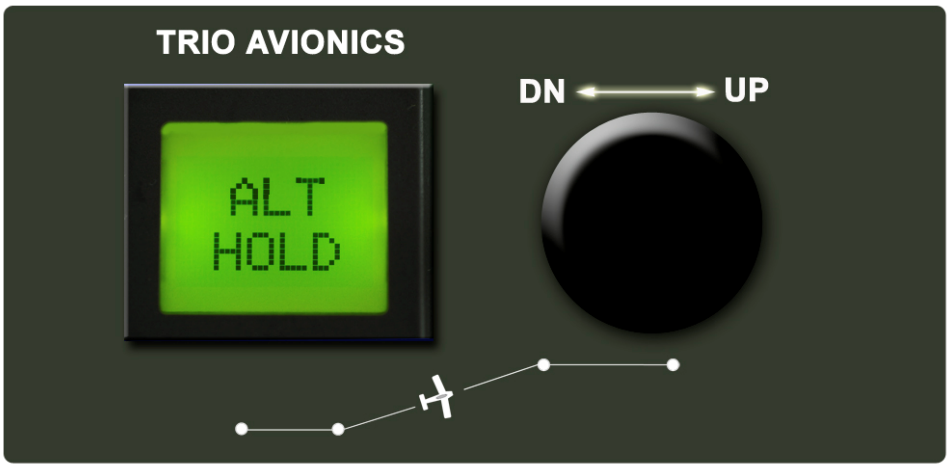
EZ Series
Altitude Control Systems



Operation and Installation Manual

Trio Avionics Corporation

Rev 1.9

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 Altitude Hold system 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 altitude hold system, 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 altitude hold system is attached directly to your elevator control system. It is possible to install or adjust it in a manner that may result in improper or unexpected elevator 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 solid state sensors, gyros and electronic components. Always keep in mind that such systems should never be thought of as totally reliable. They may be disrupted by electromagnetic interference, close proximity of transmitting antennas and cables, and other problems.

When flying an aircraft with this, or any, altitude hold system enabled, you must be constantly vigilant for any sign of improper operation of the system. When there is even a suspicion that the altitude hold system is not operating properly, you must immediately disable the altitude hold system by any of the various methods detailed in this manual. Do not fly the altitude hold system 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 altitude hold system can serve as a useful navigation aid, no altitude hold system 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 altitude hold 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

EZ Altitude Control System

1.0 Introduction

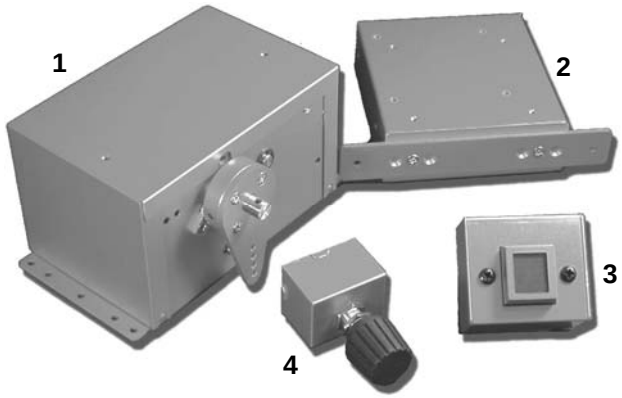
Congratulations on choosing the EZ Altitude Control System. The EZ-1 System is designed to hold a precise altitude of the aircraft. The EZ-2 system has all the features of the EZ-1 system and adds additional safety features, vertical rate selection and vertical speed or airspeed capture capabilities. The EZ-3 system builds on the capabilities of the EZ-1 and EZ-2 systems adding airspeed management modes and altitude preselect and capture features. The following paragraphs describe the EZ altitude control systems in detail. The EZ-2 system description begins in paragraph 8 of this manual. The EZ-3 system is described in section 9.

The EZ-1 will precisely maintain a desired pressure altitude for your experimental aircraft up to an altitude of 20,000 feet. In smooth air it will hold the aircraft altitude to within +/- 20 feet (generally less). In turbulent air or turns of 15 to 20 degrees bank angle it will hold to within +/- 50 feet.

While the EZ-1 is simple to use, this manual is a guide to understanding its basic functions and employing its many features. **Operation is as simple as pressing the "ALT HOLD" button.** This causes the aircraft to maintain the current pressure altitude. The following sections illustrate the built in safety measures, messages and the many features available in your new system.

2.0 General Information

The EZ altitude control system is comprised of 4 major hardware elements:



1 Elevator Servo
2 Electronics Module
3 LCD push button switch
4 Rotary encoder control

In addition, an external Sonalert or other warning device may be connected to provide an audible warning prior to system disconnect. An audio tone is also available as an input to the aircraft intercom system. An auxiliary small remote push button (momentary – normally open) switch mounted to the stick or yoke will allow access to the many additional features of this system.

3.0 Operation

When power is applied, the amber **SYSTEM TEST** message will be displayed for approximately 8 seconds. After this stabilization period the unit will become fully functional. The LCD switch will display a green **READY** message. The altitude hold function is activated by pressing the LCD switch which will then annunciate the hold condition

with a green **ALT HOLD** message on the LCD display. (At this time servo activation should be detected by resistance to manual yoke or stick movement forward or backward)

To disconnect the EZ altitude control system servo activation either the **REMOTE AUTOPILOT DISCONNECT** switch or the **LCD SWITCH** may be momentarily pressed.

During normal operation in the altitude hold mode the **ENCODER** knob may be used to dial in very fine corrections to the engaged altitude. Rotating the knob clockwise will cause an altitude increase, rotating the knob counterclockwise will result in an altitude decrease.

In addition to the servo disconnect function the **REMOTE AUTOPILOT DISCONNECT** switch can be used to "fly to" another altitude. This is accomplished by pressing **and holding** the **REMOTE AUTOPILOT DISCONNECT** switch for a period of more than three seconds. When pressed, the servo will immediately disengage so the airplane can be flown to a different altitude and will rearm after the three second delay period. While in the armed mode the LCD switch will flash the amber backlight and will display **ALT HOLD**. On the **EZ-1** system, releasing the remote disconnect switch (after the 3 second interval) will engage the servo, show a green LCD **ALT HOLD** message and hold the aircraft at the proper altitude. The EZ-2 and EZ-3 systems add a VS rate capture or an airspeed capture as additional options to this sequence (section 8.1.4)

3.1 Startup

It is strongly recommended that a 3 to 5 amp switch or circuit breaker be used to power the **EZ** altitude control system. This switch or circuit breaker will provide absolute emergency disconnect of the altitude hold servo should all other disconnect measures fail. Once the aircraft engine is started, part of the pre-taxi checklist should be to apply power to the system by engaging the switch or circuit breaker. **Power should be applied as soon as possible after engine start to ensure the inertial components within the system are stabilized prior to takeoff.**

After power is applied, the system will undergo a brief startup sequence which will last approximately 8 seconds. During this time the amber **SYSTEM TEST** message will be displayed. After this short period the unit will become fully functional and the LCD switch will display a green **READY** message.

3.2 "ALT HOLD" Mode

The altitude hold function is activated by momentarily pressing the LCD switch which will then annunciate a green **ALT HOLD** message on the LCD display. (During pre-taxi checks, servo activation can be detected by resistance to manual yoke or stick movement forward or backward).

IMPORTANT: Prior to taxi, momentarily press the remote disconnect switch to disengage the servo. The LCD switch will then display the **READY** message. A pre-flight checklist item should be created to ensure the altitude hold system is disengaged (in the **READY** mode). An additional safety feature available on the EZ-2 and EZ-3 systems is an automatic servo disconnect on takeoff.

Once the aircraft is in flight, and the desired altitude has been reached, the aircraft should be trimmed for stable, level flight. The pilot may then simply press the LCD switch and the EZ altitude control system will enter the altitude hold mode and the LCD switch will display **ALT HOLD** while it is employed. The servo will engage the elevator system and control the elevators to maintain the desired altitude.

To disconnect the EZ altitude control system, the pilot may momentarily press either the LCD switch or the **REMOTE AUTOPILOT DISCONNECT** switch on the stick or yoke.

The system will then immediately release the elevators from servo control and enter the **READY** mode. Turning off power to the unit will also release the servo.

3.2.1 Fine Adjustments to Altitude - While flying with the **ALT HOLD** engaged, the **ENCODER** knob may be used to dial in very fine corrections to the engaged altitude. Rotating the knob clockwise will cause an altitude increase (and cause the LCD to indicate "**ALT UP ADJUST**"), while rotating the knob counterclockwise will result in an altitude decrease and corresponding display. Each "click" of the rotating knob will change the altitude by approximately 5 feet, up or down, depending on the direction of rotation. When the altitude change is completed, the green **ALT HOLD** display will appear. Alternatively, the **encoder** knob may be pressed at any time to stop the adjust feature.

3.2.2 ADJUST TRIM Annunciator – As the flight progresses the aircraft may require occasional trim changes as the fuel burn lightens the aircraft, or if the throttle setting is changed. The servo will hold the proper altitude in all but extreme out-of-trim conditions, but it is prudent to keep the aircraft properly trimmed to avoid sudden excursions when the servo is disengaged.

The **EZ-1** will sense when the aircraft is out of trim. If the out-of-trim condition is minor it will not alert the pilot. However, when the out-of-trim forces on the servo exceed a predetermined amount, it will present a message (flashing up or down arrows) to the pilot advising that the aircraft trim should be adjusted. The arrows on the display indicate the required direction of trim adjustment. The altitude will be maintained even though this alert is present.

When a trim adjustment is sensed by the computer the "Trim" message will be removed, and the normal **ALT HOLD** message will return. Pressing the **ENCODER** switch while the "Trim" message is present will erase the message, remove the trim correction provided by the system and replace it with the **ALT HOLD** message. If the out of trim condition remains after a correction has been made, or the message has been cleared the message will return in a short period of time.

Probably the quickest way to eliminate the out-of-trim condition is to momentarily disconnect the **ALT HOLD** function by pressing the **LCD switch**, re-trim the aircraft for level flight, and then reengage the **ALT HOLD**.

The EZ altitude control system is available with an automatic trim option which will automatically trim the aircraft to remove any trim errors. This feature will control a separate trim motor (customer provided) such as the Ray Allen Corporation model T3-12A or similar motor.

NOTE – If the **ADJ TRIM** arrows appear on the LCD, but when the **ALT HOLD** is released there is very little trim correction required to the aircraft, the **SYSTEM GAIN** setting is probably too low, not allowing the system to properly control the aircraft. See section 6.0 for proper adjustment of the **SYSTEM GAIN** setting,

If the pilot wishes to re-trim the aircraft without disconnecting the **ALT HOLD**, trim adjustments should be made in small increments. When each adjustment is made, the pilot should wait for approximately 30 seconds to allow the system to sense the change. If the "Trim" message remains, continue further adjustments until the **ALT HOLD** message returns.

3.3 Pilot Command Steering (PCS) Mode

In addition to the servo disconnect function, the **REMOTE DISCONNECT** switch can be used to "fly to" another altitude. This is accomplished by pressing and holding the **REMOTE DISCONNECT** switch for a period of more than three seconds. The servo will immediately disengage so the airplane can be flown to a different altitude manually and will "re-arm" after the three second interval. While in the "armed" mode the **LCD switch** will flash an amber backlight and will display **ALT HOLD**. Releasing the remote disconnect switch will engage the servo and cause the **LCD switch** to present a solid green color while displaying the **ALT HOLD** message. The aircraft will then hold the selected altitude.

3.4 System Gain, Brightness, Contrast, Servo Deadband and (optional) Trim Speed settings

The **SYSTEM GAIN, BRIGHTNESS**, **CONTRAST, SERVO DEADBAND and (optionally) the TRIM SPEED** settings are adjustable with the system in the **ALT HOLD** mode. The same settings are available in the **READY** mode with the exception of the **SYSTEM GAIN** setting. This menu mode is entered from either the **READY** mode or the **ALT HOLD** mode by **pressing in and holding** the encoder switch knob for at least 3 seconds.

To activate this feature, perform the following steps when either **READY** or **ALT HOLD** message is displayed on the LCD switch:

1. Press and hold the encoder switch knob until the **GAIN SET** message appears on the **LCD switch**

2. Press (click) the encoder switch knob repeatedly until the desired selection is displayed.

3. Rotate the encoder switch knob to change the setting.

The **GAIN** setting (**ALT HOLD** only) controls the response characteristics of the system. The proper adjustment of the GAIN setting is fully discussed in paragraph **6.0.**

The **BRIGHTNESS** setting controls the illumination level of the LCD background. This setting is best done in subdued light.

The **CONTRAST** adjustment will allow setting the optimum contrast for the pilots viewing angle.

The **SERVO DEADBAND** setting controls the "deadband" width of the servo. The proper adjustment of this parameter is fully discussed in paragraph **6.0.**

The **TRIM SPEED** setting is only available if the **AUTO TRIM** option is installed. **The TRIM SPEED** setting allows the pilot to tailor the speed of the trim correction for the particular airplane and trim drive motor.

4. Press and hold the encoder switch knob for 3 seconds to exit back to **READY** or **ALT HOLD** display mode

NOTE: Even when the Contrast / Brightness / Gain / or Servo Deadband is selected, the LCD switch or the **REMOTE DISCONNECT** switch can be pressed to disengage the servo and return to the **READY** mode. Likewise, if the selection was entered from the **READY** mode, pressing the LCD switch will terminate the **SETUP** mode and activate the **ALT HOLD** mode

3.5 Safety Warning Features

3.5.1 Audible Warning

Whenever the servo disconnects from the elevator control system, an audio tone is generated, consisting of 3 beeps. This tone may be routed into the aircraft audio system, as shown on the wiring diagram on page 19. Alternatively, an sequential DC voltage is also provided on the connector to allow use of an external warning device, such as a Sonalert[tm] or other warning instrument.

3.5.2 G Force Limit

When giving elevator control over to a servo, the pilot must be constantly vigilant to assure that any unexpected system activity such as that caused by extreme turbulence or meteorological wave activity cannot impose excessive acceleration forces on the aircraft. To assist in this endeavor, the **EZ** altitude control system incorporates an accelerometer system that continually monitors the G forces being experienced by the aircraft.

In the event the aircraft experiences abnormal G forces, the **EZ** altitude control system is designed to automatically disconnect from the control system before structural damage can occur. The software is designed to detect acceleration (G) forces that can cause structural damage due to system activity (or pilot override action). The system will monitor, *but not react to*, accelerations due to moderate turbulence. However, the system may automatically disconnect in high end moderate or severe turbulence. The pilot is always cautioned to use proper judgment as to whether to engage the **EZ** altitude control system in these types of conditions. The pilot should always follow the aircraft designer's recommendations with regard to autopilot engagement, maneuvering speed limitations, etc.

System Response – When the **EZ** altitude control system detects an excessive G force condition it will immediately issue a servo disconnect tone and disconnect the servo from the control system. The LCD switch will illuminate red while displaying "**G FORCE LIMIT**".

Pilot Action – Determine the cause of the excessive G force problem. If the disconnect was due to turbulence or pilot action, the alarm may be cleared by pressing the LCD switch, which will put the system back in the **READY** condition. Altitude hold may then be re-engaged by pressing the LCD switch. Pilot judgment should be exercised in accordance with the

airframe designer's limitation regarding use of an autopilot system in turbulent conditions. If an **EZ** altitude control system control problem is suspected, turn off power to the system and contact Trio Avionics for direction before further use.

3.5.5 Servo Clutch Slip

The **EZ** altitude control system incorporates an important special safety feature: a clutch within the servo that can be overridden when actived by moderate manual stick or yoke pressure. Sensors are provided in the servo to detect slippage of the mechanical clutch assembly. The message "**SERVO CLTCH SLIP**" will appear as a flashing amber message if the condition is sensed.

The clutch adjustment should be set during installation so that the system can drive the elevator control system under normal conditions but be easily overridden by a manual pilot input. Pilot override will force the clutch to slip, allowing the pilot to take positive control away from the **EZ-1** system in emergency situations such as unexpected traffic. On the other hand, a clutch slip message that appears for no apparent reason is probably due to the clutch not being adjusted properly or by extreme out-of-trim conditions, thereby not allowing the control system to be driven correctly.

System Response – the message "**CLUTCH SLIP**" will flash with amber illumination. The message is advisory in nature and will not cause a servo disconnect.

Pilot Action – If this message occurs under conditions other than a manual servo override, the clutch adjustment should be checked to ensure it is tight enough to drive the control system under normal conditions including light to moderate turbulence and normal out of trim conditions. However, you must assure that it is set loose enough that the pilot can easily overcome it in an emergency.

3.5.4 Servo CW (or CCW) Limit

This red message indicates the servo crank arm has been moved to a clockwise or counterclockwise position outside of its normal range of operation. This error will result in an immediate servo disconnect. The cause of this error is most likely a manual system override by the pilot.

System response – immediate servo disconnect and servo power down. Red **SERVO CW (or CCW) LIMIT** message displayed.

Pilot Action – Determine the cause of the **SERVO CW (or CCW) LIMIT** message. If not due to pilot manual override, tighten the servo slip clutch to allow greater servo control of the elevator system.

3.5.5 Servo Fault

This red message can be due to several factors based on sensors within the servo and will always cause an immediate disconnect and power down of the servo.

System Response - In all cases the servo will be immediately disconnected from the system, servo power will be automatically removed and a red error message will be displayed

Pilot Action - If the **SERVO FAULT** closely followed an extreme out of trim condition, **CLUTCH SLIP** or **G FORCE** LIMIT alarm , press LCD switch and continue normal operation. If the cause is unknown, or occurs in conditions other than described above, perform ground tests of the system paying particular attention to the wiring from the servo to the electronics module and the mechanical linkage. If the problem persists, contact Trio Avionics for assistance.

4.0 System Safety Features

The **EZ** altitude control system incorporates many safety features to ensure the system cannot force the airplane into an un-commanded, unsafe flight regime. The following items are implemented to ensure flight safety.

4.1 Aircraft G-load sensing. The AH module contains an accelerometer interfaced to the main processor that is used to detect unusual positive or negative flight loads. Software algorithms prevent unnecessary detection due to turbulence, but allow shutdown of the servo if the flight loads exceed preset g-force limits. The intent of this implementation is to prevent aircraft structural failure caused by an un-commanded excursion of the servo or trim actuators. The fault condition is annunciated on the LCD switch with the **G FORCE LIMIT** message

4.2 Servo Electronics monitoring. The servo and trim motor drive circuits are instrumented and monitored by the servo main processor (SMP). The SMP commands the magnitude and direction of the servo motor drive output. Any error in the commanded state of these signals is reported back to the AH module via a digital data link and results in a **SERVO FAULT** message on the LCD.

4.3 Clutch Slip Detection. Circuitry and software is provided that detects any slipping of the safety clutch in the servo. Normally, this condition would only exist in the event the pilot manually forced the control system into a position that exceeded the commanded drive position of the servo. This event is reported to the AH module for resolution. The amber **CLUTCH SLIP** message is displayed for a momentary slip condition.

4.4 Rotation Limit Detection. Under normal conditions the servo arm moves less than 20 degrees in either direction from the neutral (servo zero) position. If, for any reason (commanded, un-commanded or pilot manual override), the crank arm transitions approximately + / - 10 degrees outside of this range servo power is disconnected and a red error message (**CW or CCW LIMIT**) is displayed.

4.5 Supervisory processor monitoring. The Servo Main Processor (SMP) is continuously monitored by an independent supervisory processor to ensure it is executing its program as designed. This is implemented via a “heartbeat” signal from the SMP each 10 milliseconds. If for any reason the processor does not provide a

"heartbeat" signal to the supervisory processor for a period of 65 milliseconds, the supervisory processor will unilaterally cut power to the safety disconnect solenoid and the trim and servo motor drive circuits. The problem will be reported to the pilot with the red **SERVO FAULT** message being displayed on the LCD switch

4.6 Servo / Trim Driver Chip Fault Detection. The integrated circuits used to drive the servo and trim motors are internally equipped to detect and report to the SMP a variety of fault conditions including:

- High side (supply side) short to ground (low side)
- Low side short to high side
- Under voltage lockout
- Over temperature shutdown

When any of these faults are detected a red **SERVO FAULT** message is displayed

4.7 Disconnect Solenoid. The servo contains a solenoid that disconnects the servo gear train whenever power is removed from the solenoid. Power can be removed under program control of the Servo Main Processor (SMP), the supervisory processor or whenever power is interrupted by the Electronics Module. With the gear train disconnected, the elevators are free to move.

4.8 SMP and Supervisory Processor Watchdog Interrupts. Both the SMP and Electronics Module processors have built in peripherals for detecting an improper cycle of the software program. If either of these processors enter this condition a watchdog interrupt will occur which will automatically reset the processor software. This condition is conveyed to the pilot with the red **SERVO FAULT** or the amber **SYSTEM TEST** message displayed on the LCD switch.

4.9 EZ-2 / EZ-3 additional safety features. The EZ-2 and EZ-3 systems incorporate an airspeed sensor which adds the capability to disengage the servo if left on during takeoff and to sense minimum and maximum airspeeds during all phases of flight. Section 8 describes these features in more detail

5.0 Installing the Altitude Hold Control Module

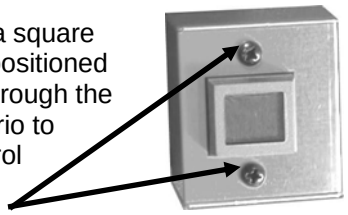
The control module is embossed with lettering indicating **TOP** and **RIGHT** (looking forward). It is important to install this module in this orientation because the gyro uses this orientation for pitch recognition. Although the controller may be installed at any convenient place and need not be in the panel or close to it, it must be installed in its proper orientation. Each face of the module has tapped holes that allow the long rectangular mounting plate to be attached to any side of the unit. This will allow for maximum flexibility in locating and mounting it in the aircraft.

A static port is provided to allow the control module to access an accurate pressure source. While it is possible to operate the altitude hold system with the port open to cockpit pressure, it is highly recommended that it be connected to the aircraft static pressure system or an independent static port for most reliable operation.

If you have an EZ-2 or EZ-3 altitude hold system, you will also be required to connect the electronics control module to your pitot system. This allows the system to sense airspeed so that it can limit Minimum Airspeed and Maximum Airspeed, allow Climb-on-Airspeed, and enable Pilot Command Steering (**PCS**) with airspeed control (see section 8). Note that the pitot port is closest to the 25 pin DIN connector.

5.1 Installing the LCD Switch

The **LCD** switch is mounted in the control panel by cutting a square hole the size of the **LCD** switch bezel. The **LCD** switch is positioned behind the control panel, with the **LCD** screen protruding through the control panel. Several optional bezels are available from Trio to facilitate this installation. The switch is secured to the control panel using the two Philips head screws that are inserted into the switch housing.



5.2 Installing the Encoder Switch

The encoder switch is attached to the control panel by means of a threaded mounting shaft that protrudes from the front of the switch housing. Mounting nuts are included that allow the switch to be mounted in panels of varying thickness. When placing the switch in the panel, it is important that the shaft extends out sufficiently to space the knob away from the panel so that the switch can be fully activated when pressing in on the knob. If the knob is flush with the panel, it will not operate properly. Allow at least 1/16 inch clearance. The knob is held to the switch shaft by a 1/16 inch allen head hex screw.

5.4 Installing the Wiring Harness

A quick check of the schematic at the back of this manual will show that the connectors to both the **LCD** switch and the **ENCODER** module are DB9 connectors. It is important to assure that the DB9 connector that has TWO cables coming into it is connected to the **LCD** module, and that the DB9 connector that has one cable connected to it is attached to the **ENCODER** module.

6.0 Servo Installation Setup

The servo unit incorporates important safety features:

- The internal gears are pulled into the engaged position by an electric solenoid. When the gears are not engaged, the output crank arm rotates freely and the elevator controls can be operated normally without friction. When the servo is engaged, the solenoid pulls the gears into place so the servo has control of the elevators. Disengaging the servo allows free movement of the elevator controls.

- The servo is engaged and disengaged by pressing the LCD push switch. The servo is engaged in any mode other than the **READY** mode. There is also a recommended remote **SERVO DISCONNECT** switch on the control stick (or other remote location). Installation of a remote switch is highly recommended, as it allows an immediate way to disengage the servo - even in heavy turbulence, when it may be difficult to operate the **LCD button**. In addition, such a switch will allow for the **PILOT COMMAND STEERING** feature (Section 3.3) and the VS and airspeed capture features (EZ-2 & EZ-3, see section 8).

- 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 altitude 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.

6.1 Installing the Servo

Begin by looking for a point on your elevator bell crank, control pushrod or cable where pushing or pulling the elevator control linkage a distance of 1.5 to 2.4 inches will do the job. Then find a place to mount the servo nearby to accomplish this by means of the pushrod. You will mount the servo and pushrod so that the elevator is in a neutral position when the servo crank arm is at mid position. That’s it, aside from carefully

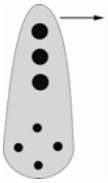
checking that **the required range of elevator movement is available within the limits of the servo travel range, and that no "over center" condition can exist.**

The servo crank arm uses a pushrod terminated by rod end bearings to link the servo arm to the aircraft elevator control system. The pushrod provided in the installation kit should be trimmed to the correct length for your particular installation. The servo should be mounted on a solid platform that will not buckle or "oilcan" and attached to a firm existing support. It is recommended that the servo platform not be mounted to the aircraft "skin" without a doubler or some other additional support**. Rigidity of the servo mount is critical to proper servo operation**. If you do not have the experience required to fabricate the required bracket please contact Trio Avionics for guidance.

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

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

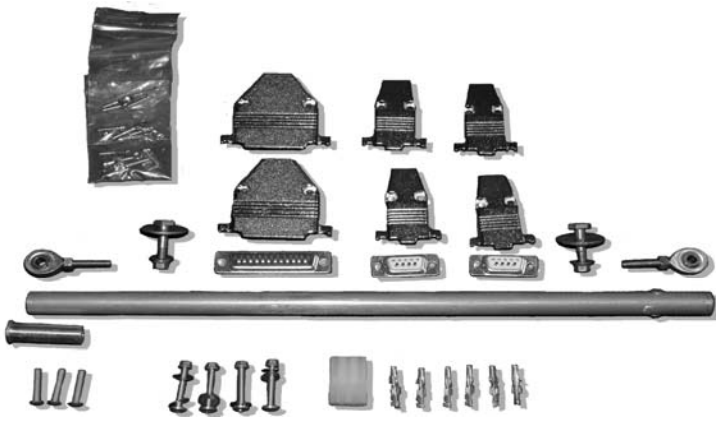
Note: It is important to assure that the proper direction of travel is preserved when modifying the crank arm orientation. Changing the crank arm mounting by 180 degrees will essentially reverse the direction of travel for the servo arm. In such a case the EZ1 must be programmed to reverse the drive signal. In the event unusual pitch changes occur in the first flight, the first check on the ground should be to be certain the servo direction of travel is correct.



Choose an operating radius on the servo crank arm that allows full elevator movement (elevator stop to elevator stop) without driving the servo crank arm into its limits. Most aircraft get best performance in the outermost hole. In the event the servo rotation is insufficient, the servo mechanical stops may be removed. Contact Trio Avionics if this appears to be necessary.

6.2 Servo Mounting Hardware

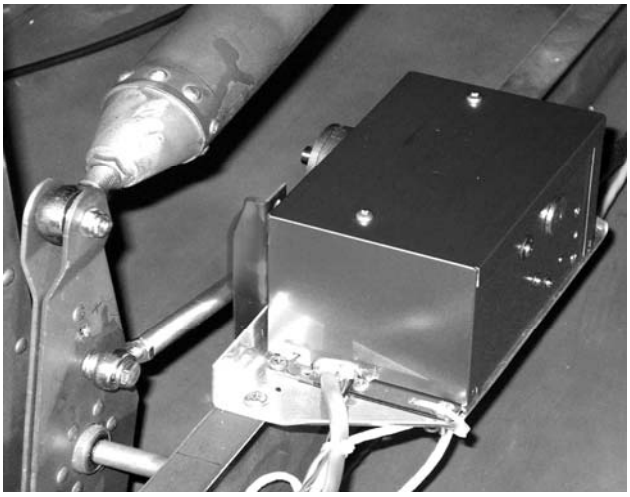
Below is the provided electrical and mechanical installation kit. A pushrod is provided, along with two rod end bearings. Typically, one of these connects to the servo crank arm and the other is connected to the elevator bell crank. When the servo is connected to the elevator control system it should be installed so that the servo crank arm is at a right angle to the control rod. This mechanically centers the servo mechanism to the control system so that there is *equal displacement in either direction* when the servo is actuated. Fine zeroing checks conducted after the installation is complete will verify proper positioning.



6.3 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 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 elevator control system.



RV-6 Installation

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

When the above conditions are met, the system usually performs best when the pushrod is attached to the outermost hole in the servo crank arm. If your aircraft employs an elevator bell crank, you should ideally attach the pushrod to the bell crank at a distance from its pivot point equal to that of the servo crank arm radius (distance from crank arm pivot point to pushrod attach point).

Again, never allow the servo to limit elevator travel.

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

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

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

Usually the servo pushrod will terminate on a control pushrod or a bell crank. If you are connecting to a pushrod **care should be taken to keep the pushrod from being free to rotate.** (To repeat, the pushrod should **NOT** rotate.) The reasoning for this is that as the pushrod rotates there is "lost motion" in the system, i.e., movement of the crank arm does not result in movement of the control system.

The control movements are so small that it takes very little slop in the system to make the airplane not track properly.

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

6.4 Install the Servo Pushrod

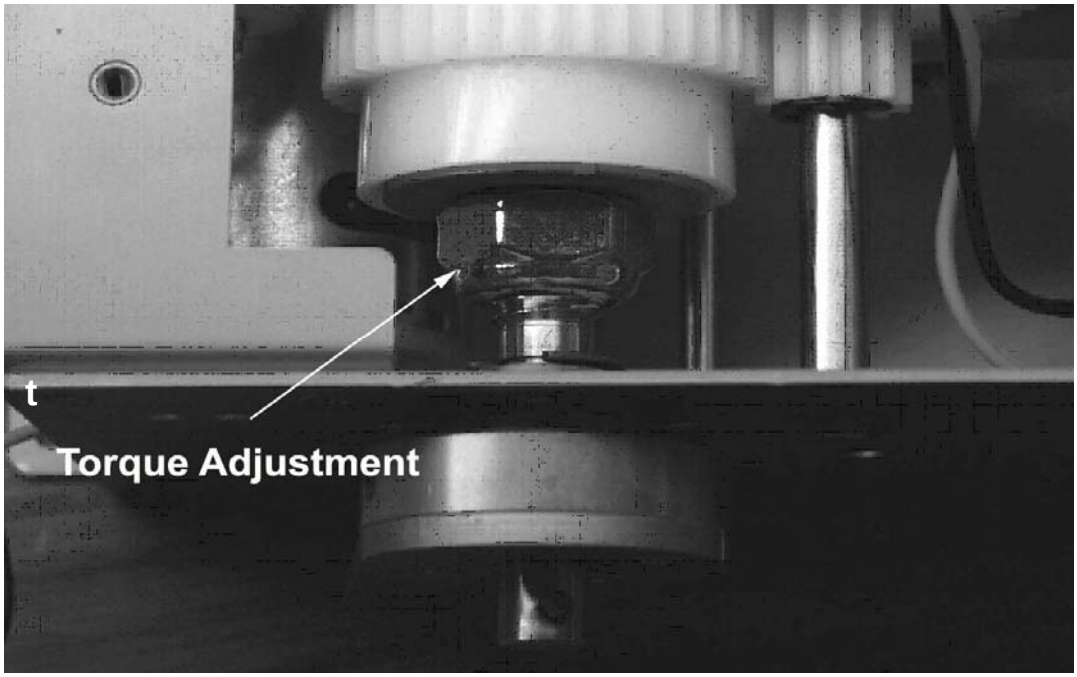
Cut the pushrod to the proper length so that, when the servo is at **neutral**, or centered in its full rotation stop to stop, the elevator is also neutral (see note).

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

Note: The **crank arm neutral position** for your elevator control system will be dependent on the particular aircraft design. Many designs require more throw of the control system from the neutral elevator position to the full stick back position (elevator up) than the other direction. In this case when the elevators are positioned at their neutral position , the crank arm will not be at it's centered (exact vertical or horizontal) position. This is not of concern during operation of the system as the servo design compensates for this offset automatically during operation. Again, the important thing to remember is that the elevator control system must contact its mechanical stops before the servo contacts it's mechanical stops

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

6.5 Setting Servo Override Force (Slip Clutch)



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

Engage the servo by pressing the **LCD** switch. You should hear the solenoid operate inside the servo housing and the servo crank arm should become firmly held in place by the gear train. Then push the control stick hard enough to override the servo. Using an 11/16 " or 17mm open end wrench set the override force to a value that seems strong enough to give a fairly good pitch 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 elevator authority to handle a reasonable amount of turbulence or trim error. **Do not tighten the nut to the point where the clutch cannot slip. If you do, and exert sufficient force on the control stick, it may cause gear teeth in the servo to strip – this is a safety feature to allow control movement in such a situation.**

6.6 Adjustment of Servo Rotation Direction, Trim Rotation Direction (optional) and Factor Default Setting restore.

After installation wiring is complete the system servo direction check must be accomplished.

IMPORTANT – Prior to performing step 6.6.1 the system must be powered up and placed in the **READY** mode for a full 5 minute period to allow the gyro and accelerometers to bias to their zero position. During this time the aircraft must remain perfectly still. After the 5 minute period has elapsed secure power to the EZ altitude control system and perform step 6.6.1

6.6.1 Servo Direction Setting - The servo direction must be set so that the system knows which way to drive the controls for an increase or decrease in altitude. This is a one time ground setting and **should never be attempted in flight**.

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

Do the following to enter the servo direction setting mode:

Turn on power to the system.

While the **SYSTEM TEST** message is being displayed, simultaneously press and release **both** the **LCD** switch and the **ENCODER** switch – The LCD switch will now display the amber **SERVO DIR NORM** or **SERVO DIR REV** message.

> **NOTE:** At this point the servo will engage and drive the servo to its mechanical zero position.

a. Rotate the **ENCODER** knob **clockwise** while observing the elevator travel direction. The elevators should move in a direction that would cause an **increase in altitude**.

b. If the elevators drive in the opposite direction momentarily press the **ENCODER** switch. The LCD message will now read **SERVO DIR REV**.

Repeat step "**a**" above and verify correct elevator directional control is achieved.
Pressing the LCD switch will advance to the **TRIM DIRECTION** screen if the system has the **AUTO TRIM** option installed

6.6.2 Setting the Trim Motor Direction – <u>This procedure is only available on models equipped with the auto-trim option.</u>

When in this mode, the LCD message will be amber and read "**TRIM DIR NORM**" or "**TRIM DIR REV**". You should verify that when the **ENCODER** is rotated in a **CLOCKWISE** direction the trim system is moved so as to make the airplane **CLIMB**. If this is not the case, momentarily press the **ENCODER** switch to reverse the sense of the command to the trim motor.

Pressing the LCD switch will advance to the **RESTORE FACTORY DEFAULTS** screen.

6.6.3 Restore Factory Defaults Procedure - The display will now be amber and display "**RESTOR DEFLTS**". If you want to return all internal gains and variables to the factory settings perform the following steps, otherwise press the LCD switch momentarily an proceed to step 7.0

The display will now be amber and display "**RESTOR DEFLTS**". To activate the restoration, once again press and hold the **ENCODER** switch followed by pressing and holding the LCD switch. The display will change from a steady amber color to a flashing green color. Continue to hold the two switches for approximately 10 seconds until the flashing green screen turns to a steady green screen. Once this has occurred restoration of the factory settings is complete. To advance to step 7.0, press the LCD switch momentarily.

NOTE. Releasing either switch during the flashing green display will cause the restoration to be inhibited. If this occurs, simply recycle power to the system and start the procedure again at step 6.6.1

7.0 SYSTEM GAIN and SERVO DEADBAND Adjustment

The System Gain and Servo Deadband Settings optimize the EZ altitude control system tracking performance for your individual airplane

7.1 SYSTEM GAIN

The system gain adjustment allows the EZ altitude control system to be tailored to your individual airplane. The factory setting is a nominal value which should give good performance in most airplanes. However, to achieve best performance in your airplane the **SYSTEM GAIN** adjustment should be optimized.

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

a. Enter the **ALTITUDE HOLD** mode in smooth air at your normal cruise speed after verifying the pitch trim is properly adjusted for level flight.

b. Press the **ENCODER** knob for more than 3 seconds until the **SYSTEM GAIN** setting is displayed.

c. Execute a turn at a bank angle of approximately 15 degrees. If the altitude sags more than 30 feet after entering the turn the system gain needs to be increased. Perform step d.

d. Increase the **SYSTEM GAIN** by 5 units, then repeat step c.

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

7.2 SERVO DEADBAND

The **SERVO DEADBAND** adjustment optimizes servo performance for your particular installation. The "deadband" is an area in the servo rotation where drive signals are momentarily nulled to prevent unnecessary hunting and / or oscillation of the servo mechanism. The lowest setting that gives satisfactory performance is the optimum setting. The factory setting is a nominal value which should give good performance in most airplanes. However, to achieve best performance in your airplane the **SERVO DEADBAND** adjustment should be optimized.

To optimize the servo deadband setting in your airplane perform the following steps:

a. Enter the **ALTITUDE HOLD** mode in smooth air at your normal cruise speed after verifying the pitch trim is properly adjusted for level flight.

b. Press the **ENCODER** knob for more than 3 seconds until the **SYSTEM GAIN** setting is displayed.

c. Press the **ENCODER** knob several more times until the **SERVO DBAND** message is displayed

d. Decrease the deadband setting by slowly rotating the **ENCODER** knob counterclockwise until jitter or bumping is experienced in the control stick.

e. Rotate the encoder clockwise until the jitter or bumping just stops. This is the optimum gain setting for your installation.

NOTE – A **SERVO DEADBAND** setting of between 3 and 6 has proven to be optimum in several aircraft used for flight evaluation. Your settings should be similar

8.0 The EZ-2 / EZ-3 ALTITUDE CONTROL SYSTEMS with Climb and Descent capability.

Section 8 describes the additional features of the EZ-2 systems. The EZ-2 and EZ-3 altitude control system incorporates all of the features of the EZ-1 while adding several additional capabilities and safety features.

- A major safety feature of the EZ-2 and EZ-3 system is its ability to prevent the system from stalling or over speeding the aircraft. To facilitate this, the electronic module contains an airspeed sensor, which must be connected to the aircraft pitot system.
- Another safety feature is autopilot disconnect on take off. The autopilot will automatically disconnect at an airspeed below 50 kts IAS - if inadvertently left on during takeoff.
- Vertical climbs and descents may be performed by setting the desired vertical rate via the encoder knob and LCD switch.
- Pilot Command Steering (**PCS)** allows the pilot to press the remote disconnect switch to fly the aircraft manually to establish a desired climb or descent rate and (when the remote disconnect button is released) the aircraft will hold that vertical rate.
- Alternatively, the pilot may choose– via a setup menu – to have the **PCS** mode climb and descend on airspeed (instead of vertical speed). This will allow the ability to maintain a specific airspeed during climb or descent to help maintain proper engine temperature.

8.1 EZ-2, EZ-3 Operation

8.1.1 VS Mode

To enter a vertical climb or descent rate, momentarily press the encoder button until the VS set selection screen is present on the LCD switch. The screen color will change to amber and display the message shown. This screen may be used to set the desired vertical speed regardless of whether the system is in the "**ALT HOLD**" or in the "**READY**" mode.

If the LCD switch is pressed while the **VS SET 0** screen is active, or the vertical rate is set to zero while the VS mode is active, the system will capture and hold the current altitude.

Rotating the encoder knob while the VS set selection screen is active will change the vertical speed increment (VSI) on the screen in 100 foot per minute intervals – to a maximum setting of 2,000 feet per minute. Rotating the knob clockwise will indicate that a climb rate is being input. Rotating the knob counterclockwise will indicate that a descent is being entered.

Once the desired vertical rate has been entered, **the pilot must press the LCD switch to begin the climb or descent**. If the display was in the "**READY**" mode (system not engaged), pressing the LCD switch will engage the servo and the climb or descent will begin. If the display is in the "**ALT HOLD**" mode when vertical speed is selected, it will begin to execute the climb or descent rate once the LCD switch is pressed. If **the VS SET 0** screen is active when the LCD is pressed the system will hold the current altitude.

When the LCD switch is pressed, the color of the screen changes to green and displays a "VS ACT" (Vertical Speed Active) message. Once the aircraft is climbing or descending

under autopilot control, the pilot may adjust the rate by simply turning the encoder knob. The aircraft will then respond to that vertical command rate.
It must be noted that soon after a climb or descent is initiated, the screen will likely flash a warning that the aircraft is out of trim. If the climb or descent will be of significant duration, the pilot must adjust the aircraft trim and throttle settings as required. The trim message will alternate with the normal "VS" message. (Note: If the out-of-trim condition is large, the commanded vertical speed may not be attained and there may be some hunting or surging of the system.)

NOTE – The vertical mode has a separate gain term from the **ALT HOLD** mode in the EZ-2 and EZ-3 systems. If the aircraft does not achieve the commanded vertical rate, and/or excessive out-of-trim alarm messages are experienced, the vertical gain may be set too low. To adjust the gain in simply press the encoder knob for 3 seconds (while in the "VS" mode) until the setup menus appear. Adjust the gain in 5 unit increments until satisfactory performance is obtained. The lowest gain setting that gives satisfactory performance is the best setting.

If the gain is set too high, there may be excessive excursions when engaging the VS mode while in a high rate of ascent/descent climb/dive.

Once the destination altitude is reached, the pilot may simply push the **LCD** switch to enter the "**ALT HOLD**" mode, and the system will capture the reference altitude at the moment that the switch was pressed. Because of the aircraft dynamics, it will overshoot the altitude slightly and smoothly return to level flight as it settles onto the referenced altitude.

As the aircraft transitions to a climb/descent and then back to level flight it may be necessary to adjust the aircraft trim and throttle settings again to maintain desired flight parameters.

Note: The **TRIM** message will not appear immediately after a trim imbalance is detected. The system is designed to delay this message so that it doesn't appear in normal turbulence or other short term excursions. Likewise, when you adjust the trim setting on the aircraft to normal, it may not immediately disappear. Because this function is damped for smooth operation it may take a while to remove the warning. In the **ALT HOLD** mode, a quicker way to accomplish this is to press the LCD switch to return to the **READY** mode, trim the aircraft and then reengage the system.

8.1.2 Minimum & Maximum Airspeed Control

The EZ-2 and EZ-3 systems incorporate an airspeed sensor in the electronics module. This allows the system to constantly monitor airspeed to avoid stalling or over-speeding the aircraft while under autopilot control. The proper minimum and maximum airspeed limits are set by the pilot, using the setup menu. These limits must be individually determined by the aircraft type (giving full consideration to stall and Vne speeds) and the pilot's preferences. (See paragraph 8.1.3). Once set up, these settings will remain in nonvolatile memory.

Let's assume that the aircraft is in the "VS" mode and a climb rate of 500 fpm has been entered. When the LCD switch is pressed,

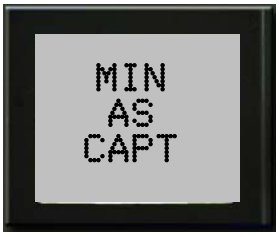
the aircraft will begin to climb. The pilot will likely advance the engine power to keep the speed up during the climb. Now let's assume that the pilot rotates the encoder to command a 2,000 fpm climb. Most aircraft will not be able to achieve such a vertical rate and the aircraft will approach a stall. As the airspeed falls to the Minimum Airspeed Limit, the LCD display will flash red and display "**MIN AS LIMIT"** and the system will issue a pitch down command to the servo to prevent a stall. Once the airspeed increases back above the minimum alarm airspeed, the LCD will display a flashing green **MIN AS CAPT** message and then track that minimum airspeed instead of the commanded vertical rate. The aircraft will continue to climb, but will be adhering to the airspeed limit instead of the commanded vertical rate.

Similarly, if a steep descent is commanded and the airspeed reaches the Maximum Airspeed limit, the LCD display will flash red and display **MAX AS LIMIT** and the system will reduce the descent rate to keep the aircraft from exceeding the limit speed. Once below the maximum alarm the LCD will display a flashing green **MAX AS CAPT** message and then track that maximum airspeed. In the **ALT HOLD** mode only the minimum airspeed limit will be sensed. This allows the pilot to fly straight and level at airspeeds above the maximum airspeed limit.

> **Note:** Because of the inertia of the airframe in any flight mode, the system cannot correct instantaneously. It is therefore very important that the Minimum and Maximum limits be set with a significant margin to allow for some overshoot of the limit airspeeds.

8.1.3 Setting Minimum & Maximum Airspeed

The MIN and MAX airspeed limits are set in flight by flying the aircraft manually to the airspeed desired and then entering that pitot pressure value into the system. This is done automatically by simply pressing the LCD switch as follows:



With the EZ-2 or EZ-3 in the "**READY**" mode, press and hold the encoder button until the system is in the **SETUP** menu. Then momentarily press the encoder button repeatedly until the amber display reads "**MIN AS SET**". Slow the aircraft to the desired minimum airspeed (giving plenty of margin before a stall) and press the LCD switch. The display will be green and read "**MIN AS CAPT**" as the airspeed is captured in nonvolatile memory.

Momentarily press the encoder button again and the amber display will read "**MAX AS SET**". Now fly the aircraft to the maximum desired speed and once again press the LCD switch. The display will read "**MAX AS CAPT**".

Press and hold the encoder button to exit the **SETUP** mode. Once the system is in the **READY** mode, press the encoder button to enter the **VS MODE**. Rotate

the encoder to enter a 500 fpm climb and press the LCD switch to engage the servo. Once the aircraft is established in the climb, slowly retard the throttle until the airspeed decays to the minimum airspeed that you have previously set. The LCD display should flash red and indicate "**MIN AS LIMIT**". Check to be sure that the system lowers the nose of the aircraft so that the airspeed settles out at the minimum airspeed that you have set. The display will flash green and display "**MIN AS CAPT**" as the autopilot continually adjusts the elevator control to keep the speed at this limit.

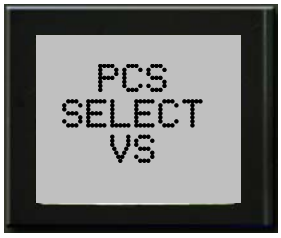
The pilot should then check the maximum airspeed alarm limit by pressing the LCD to return to the **READY** mode, then re-entering the **VS mode** by pressing the ENCODER switch. Once the **VS MODE** message is displayed the pilot should dial in an appropriate descent rate and then activate the command by pressing the LCD switch. When the maximum airspeed limit is achieved the red LCD display should read **MAX AS LIMIT** and the system should raise the nose of the aircraft to slow it to the prescribed limit. Here again, as the speed slows, the display will flash a green **MAX AS CAPT** message after the speed has decreased to the maximum airspeed setting. The autopilot will then adjust the elevator to maintain a speed at the set limit.

8.1.4 Vertical Rate and Airspeed Track Pilot Command Steering (PCS)

The vertical rate and airspeed track **PCS** modes require that a remote servo disconnect button be installed on the control stick or other location. If the aircraft is equipped with an EZ Pilot autopilot, it is recommended that the same disconnect switch be used for the EZ-2 (so that the common switch will disconnect both servos in the event of an emergency).

PCS operation is essentially the same as described in the EZ-1 section of this manual. Pressing the remote disconnect switch disengages the servo. However, if the switch is held down for 3 seconds it will "arm" the servo so that it will reengage when the switch is released. Once released the autopilot will enter either the **PCS VS** mode (hold a vertical rate) or the **PCS AIRSPEED** mode (hold the airspeed when released)

If the VS option (vertical speed) is selected in the **SETUP** menu, the EZ-2 and EZ-3 allows the pilot to use the **PCS** function for vertical speed (rate) climbs and descents. A typical scenario on using the EZ-2 and EZ-3 for this function follows:



Assume that the VS option is selected; the system is in the **ALT HOLD** mode and is maintaining a level altitude of 5,500 feet. If it is necessary to climb to 7,500 feet the pilot may press and hold the remote disconnect switch then manually fly the airplane at the desired climb rate. Once the vertical speed is established and stabilized (and the system is armed), releasing the switch will cause the system to engage the servo and continue the climb at that rate. When the aircraft reaches 7,500 feet, pressing the LCD switch will put the system back into the **ALT HOLD** mode.

PCS Airspeed Operation. If it is preferred, the pilot may use the PCS mode to conduct a change in altitude based on *airspeed* rather than *vertical speed*.

The pilot must use the **SETUP** menu to configure the EZ-2 or EZ-3 **PCS** mode to use airspeed instead of vertical speed. This is done by pressing and holding the encoder knob until the system enters the **SETUP** mode. Once in the **SETUP** mode, repeatedly press the encoder until you arrive at a display that reads **PCS SELECT VS**.

Rotating the encoder knob will change the display to read "**PCS SELECT AS**". Once this display has been selected, exiting the **SETUP** mode (by pressing and holding the ENCODER switch or

pressing the LCD switch) will store this function in nonvolatile memory. The **PCS** mode will now climb and descend on *airspeed* rather than vertical speed. Therefore, a pilot may wish to climb at, say, 120 knots for best engine cooling. This may now be done by pressing and holding the remote disconnect switch and placing the aircraft into a climb that indicates an airspeed of 120 knots. Releasing the button will reengage the servo and continue the climb at that airspeed.

> **NOTE:** To enable a **PCS** climb or descent, the pilot must establish a vertical speed of at least 200 fpm while holding the remote disconnect switch down. If the switch is released without achieving 200 fpm, the system will enter the **ALT HOLD** mode when it is released. This is to facilitate joint use of the **PCS** remote disconnect switch for both the altitude hold and VS/AS features. While performing a turn under **PCS** control, it may be difficult to hold altitude (or vertical speed) while turning, and this feature helps prevent an unwanted **PCS** climb command.

PCS "Active" Displays

PCS VRTSPD – Pressing the remote servo disconnect switch will disengage the servo. However, if the switch is held down for more than 3 seconds, the screen will begin to flash and display the message "**PCS VRTSPD ARMED**". This message indicates that the servo will reengage when the switch is released. If the **PCS** has been set up to climb and descend on vertical speed (instead of airspeed), once the remote disconnect switch is released the LCD screen will show a normal "VS" (Vertical Speed Active) message. It will display the approximate vertical speed that was established by the **PCS** maneuver, and after a short period of time it will probably also show that the aircraft needs to be trimmed for the climb or descent. *Once this display appears, it is also possible for the pilot to alter the climb or descent rate by rotating the encoder knob*.

PCS AIRSPD – Here again, while the remote servo disconnect switch is being held down the screen will begin flashing **READY**, and after a 3 second delay and the display will read "**AS TRK SELECT**". If the **PCS** has been set up to climb and descend on airspeed, the LCD screen will show the message "**AS TRK ACTIVE**". While in this mode, the aircraft will climb or descend at the airspeed selected. Trim arrows may also be displayed and, if the aircraft is significantly out of trim, it will be necessary to correct the trim imbalance to achieve the proper airspeed. Once this display appears, it is also possible for the pilot to increase the airspeed by rotating the encoder know clockwise, or decrease the airspeed by rotating the encoder knob counterclockwise.

9.0 The EZ-3 ALTITUDE CONTROL SYSTEM with Altitude Pre-select

Section 9 describes the additional features of the EZ-3 system. The EZ-3 altitude control system incorporates all of the features of the EZ-2 while adding altitude pre-select and other capabilities.

- The pilot may pre-select a destination altitude. When engaged, the system will command the aircraft to climb or descend to the selected altitude. Upon arrival at the destination altitude, the system will automatically switch to the **ALT HOLD** mode and assume level flight.
- To be accurate, the EZ-3 must have current altitude information. Once the pilot has adjusted the baro setting on the aircraft altimeter, the baro altitude in the EZ-3 may be easily adjusted to agree with the aircraft altimeter.
- When initiating a climb or descent to a destination altitude, the EZ-3 system will begin the climb/descent at either the rate set by the pilot, or a vertical speed that has been predetermined in the SETUP menu. The factory preset is 500 fpm, but this may be changed by the user. Once the climb or descent is under way, the pilot may toggle the display to the VS (Vertical Speed) screen and adjust the current climb/descent rate to a different vertical speed.
- If, at any time, (in a climb, descent or level flight) it is desired to have the system track an airspeed, the user may toggle to the screen labeled **AIRSPD TRACK SELECT** and press the LCD switch. The system will then vary the pitch angle of the aircraft to maintain that speed. For instance, a climb may have been commanded with a vertical speed (VS) command of 1,000 fpm. While at low altitude this may be realistic for some higher powered aircraft, but as you climb higher the airspeed will drop off as the system attempts to hold 1,000 fpm. When the airspeed drops to the "best engine cooling" speed, the pilot may press the **AIRSPD TRACK SELECT** screen and the system will hold that airspeed for the duration of the climb.

9.1 EZ-3 Operation

For the Altitude Pre-select to be accurate, it is important that the system be calibrated for the current local barometric pressure. Just as the primary aircraft altimeter must be adjusted to compensate for barometric pressure changes, the EZ-3 also provides a means for making such adjustments. While the primary aircraft altimeter is adjusted using a scale calibrated in "inches of mercury" (i.e., 29.92), the EZ-3 is adjusted to agree with the altitude shown on the primary altimeter.

9.1.1 Elevation (Baro) Set

When the EZ-3 system is turned on the LCD screen will display an **ELEV SET** (elevation set) message or **an ALT SET** message depending on whether the airspeed is below or above flight speed, respectively – i.e., whether the plane is on the ground or flying. The initial **elevation** should be set to be as close to that of the airfield elevation as possible. Any difference will be the result of barometer changes since the system was last used. Rotating the encoder knob will change the **elevation** in 5 foot increments, and it should be set to be as close to the actual airfield elevation as possible, in feet. This will assure that the internal system altimeter will agree closely with the aircraft altimeter. In practice, during preflight checks the pilot will set the aircraft altimeter using a current barometer setting. The aircraft altimeter will then be indicating the current elevation. The EZ-3 **ELEV SET** should be set to agree with the corrected aircraft altimeter.

Once the setting is correct, press the LCD switch to put the system in the **READY** mode. The system is now calibrated and ready to use.

If the system is cycled in flight, it will sense airspeed and the message will read as shown to the right (now indicating **altitude** instead of elevation). The aircraft should be level (not climbing or descending) so that the aircraft altimeter needles are not moving. The initial altitude will be close to that shown by the aircraft altimeter. Here again, any differences will be the result of barometer changes since the last time it was set.

The **ALT SET** may be changed by rotating the encoder until the indicated altitude agrees with the aircraft altimeter. The display resolution is in 20 foot increments for the **ALT SET** function. In normal flight, unless remarkable barometric changes have been experienced, the **ALT SET** should agree with the current altimeter indication.

Note: The mechanical aircraft altimeter is subject to small errors at different altitudes. It should be kept calibrated according to FAA guidelines. The EZ-3 contains an accurate model of the atmosphere but it, too, may exhibit small errors attributed to normal manufacturing tolerances of the precision sensors. Such accumulated errors between the two systems will typically be less than 1%. During rapid climbs and descents it may also be observed that the mechanical altimeter "lags" the EZ-3 altimeter **ALT SET** due to the faster response of the solid state sensors.

9.1.2 EZ-3 Menu System

Because of the many additional functions in the EZ-3, a review of the menu system will be helpful in explaining the operation of the system.

The diagram on the following page illustrates the use of the encoder switch and LCD switch…..

1. From the **READY** mode, repeatedly pressing the encoder will toggle through the various mode screens as shown below (solid arrows). These screens will appear as amber (waiting) unless the LCD switch is pressed when they will change to green (working). A red screen either disconnects the EZ-3 or, in the case of max airspeed, indicates that significant safety measures have been implemented.

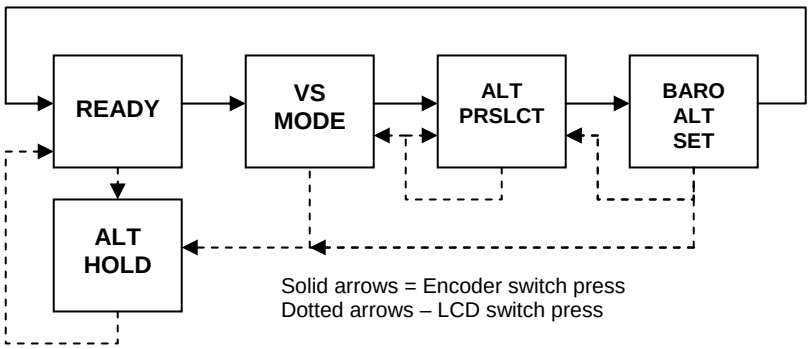
   In the **READY** mode, press the LCD switch to engage **ALT HOLD.** Press **ALT HOLD** to go back to **READY**.

2. In the **VS MODE**, rotate the encoder to set the climb or descent vertical speed. Pressing the LCD switch will initiate a climb/descent at that rate. (If the rate is left at "0" when the LCD switch is pressed, the system will engage and hold the present altitude). At any time during the climb or descent, pressing the LCD switch will enable **ALT HOLD** and the aircraft will return to level flight. If the encoder is used to set the vertical speed but the **VS MODE** is not engaged (still amber), the selected rate will be activated when **ALT PRSLCT** is engaged.

   Note: *For convenience, the pilot may skip entering a value in the VS mode (leave it at "0") and go directly to the ALT PRSLCT menu. When ALT PRSLCT is engaged, the VS will default to a value previously set in the setup menu. The factory sets this value at 500fpm, but pilots may change this to suit their preference.*

3. When in the **ALT PRSLCT** mode, the encoder can be rotated to modify the capture altitude. (Rotate for 100 ft. increments. Press and rotate for 1,000 ft. increments). When the encoder is rotated the **ALT PRSLCT** screen will turn amber indicating the new altitude is "waiting". The pilot must press the LCD to activate the new capture altitude., otherwise he display will time out and return to the original altitude pre-select display. When the LCD is pressed, the LCD display will briefly switch to the **ALT SET** screen. This screen will remain visible for 5 seconds so the pilot can check to see if the baro **ALT SET** altitude agrees with the corrected aircraft altimeter (if not, rotating the encoder will change it). After the 5 second delay times out (or if the LCD is pressed) the aircraft will begin the climb/descent at the selected (or default) vertical speed. The "VS" mode screen will be present and a **TARGET ALT** screen will flash momentarily to keep the pilot advised of the pre-selected altitude. Once the aircraft reaches the target altitude the system will go into the **ALT HOLD** mode and level the aircraft.

   When the aircraft is within about 100 feet of the pre-selected altitude, the vertical rate is automatically decreased to 200 fpm to minimize any overshoot of the capture altitude. Once the lower VS rate is invoked, the pilot can adjust that VS rate by rotating the encoder knob.



Note: Any time the system is in the green **ALT HOLD** mode, pressing the LCD switch will disengage the altitude control system and return it to the **READY** mode. This may also be accomplished in any mode by a single press of the remote disconnect switch on the control stick.

9.1.3 Enter Vertical Speed (VS)

To enter a vertical speed, press the encoder switch to advance to the **VS MODE** screen. It will initially indicate a "0" vertical speed. To initiate a climb or descent, just dial in the climb or descent rate and press the LCD switch. The aircraft will then begin to climb or descend at the vertical speed that was entered. The mode of operation here is the same as it is in the EZ-2 system.

If at any time a capture altitude is desired, the pilot can toggle to the **ALT PRSLCT** screen and set the desired altitude as previously described

If the VS is left at "0" (and not engaged) and the encoder is pressed again, the display will advance to the **ALT PRSLCT** screen. If an altitude is entered and the system is engaged, the vertical speed will default to the value stipulated in the setup menu and the aircraft will begin to climb/descend. This is set to 500 fpm at the factory, but may be changed by the user when in the setup menu.

9.1.4 Enter a Destination Altitude

To enter a destination altitude, press the encoder button to toggle to the amber **ALT PRSLCT** screen and rotate the encoder knob to select the desired altitude. Let's assume that we wish to climb to 7,500 feet. Rotating the encoder switch will increment the value by 100 ft. per click – Pressing and rotating will increment the value by 1,000 ft. per click) Once the proper altitude is displayed by rotating the encoder switch, press the LCD switch to engage the climb.

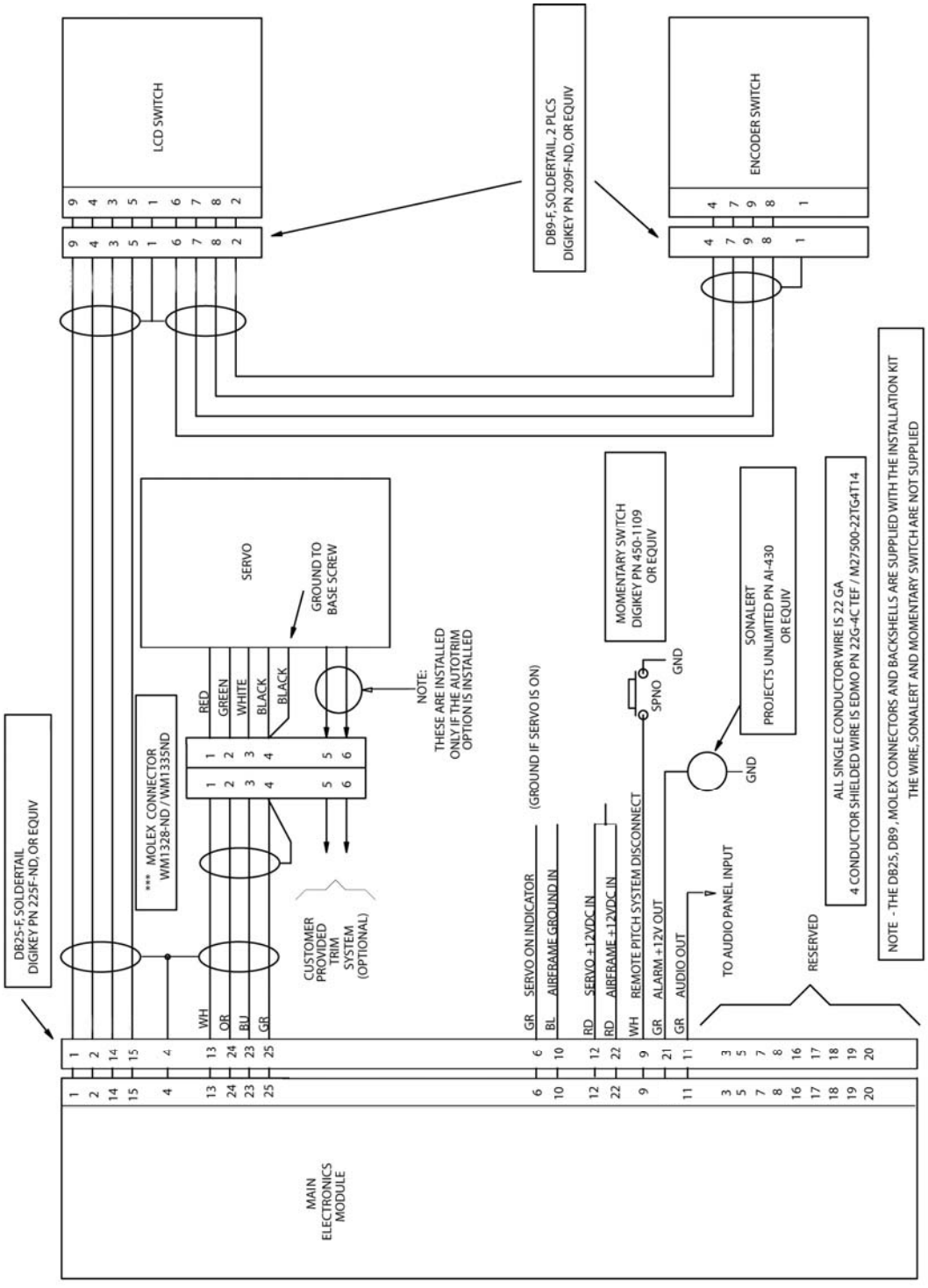
The LCD screen will briefly display the **BARO ALT** screen so we can check the EZ-3 altimeter against the aircraft altimeter. This display automatically times out 5 seconds after a change is made. Once the timeout occurs (or the LCD switch is pressed again) the LCD screen will display the default climb or descent rate, alternating with the destination altitude.

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

The **ALT PRESLCT** screen may be selected at any time and, if active (green), the pre-selected altitude may be adjusted. (As the encoder is rotated, the screen will change from green to amber, indicating that the new target altitude has not been invoked). Any changes made while this screen is present are activated by pressing the LCD switch as noted previously.

Additionally, to cancel the pre-selected altitude, toggle to the active **ALT PRSLCT** screen and press the LCD switch without rotating the encoder knob. The screen will now turn amber indicating the mode is inactive.

10.0 Altitude Hold Wiring Diagram



Altitude Hold Wiring Diagram

Note: the +12VDC input (pins 12 and 22) should be sourced through a circuit breaker with a rating of 3 to 5 amps.

11. 0 Automatic Trim

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

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

It is a common complaint that electric trim operation is often "too fast" and difficult to adjust properly. To address this, the EZ series altitude control systems offer a very effective means to adjust the speed at which the trim motor runs. Adjusting the trim speed is covered in paragraph 3.4 on page 8 and 9.

The drive to the trim motor originates within the EZ Gold Standard (GS) servo. It provides the drive signal to the trim motor through the 6 pin connector on the GS servo. Pins 5 and 6 are reserved for this purpose, as shown on the schematic on the previous page.

A means must be provided to allow the pilot to manually adjust the aircraft trim when the altitude hold system is not engaged. It is also a necessary safety feature to allow the pilot to manually override the servo trim function if required.

In aircraft that have the Auto-Trim feature, when the servo is engaged trim will automatically be adjusted. If the servo is **NOT** engaged (i.e. in the **READY** mode) the electric trim may be manually adjusted by rotating the encoder knob.

When the altitude control system is engaged and commanding the Auto-Trim to run the electric trim motor, it will display a small triangle on the LCD display indicating the direction of the trim correction.

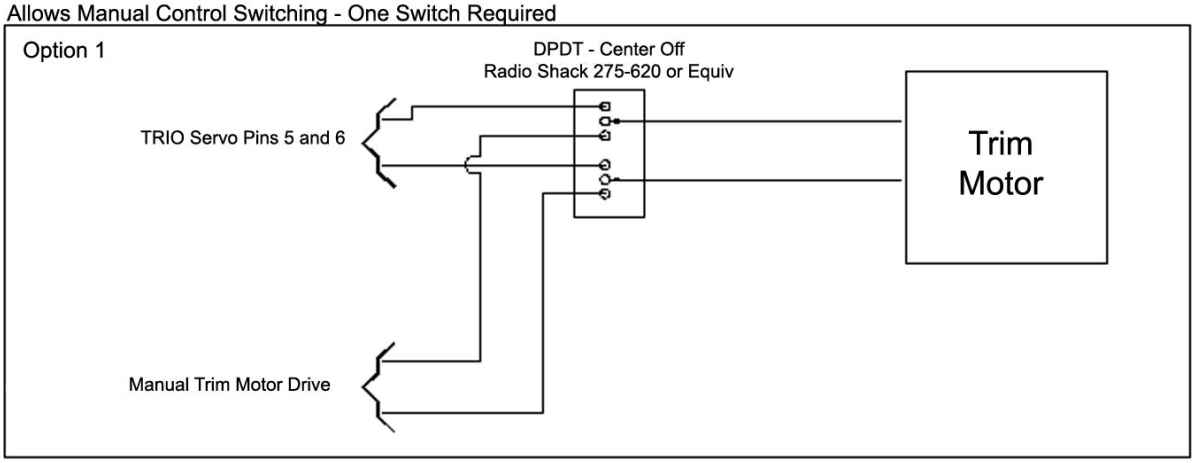
When in the **READY** mode, and if the Auto-Trim option has been installed, rotation of the **ENCODER** knob will allow manual adjustment of the trim motor servo. "Clicking" the knob position will result in a very fine adjustment of the trim servo position, while "slewing" the **ENCODER** knob rotation will result in larger changes of the trim servo position. The LCD will display as shown. The speed at which the trim servo slew rate is set is managed in the setup menus using the **TRIM SPEED** parameter (see paragraph 3.4.)

The diagrams on the following page show two methods that allow switching between manual and automatic trim operation.

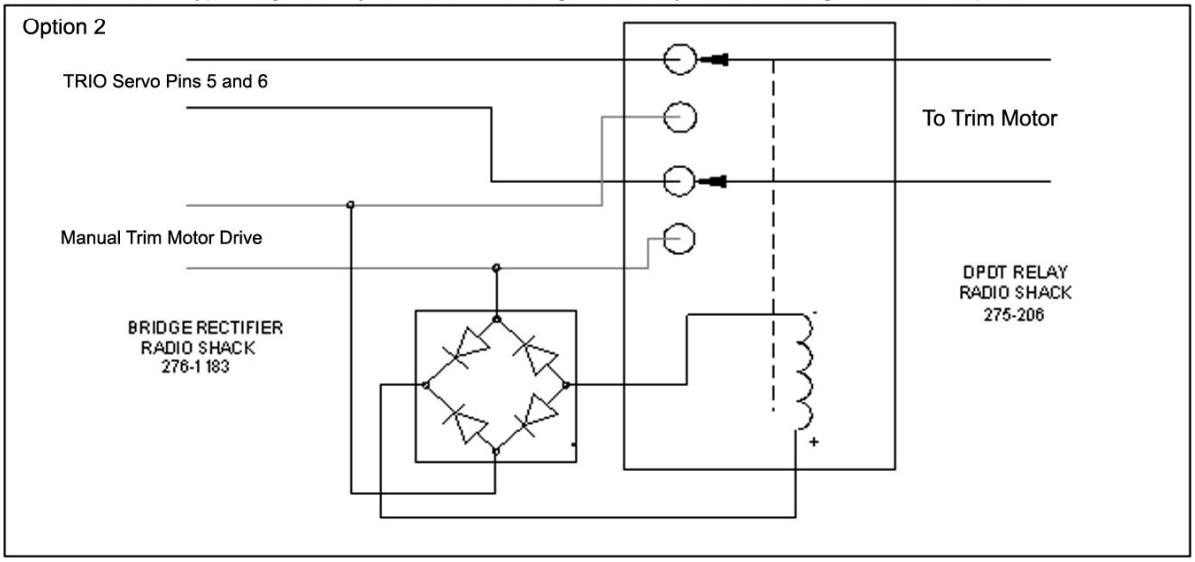
Option 1 is a manually operated toggle switch that can be positioned in either the "Manual" or "Auto" position. In the Manual position, there will be no automatic trim available, and in the "Auto" position there will be no manual trim available. It will require that the pilot remember to reposition the switch when the altitude hold system is not engaged.

Option 2 shows a method that disengages the automatic trim circuit from the GS servo whenever the manual trim switch is operated.

Allows Manual Control Switching - One Switch Required



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



12.0 Glossary of Terms

Brightness	A measure of the intensity of illumination on the LCD switch
Contrast	A measure of legibility of the LCD screen
EEPROM	Electrically Erasable Programmable Read Only Memory
Firmware	Computer program permanently stored in the autopilot memory
G-Force	A measure of acceleration (one G = normal earth gravity)
Gain	Increasing gain results in increased system sensitivity
LED	Light Emitting Diode
LCD	Liquid Crystal Display
PCS	Pilot Command Steering
Processor Interrupt	A signal that will command immediate processor attention
Rotary Encoder	A rotating control knob for adjusting system parameters
Servo	Deflects elevators as required by altitude hold system
Servo Clutch	Allows a moderate force to overcome servo control
Servo Deadband	Adjustable parameter to prevent servo oscillation or “hunting”
SMP	Servo Main Processor
Solenoid	An electro-magnetic actuator that engages the servo gears
RS232	Specification for data transfer protocol between systems

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