot will bring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

**Note:** In the above example, it might be expected that the EZ Pilot would immediately begin to turn toward the first programmed waypoint when the servo is engaged. However, it must be remembered that the flight plan establishes the courseline between the departure WPT and the first destination WPT. Therefore, the autopilot will fly to the courseline and then turn toward the WPT.

To proceed directly to the WPT from present position, the pilot would need to utilize the "Direct To" feature of the GPS receiver. The EZ Pilot would then track direct to the desired WPT.

During the flight on this leg some other navigation parameters are available for review, such as estimated time to the waypoint (**ETE** or **ETe**). Pressing the **DISPLAY** switch presents this data. Pressing the **DISPLAY** button again shows **RNG** (distance) to this waypoint. The **DISPLAY** button is pressed repeatedly until **GS** or **WPT** is back on the display, since they are probably referred to most often in flight, or the pilot may engage the scan mode to see all parameters (see Sec. 3.2.9.10). Additionally, the upper right display field can be programmed to display any of the GPS derived data as described in paragraph 3.2.13.

## 5.3 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 loss of GPS signals. In such case, after

approximately 7 seconds without signal the EZ Pilot displays the **NO GPS** message. Since the EZ Pilot is no longer able to provide the navigation function, the **L-R** switch can be used to control the aircraft turn rate.

The EZ Pilot servo is still engaged so the aircraft is being controlled in the “wing leveler” mode (aircraft roll stabilization). Without the GPS signal, the EZ 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 stop the drift, the pilot engages the **L-R** switch (correcting the spontaneous drift) until the drift is neutralized. Let's assume that several minutes later the GPS comes back on line.

## 5.4 CRS Mode Operation

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, (or the optional remote mode pushbutton).



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 **L-R** switch is held to the right until 040 is displayed as the **CRS** value. The EZ Pilot turns the airplane to a track of 040.

2. **PCS** mode (see paragraph 5.6) is invoked by pressing and holding the **Remote Servo Disconnect** switch and manually flying the aircraft to the desired groundtrack, releasing the switch when the proper groundtrack 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 **DTK**.



1. The intercept mode (**INT**) may be used to return to the original preprogrammed route, or

2. Going directly back to the **TRK** mode causes the EZ Pilot to more gradually curve back to the **DTK**.

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

## 5.5 INT Mode Operation

Assume that, while in the **CRS** mode, the aircraft flew 5.1 miles right of the **DTK**, as shown on the display’s **XTK** field. Also assume that the computed switch point is 1.0 miles. The **INT** mode is selected by pressing the **MODE** switch to get back on the **DTK**. The **CRS** LED extinguishes, and the **INT** LED illuminates and flashes at a 1 PPS rate. The following changes are present on the display:



```
INT 345 IDS<4.1
TRK<010 KJFK
```

The **XTK** label changes to **IDS** (intercept distance) 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 EZ Pilot selects a 25 degree intercept angle automatically.

The aircraft is now turning left to the groundtrack commanded in the **INT** field. The **IDS** value is steadily decreasing 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** (see Section 5.6) by pressing the **Remote Servo Disconnect** switch and manually flying the aircraft to the desired intercept course. Releasing the switch locks the new groundtrack as the desired intercept angle. The **L-R** switch may also be used to change the intercept angle (**INT** field) while in the **INT** mode.

Progressing toward the **DTK**, as the **IDS** value approaches 0.0 the EZ Pilot switches automatically from the **INT** mode to the **TRK** mode when the aircraft is 1.0 miles right of the **DTK**. The EZ Pilot now is turning the airplane back to the right slightly and the **XTK** is approaching 0.00. The EZ 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.

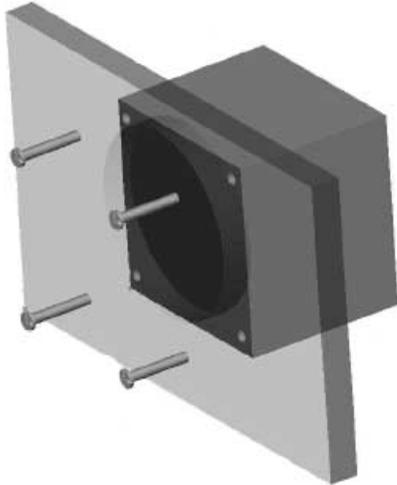
## 5.6 Pilot Controlled Steering (PCS)

The EZ 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 and, 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 **Servo** button on the control/display unit.

**NOTE:** If **SERVO POWER** 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 **Servo 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 **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.

## 6.0 Installing the Control Head



The EZ Pilot control head mounts from the rear side of the instrument panel. It is held in place by 4 ea. Number 6 screws. When mounted, the visible area is contained within a standard 3-1/8 inch instrument cutout.

The autopilot system (including servo) normally draws less than 1 amp of current from the 12 volt source. While the unit is internally fused, it is strongly recommended that an external fuse or circuit breaker be provided to protect against the possibility of a short in the wiring harness to the system. A three amp fuse or breaker is recommended for the wire sizes recommended in the installation procedures.

Once the unit is installed, turn on aircraft power and energize the control head using the **POWER** toggle switch at the top of the faceplate.



The display will illuminate showing a brief message that describes the software version contained within the control head. Alternatively, it may present a customized message (example – your name, aircraft type and tail number) if you have customized the startup screen.



After a few seconds, the display will show a “**NO GPS**” message. At this point, you should turn on your GPS and move your aircraft to a position where it will obtain reliable GPS signals. Once you enter a

flight plan into your GPS, and/or attain a groundspeed of several knots, you should observe normal flight data similar to that shown in earlier pages of this manual.

### 6.1 Your GPS

If you do not get a proper display (once your GPS is turned on and has a clear view of the sky) check the wiring connections between the GPS unit and the EZ Pilot. The signal input requires a data input and a ground, and these must be wired as shown in the wiring diagram (Section 8.6).

Although GPS receivers generally conform to industry standards (NMEA 0183 for portables and Aviation Data Link for most panel mount receivers) they do vary in the format of the output data stream. This is especially true for older systems. Some do not put out enough information for navigational purposes, as they were designed before it was realized that such outputs could be useful to other devices. The EZ Pilot is compatible with most mainstream receivers. It scans and analyzes the data and configures itself to process it so it is useful for navigation. If your receiver does not provide data that the EZ Pilot recognizes, the autopilot display will present the message “**NO GPS**”. You should notify the factory if you cannot sync to the signal. However, it is important to check for the following:

1. Your GPS probably has a setup mode where you must enable the output. Some have several possible output modes. The proper mode must be enabled for the GPS to communicate with the autopilot. For the NMEA format the desired output is NMEA 0183 Rev 2.0 (or greater), 4800 baud rate, 8 data bits, no parity, 1 stop bit (8, N, 1). The AVLINK is 9600 baud, 8 data bits, no parity, 1 stop bit (8, N, 1). Refer to your GPS user's manual for guidance.

2. You must be in an area of good signal strength for your GPS receiver to operate properly. If you try to use it in a hangar, for instance, the weak signals will not provide reliable data and the **“NO GPS”** message will appear.
3. For reliable operation, you will probably need to employ an external antenna for your GPS. Or, if using a portable GPS and you don't have an external antenna, you will need to mount the GPS where the antenna has a clear “view” of the sky in all directions at all normal flight attitudes.
4. Some GPS units will not yield a serial output until a flight plan or “Go To” is entered and **NO GPS** will be displayed until this is accomplished. Some other GPS receivers output only a few of the parameters needed for autopilot operation which the EZ pilot will recognize by entering the **NO FPLAN** mode. Other receivers (KING KLN-XX models, for example) will not output a valid data link signal until a certain groundspeed (usually a few knots or more) has been attained.
5. Some GPS units will not yield an output until a certain groundspeed is attained.

## 7.0 Servo



The servo unit incorporates two very 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 aileron controls can be operated normally. When the servo is engaged, the solenoid pulls the gears into place so the servo has control of the ailerons. Disengaging the servo allows free movement of the aileron controls.
- The servo is engaged and disengaged by pressing the **SERVO** button on the EZ Pilot control head. There is also a provision to accommodate a remote **SERVO DISCONNECT** switch on the control stick (or other remote location). Installation of a remote switch is highly recommended, as it allows a convenient and an immediate way to disengage the servo - even in heavy turbulence, when it may be difficult to operate the small **SERVO** button on the EZ Pilot control head.
- The servo also employs a clutch, which allows the pilot to override the servo 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, or an autopilot anomaly, the pilot can thus override the servo to control the airplane. In such an instance, the servo should 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.

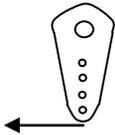
The entire job of the servo is to have the power driven crank arm, which is linked to your aircraft aileron controls, push the stick left or right when the autopilot requests aileron adjustment. That’s all. Further discussions simply relate to ways to do this, and to facilitate the installation.

### 7.1 Installing the Servo

Begin by looking for a point where pushing or pulling the aileron 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 ailerons are neutral when the servo crank arm is at mid position. That’s it, aside from carefully checking that the required range of aileron movement is transited within the limits of the servo travel range and that no “over center” condition can exist.

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

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 hub by four machine screws that can be removed for indexing the crank arm in 90 degree increments (see Paragraph 7.8 for additional precautions).



**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 EZ Pilot control head must be programmed to reverse the drive signal.



In most cases the servo is installed with the bottom of the servo parallel to the ground, but it operates equally well in any orientation.

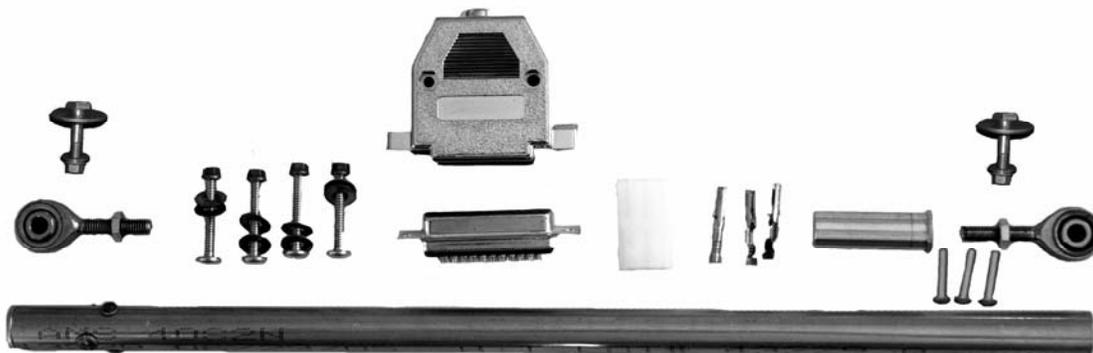
There are four holes in the crank arm that give operating radii with the combinations of force and peak-to-peak travel listed in Table 1 below:

Crank Arm Radius	Max. Travel (peak-to-peak)	Pounds of Force
1.0 inch	1.5 inch	36
1.2 inch	1.8 inch	30
1.4 inch	2.1 inch	26
1.6 inch	2.4 inch	22.5

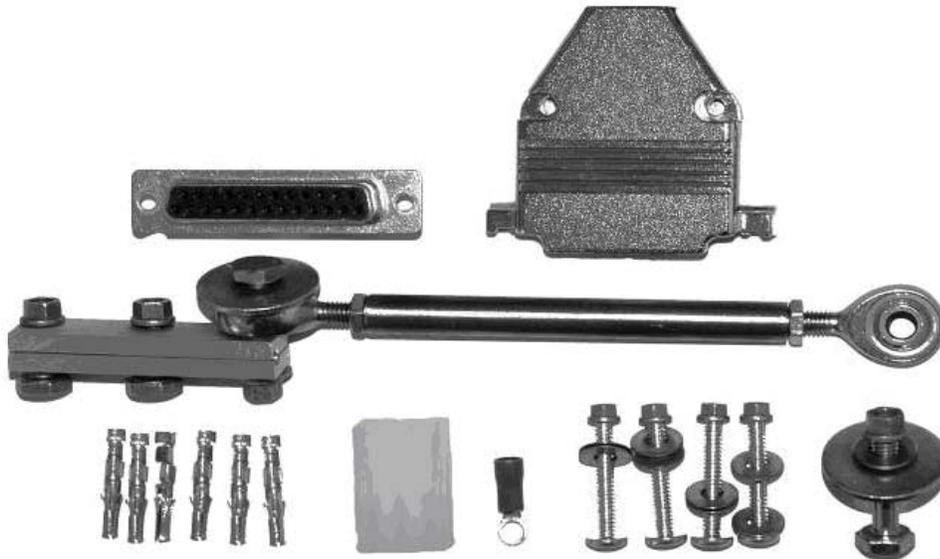
Choose an operating radius on the servo crank arm that allows full aileron movement (aileron stop to aileron stop) without driving the servo crank arm into its limits (+/- 50 degrees). Most aircraft get best performance in the 3<sup>rd</sup> or 4<sup>th</sup> (outermost) hole.

## 7.2 Servo Mounting Hardware

A hardware mounting kit is shown below. A push rod is provided, with two rod end bearings. The pushrod has a tapped insert riveted into one end. The other end is left open so the tube can be cut to proper length. Once the rod is cut to the desired length, the second insert must be riveted into place. Typically, the end of the pushrod connects to the servo crank arm and the other attaches to an aileron bellcrank. When the servo is connected to the aileron control system it should be installed so that the servo crank arm is at a right angle to the bellcrank. This mechanically centers the servo mechanism to the control system so that there is *equal displacement in either direction* when the servo is actuated. Fine zeroing using electrical trim will be accomplished later in paragraph 7.6.4.



When the servo is to be connected to an aileron control system that is operated by cables, the installation kit shown below will be provided. A shorter pushrod is included. The clamp that is attached to the pushrod will be placed around the cable and securely tightened.



### 7.3 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, to some extent, the angle it makes with the driven element are user selectable.

The rod end bearing allows some misalignment, usually 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, such as may be caused by elevator action being mixed with the aileron movement at the stick, 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 aileron control system.

**Note:** A longer aileron crank radius dictates a correspondingly longer radius at the drive end. **The ailerons must travel from aileron stop to aileron stop within the range of movement allowed by the servo stops** which limit crank arm rotation.

The mounting place must be strong and rigid – conceivably a lateral force of up to 50 pounds could be encountered. If, for example, you need to mount the servo on the skin of an airplane, it will likely be necessary to use additional bracing or a doubler to provide appropriate rigidity. You do not want the push-pull of the servo to fatigue the metal that holds it.

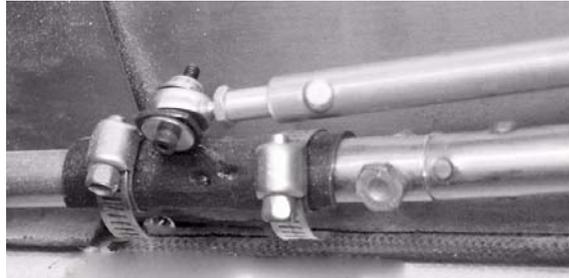
When mounting the servo, be careful not to drill mounting holes into a wing spar or other load bearing member. It may be best to construct a wooden, composite or metal mounting plate, place and bond machine screws so that they will interface with the case mounting tabs, and then secure the assembly into place. Once the assembly is complete, the servo base



mounting tabs will fit down over the screws. Nuts can be tightened down to secure it. For a composite aircraft installation, the bottom of the plate (shown above) 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.

Usually the servo pushrod will terminate on a control stick, a bellcrank, or perhaps a lever sticking off of a torque tube. But in some cases (EZ's for example) it is more convenient to terminate on an aileron control pushrod, **in which case 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 as follows:

If the servo pushrod will terminate on the aileron pushrod, the servo pushes or pulls on a saddle bracket mounted on an aileron control pushrod, the attach point being offset approximately an inch from the centerline of the control pushrod. **If the two pushrods are not perfectly aligned, the control pushrod may rotate instead of moving laterally.** Rotating, instead of moving, has the effect of putting play, or slack, into the linkage and will result in "hunting" while tracking. **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 lid.

#### 7.4 Install the Servo Pushrod

Cut the pushrod to the proper length so that, when the servo is at **neutral**, the ailerons are also neutral (see Note). Don't worry about being exactly correct – the servo neutral position will later be positioned (on the ground and in flight) using the electronics in the EZ Pilot control head.

**Note:** The **neutral position** for your ailerons will be dependent upon how precisely your flying surfaces are aligned. In many homebuilt airplanes, the ailerons must be trimmed for proper (hands off) straight and level flight. It is important to test fly your airplane prior to installing the servo to accurately judge the position of your ailerons in trimmed level flight. Remember this position – it is the neutral position for your ailerons

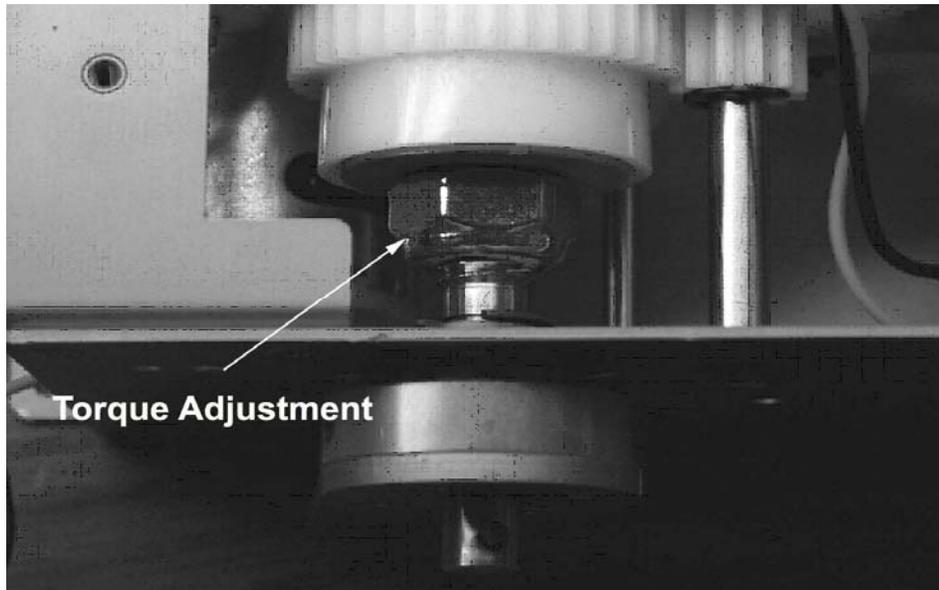
Choose the longest possible crank arm radius that accommodates a pushrod range of movement equal to or exceeding that required for full aileron travel. **Be sure that the rod end bearings never jam due to misalignment as the pushrod angle is varied by different combinations of control system input.** Put the control stick (or control wheel) in all four corners to test this.

#### 7.5 Setting Servo Override Force (Slip Clutch)

The servo Torque Control nut (the locknut 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 SERVO button on the control head. 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. Set the override force to a value that seems strong enough to give a fairly good roll authority, but not so strong as to be difficult to override with the control stick. Work toward setting the servo slip clutch to the minimum torque necessary to give enough roll authority to handle a reasonable amount of turbulence.



If you tighten the clutch enough to exceed the maximum torque rating, you may hear a loud clacking sound in the servo and the servo may disengage. This clacking happens when the force pushing the gears apart exceeds the solenoid's ability to hold the gear train engaged. This is a redundant safety feature – just back off on the control nut a little and recycle the power switch to re-engage the servo.

## 7.6 Adjustment of Servo Rotation Direction and Servo Neutral

With the autopilot now fully installed, it is necessary to perform a preliminary adjustment to the servo neutral position. This procedure will set the neutral position and also determine the direction of servo rotation for a left or right roll correction.

**Note:** In older systems it was sometimes necessary to reverse internal servo wiring and/or to fly the aircraft several times, and adjust the servo push rod position several times, to accurately fix the neutral position. The EZ Pilot incorporates an electronic method to “zero” the servo once it has been properly installed. This setting is then stored in the autopilot permanent memory, thus eliminating the need to perform repetitive mechanical adjustments to achieve an accurate neutral position.

### 7.6.1 Setup Mode Entry

With the GPS receiver turned off, turn on the EZ Pilot power switch while simultaneously holding down the **DISPLAY** pushbutton. Then release the **DISPLAY** pushbutton. The EZ Pilot is now in the “setup” mode. Press the **SERVO** button on the control head to engage the servo. You should hear the solenoid engage the gears and you may see some brief movement of the ailerons. The autopilot will now be in the “servo calibration” mode with the **SERVO POSITION** screen displayed. If this is an LCD model, advance to the servo positioning screen by pressing the mode button 1 time.

## 7.6.2 Servo Rotation Testing

**Note:** The servo rotation direction is critical to flight safety and proper autopilot operation. If this is not set correctly the autopilot will not track correctly and will cause the airplane to roll to bank angles in excess of 30 degrees either right or left when the servo is engaged. This setting cannot be changed in flight so it is critical that this be set correctly during ground setup and testing.



SERVO POS = 07500  
SERVO = NORM

The numbers that appear in the readout represent the servo position. Higher numbers position the ailerons for a right turn and lower numbers position the ailerons for a left turn.

Push and hold the **L-R** switch to the right position to increment the number to the 9000 setting (the right limit). Ensure the ailerons are positioned for a right turn, left aileron down, right aileron up. If they are not positioned for a right turn proceed directly to Paragraph 7.6.3. If this is okay, run the **SERVO POSITION** to the extreme left (6000) position and verify proper control system movement. This is a good time to observe that the pushrod does not rotate when the servo is slewed to the two extreme positions. Once this is verified proceed to Paragraph 7.6.4.

## 7.6.3 Servo Direction Reversal

To reverse servo rotation, press the **MODE** switch one time until the arrow cursor points at the **NORM** to the right of the **SERVO** readout. Move the **L-R** switch either direction to change the **NORM** in line 2 to read **REV**; then, press the mode switch several times to scroll through the remaining setup screens and return to the **NO GPS** display. The servo rotation is now in the “reversed” state.

**Turn the autopilot off and return to paragraph 7.6.1 of this procedure and retest the servo rotation direction.**

## 7.6.4 Servo Neutral Setting

Use the **L-R** switch to move the ailerons until they are in the proper neutral position. This is the approximate position of your ailerons that you observed in trimmed, level cruise flight.

Exit the display by pressing the **MODE** switch several times until the display cycles back to the **NO GPS** display. This will store the adjustments you made into the non-volatile memory.

## 7.7 In Flight Adjustment of Servo Neutral

The final check of Servo Neutral is conducted in flight. Be sure that the airplane is in straight and level flight, *the GPS is providing tracking data to the autopilot*, and the airplane is properly trimmed (using the aircraft roll trim) so that there is no tendency to roll off to the right or left. Turn the autopilot off, then back on while pressing and holding the **DISPLAY** button. Release the **DISPLAY** button and then press the **SERVO** button to engage the servo.



SERVO POS = 7500



SERVO POS ► 7528

If the aircraft tends to turn to the right with the servo on, disengage the servo and push the **L-R** switch to the left for a very brief period. You will see the readout numbers decrement and this should reduce the tendency to turn right. Level the airplane manually and re-engage the servo. If it still shows a tendency to turn, repeat the process until the aircraft remains stable in

level flight.

Similarly, if the aircraft tends to turn left, disengage the servo and push the **L-R** switch to the right to compensate. Re-level the aircraft; then engage the servo again to check for any remaining tendency to turn. Repeat this exercise until the aircraft remains stable with no tendency to turn when the servo is engaged.

**Once the final Servo Neutral is achieved, you should never have to adjust it or your servo again unless you make modifications to your airframe or controls that change the servo mechanical zero position. The settings that you achieved are stored in non-volatile memory and are not affected when you turn the unit off.**

## 7.8 Repositioning the Servo Crank Arm

To suit your particular installation, you may need to reposition the servo crank arm to get the correct geometry to drive the roll control system. This can be accomplished by rotating the crank arm to one of 4 positions, in 90 degree increments.

It is important, because the screws are secured with Loctite®, to apply heat with a heat gun before attempting to loosen the four screws. Failure to heat the assembly will more than likely cause the screws to break off when being removed.

**To reposition the servo Crank Arm, perform the following steps:**

1. Use a #2 Phillips screwdriver to remove the screws.
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.

## 7.9 System Optimization, Flight Time, Distance Counters and Totalizers

### 7.9.1 System Optimization

The response of the aircraft to 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 ailerons are rigged can affect aircraft response to control movement.

The EZ Pilot allows the pilot to adjust 3 system parameters to achieve optimum performance. However, care must be exercised when adjusting these numbers. Too much gain may cause the aircraft to hunt, or oscillate, around the course line. Too little gain will result in slow response to system commands or offsets in tracking.

The 3 adjustable parameters that are available to the pilot are:

1. **FINE CRS QLT:** Fine course quality. This adjustment controls how sensitive the system is to course commands when in the Course (CRS) mode, and within 5

degrees of the desired course. It has no effect outside of 5 degrees of the selected course heading.

2. **FINE TRK QLT**: 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 crosstrack error or showing greater than 5 degrees of error to the selected course.

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

To adjust the settings it is necessary to enter the “**Calibration Menu**” as follows:

Press the “**DISPLAY**” button and hold it in for 6 seconds. After six seconds the flight time and /or calibration screens will be displayed. If the flight time screen is displayed, momentarily press the **DISPLAY** button until the below screen is on the display



A monochrome LCD screen showing two lines of text: "FINE CRS QLT= 1" on the top line and "FINE TRK QLT= 2" on the bottom line.

If you wish to change the gains you can gain access to them by using the following procedure:



A monochrome LCD screen showing two lines of text: "FINE CRS QLT▶ 3" on the top line and "FINE TRK QLT= 2" on the bottom line.

To change the gain of the **FINE CRS QLT**, you must press the **MODE** switch once. This will replace the equal sign (=) with a triangle or “arrow” that indicates that the gain

number can be changed by using the **L-R** switch. You can increment the number, increasing the gain, by momentarily pressing the **L-R** switch to the right. Pressing the button to the left will decrement the gain value. When adjusting the gain number it is best to increment or decrement by a count of 1 and then observe the aircraft response.



A monochrome LCD screen showing two lines of text: "FINE TRK QLT= 3" on the top line and "FINE CRS QLT▶ 3" on the bottom line.

To change the gain of the **FINE TRK QLT**, press the **MODE** switch again. This will advance the arrow to the next line and allows use of the **L-R** switch to adjust the

Fine Course Quality gain.

*It is important to note that, while viewing the calibration screens, you cannot change from the “Track” mode to the “Course” mode or visa versa. This is because the **MODE** 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 calibration function.*

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 **FINE CRS QLT** gain to lessen the deviations. Additional gain may improve the performance, but be aware that too much gain may also cause oscillations. You should adjust it to find the “sweet spot” for your aircraft where it holds the course best. Use the following procedure.

### **CRS MODE GAIN SETTING**

1. Verify the in-flight **SERVO POS** per the manual procedures
2. Select the **CRS** mode and allow the airplane to stabilize on the selected groundtrack (**TRK**) for a few minutes
3. Select the **CALIBRATION** screens (press and hold the **DISPLAY** button until

- screens are displayed)
4. Use the **MODE** button to select the **FINE CRS QLT** parameter
  5. Increase this number one count
  6. Exit the calibration screens (press and hold **DISPLAY** until the normal nav screen returns)
  7. Observe tracking performance. If the oscillation increases return to step 3 and lower the **FINE CRS QLT** setting by two counts (original count minus one)
  8. Repeat steps 3 to 7 until best tracking is obtained. Normally the **EZ Pilot** will hold the groundtrack within +/- 1 degree in smooth air

You should then adjust the **FINE TRK QLT** for best performance while in the Track mode. To do this you must first exit the calibrations screens, back to the normal autopilot functions. Here you should place the autopilot in the Track (**TRK**) mode and allow the aircraft to stabilize on the track that you have selected on your GPS flight plan. Once the aircraft is stabilized, press the **DISPLAY** switch and hold it for 6 seconds to enter the calibration screens, where you can adjust the **FINE TRK QLT**. You should increment and decrement the number by one digit at a time and observe the effect on aircraft tracking. Use the following procedure:

#### **TRK MODE GAIN SETTING**

1. 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. Select the **CALIBRATION** screens (press and hold the **DISPLAY** button until screens are displayed)
4. Use the **MODE** button to select the **FINE TRK QLT** parameter
5. Increase this number one count
6. Exit the calibration screens (press and hold **DISPLAY** until the normal nav screen returns)
7. Observe tracking performance. If variation around track centerline increases return to step 3 and lower the **FINE TRK QLT** setting by two counts (original count minus one)
8. Repeat steps 3 to 7 until best tracking is obtained

Pressing the **MODE** switch again will bring up the next calibration screen.



Here again, pressing the **MODE** switch will replace the equal (=) sign with an arrow and allow the value to be changed using the **L-R** switch.

To exit the calibrations screens, simply press the display switch and hold it for 6 seconds. This will bring you back to the normal autopilot display.

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 **L-R** 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 **PULL IN** gain. If it is overshooting the new course, you may wish to lower the **PULL IN** gain.

The above settings should be adjusted with the aircraft flying in smooth air in a stabilized mode. Once properly adjusted correctly, these settings should not have to be changed.

## **7.9.2 Flight Time, Distance and Totalizer Counters**

The EZ Pilot contains flight time and flight and distance counters and Flight time and distance totalizers on two screens within the calibration displays menu.

### **7.9.2.1 Flight Time and Distance Counters**

The Flight time and Flight distance counters on the first display screen and count the time of flight and flight distance as long as a speed of 50 knots or above is maintained. This means that the flight and distance counters do not include time and distance information in the pre or post flight regimes. These counters can be individually reset to zero at any time by selecting the appropriate display line with the MODE switch (an arrow will precede the selected field) and then bumping the L-R switch 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 each minute so if power is lost momentarily only a maximum of 1 minute of time and distance information will be lost.

The Distance counter counts actual distance flown and measures and excursions from the programmed flight plan. This means that if, for example, you did 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.

Pressing the **DISPLAY** switch will advance from the Flight time and Distance counters to the Flight Time and Distance Totalizer display

### **7.9.2.2 Flight Time and Distance Totalizer Displays**

This display shows the total accumulated flight time and total accumulated flight distance in nautical miles. This display cannot be reset and is saved once each minute in nonvolatile memory.

## **8.0 Electrical Requirements**

For your EZ Pilot to operate properly, it is important to assure that it has been installed properly. Pay particular attention to assuring correct wire size and careful connector assembly. If soldering, be sure to use shrink tubing to cover the solder joints, and provide support for the harness assembly so it is not affected by vibration. If you crimp the wires, be sure to use the proper tool.

### **8.1 Primary Input Power**

The EZ Pilot requires an input power on pin 13 of 10 to 14 VDC at 1 amp and servo power on pin 19 or 18 of approximately 1 amp. The EZ Pilot is internally fused and requires wire from a circuit breaker capable of supplying approximately 3 amps. Both the autopilot and servo power are normally supplied from the same circuit breaker. 24 gauge wire is recommended although a larger size (22 or 20) is acceptable. The power ground should be a minimum 24 AWG wire size and is connected to pin 11. This wire should be the same size or larger (lower gauge number) as that used for the input power to pin 13.

Additional ground wires are required to supply the current return path for other EZ Pilot signals.

## **8.2 Servo Power**

The EZ pilot is capable of switching up to 5 amps of DC power to the EZ Pilot servo. The current servo design draws less than 1 amp (max) under heavy load conditions. The roll servo power is supplied to J1 pin 19 and the switched power to the servo is available on pin 25. The servo ground is available on pin 9, or a suitable airframe ground can be used instead. This wire should be the same size or larger (lower gauge number) as that used for connections to pin 19 and 25.

## **8.3 GPS Data Input**

The GPS data input signal is to J1 pin 7. The ground signal for the GPS is on pin 8. This wire can be 26 gauge or larger.

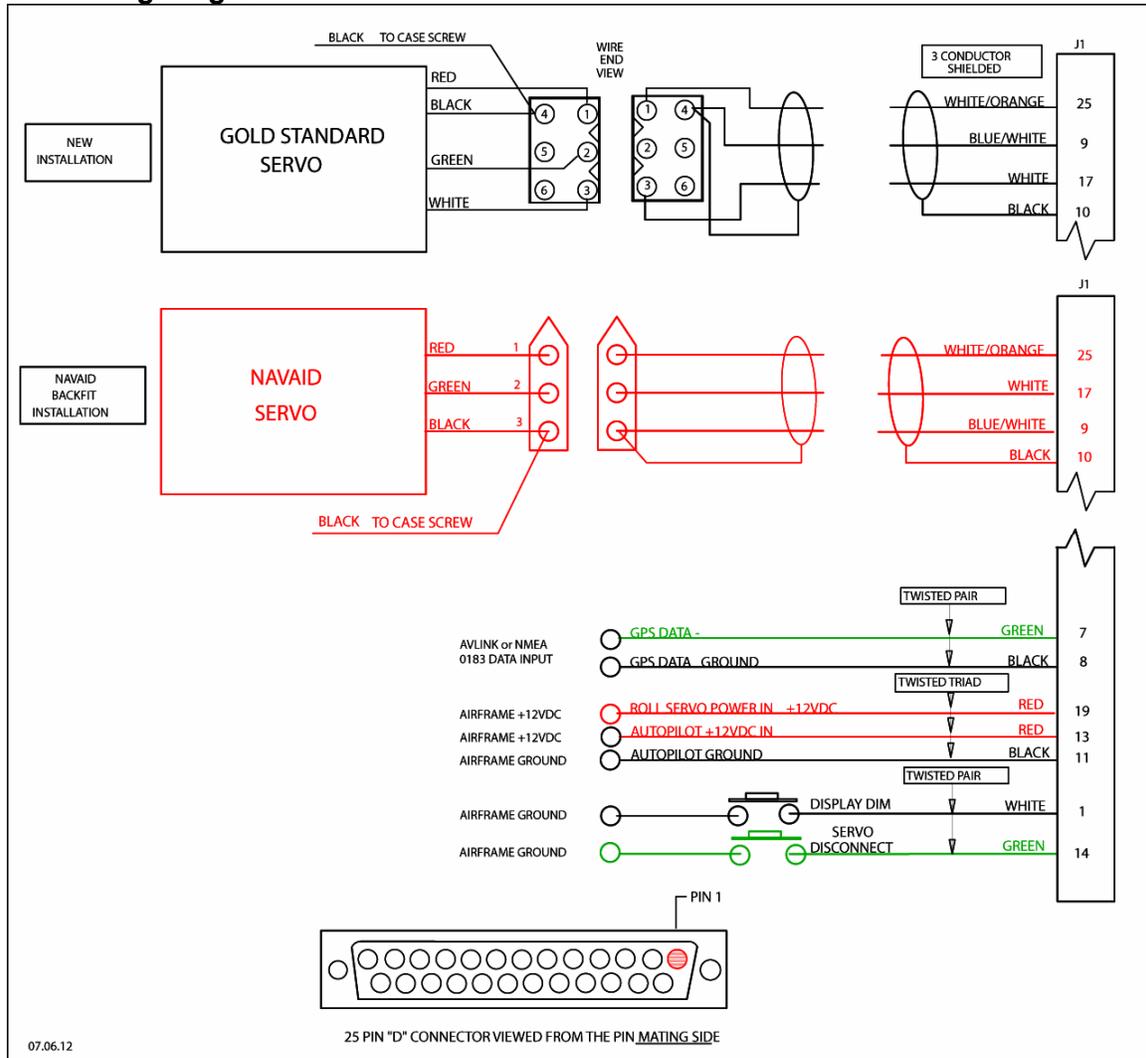
## **8.4 Remote Display Brightness / Mode Switching**

J1 pin 1 can be grounded momentarily to provide a signal input for controlling display brightness. This switch is identical in function to the EZ Pilot DISPLAY switch. Optionally, this pin can be used to enable the remote **MODE** switching capability. In either case the dimming and the mode function of the front panel switches remains effective.

## **8.5 Autopilot Servo Disconnect**

This signal is a momentary ground input to the EZ Pilot on pin 14. Momentarily grounding this pin causes the Servo power signal on pin 25 to be disconnected, which effectively disconnects the EZ Pilot from the control system. Alternatively, this signal is used to enter the PCS mode.

## 8.6 Wiring Diagram



## 8.7 J1 Connector Pin Mapping Chart

Pin	Function	Signal Type	Function
1	Remote Dim / Mode	data	momentary ground
2	Reserved		
3	Reserved		
4	Reserved		
5	Reserved		
6	Reserved		
7	GPS NMEA 0183 data in	data	GPS RS232 serial data input
8	GPS Data return (ground)	data	GPS data return
9	Ground	power	servo power ground
10	Ground	power	shield ground
11	Main ground in	power	airframe ground
12	Reserved		
13	Airframe +12VDC power	power	logic power
14	Autopilot disconnect	data	momentary ground
15	Reserved		
16	Reserved		
17	Roll servo PWM out	data	positioning modulation
18	Reserved		
19	Roll servo power input	power	servo Power
20	Reserved		
Thru	Reserved		
24	Reserved		

25 roll servo power output power switched power to roll servo

Notes:

1. All power and data wiring is #22 AWG
2. The circuit breaker used to provide power for these inputs should be sized according to the size of the wire being used to provide power to the circuit. A 5 amp circuit breaker/fuse is appropriate for the EZ Pilot.

## 9.0 Glossary of Terms

Aviation Link	GPS output data format (most recent panel mount units)
BTW	Bearing to Waypoint
CRS Mode	Autopilot follows a pilot selected course (bearing)
CRS	Course – the commanded track of the aircraft over the ground
DIS?	Distance tolerance error indicator
DTK	Desired track
EEPROM	Electrically Erasable Programmable Read Only Memory
ETE	Estimated time en route, hours and minutes format
ETe	Estimated time en route, minutes and seconds format
Firmware	Computer program permanently stored in the autopilot memory
GPS	Global Positioning System
GS	Groundspeed, closure speed on the destination waypoint
Groundtrack	The current track of the aircraft over the ground
HH:MM	Hours : Minutes
IDS	Intercept Distance – Distance to switch point from INT to TRK
INT Mode	Intercept Mode – Guides aircraft to intercept the desired track
LED	Light Emitting Diode
L-R	Left – Right
MM:SS	Minutes : Seconds
NMEA 0183	Specification for GPS output data (generally hand-helds)
PCS	Pilot Controlled Steering
PLED	Polymer Light Emitting Diode display
PWM	Pulse width modulation – the signal that drives the servo
Servo	Deflects ailerons as required by EZ Pilot
TC	Digital graphic turn coordinator display
TRK Mode	Track mode – Autopilot tracks a preprogrammed GPS flight plan
TRK	Track – Autopilot follows a line to a specified waypoint
TRN?	Turn tolerance error indicator
RNG	Range (distance) from the current “TO” waypoint
RS232	Specification for data transfer protocol between systems
SPD?	Speed tolerance error indicator
TOP	Track Offset Position
Wing Leveler	Holds wings level without reference to navigation signals
WPT	“TO” waypoint identifier
XTK	Cross Track Error – measure of deviation from DTK

## 10.0 Contact Information

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