



STC GROUP LLC  
480 RUDDIMAN DRIVE  
NORTH MUSKEGON, MICHIGAN 49445-2783

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TRIO PRO PILOT AUTOPILOT AVIONICS ADDENDUM

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## **1.0 TRIO PRO PILOT AUTOPILOT AVIONICS ADDENDUM**

This document is intended to provide more information about the Trio Pro Pilot Autopilot. The Installation Instructions, Illustrated Parts Catalog, Airplane Flight Manual Supplement, and ICA should be referred to in all cases as it is FAA approved data.

[www.thestcgroupllc.com](http://www.thestcgroupllc.com)



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## **2.0 GENERAL**

Thank you for your purchase of the Trio Pro Pilot Autopilot.

This document is an addendum to the installation instructions for your aircraft type.

Contact the STC Group LLC directly for any approved data that you require.



### 3.0 SERVO GAIN ADJUSTMENT

#### 3.1 H NAV GAIN SETTING

**Note:**

If at any time during this procedure you get "lost" you can recycle power. If you change a setting and want to restore the defaults, you can accomplish a **RESTORE DEFAULTS** procedure as detailed below.

1. To ensure all autopilot (AP) gains and settings are initially at the factory defaults a **RESTORE DEFAULTS** will be the first item accomplished.
2. If you are certain that the defaults are correct you can skip this step.
3. If the **RESTORE DEFAULTS** is performed, you will need to reset the **MINIMUM** and **MAXIMUM** airspeed thresholds as also detailed below after the gain setting procedures.

Practice this procedure on the ground before flight so you won't get confused in the air.

A black rectangular box with white, pixelated text that reads "RESTORE DEFAULTS" on the first line and "ALL HNAV VNAV" on the second line, mimicking a digital display.

#### 3.2 RESTORE DEFAULTS PROCEDURE

Several of the variables used to optimize Pro Pilot are captured to EEPROM (nonvolatile memory) during initial setup. Further, tracking gains that are set for differing flight conditions are also maintained in system EEPROM.



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

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

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



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

1. Enter the **MAINTENANCE SETTINGS** menus by pressing the **ENCODER** and **VMODE** buttons simultaneously, then select the **RESTORE DEFAULTS** display.
2. Press and release the **H MODE** button. The arrow will be placed at the "ALL" setting field. Press the encoder knob to activate the restore. All lower display parameters will flash when the function is complete.
3. If it is desired to reset only the **H NAV** defaults, Press and release the **H MODE** button to position the cursor adjacent to **HNAV**. Press the **ENCODER** knob to activate. The **HNAV** display will flash when the function is complete.
4. If it is desired to reset only the **VNAV** defaults, Press and release the **H MODE** button again to position the cursor adjacent to **VNAV**. Press the encoder to activate. The **VNAV** display will flash when the function is complete.
5. Press the **H MODE** button until the right arrow is absent from the display.
6. Cycle power on the autopilot to exit the maintenance screens.

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

### 3.3 GROUND CHECKS

1. Check servo actuation, slip clutch operation and servo disconnect / release

### 3.4 INITIAL FLIGHT SETTINGS

1. Be sure to turn the AP on after engine start to stabilize the internal gyro before flight. Leave the autopilot ON unless otherwise noted

#### Note:

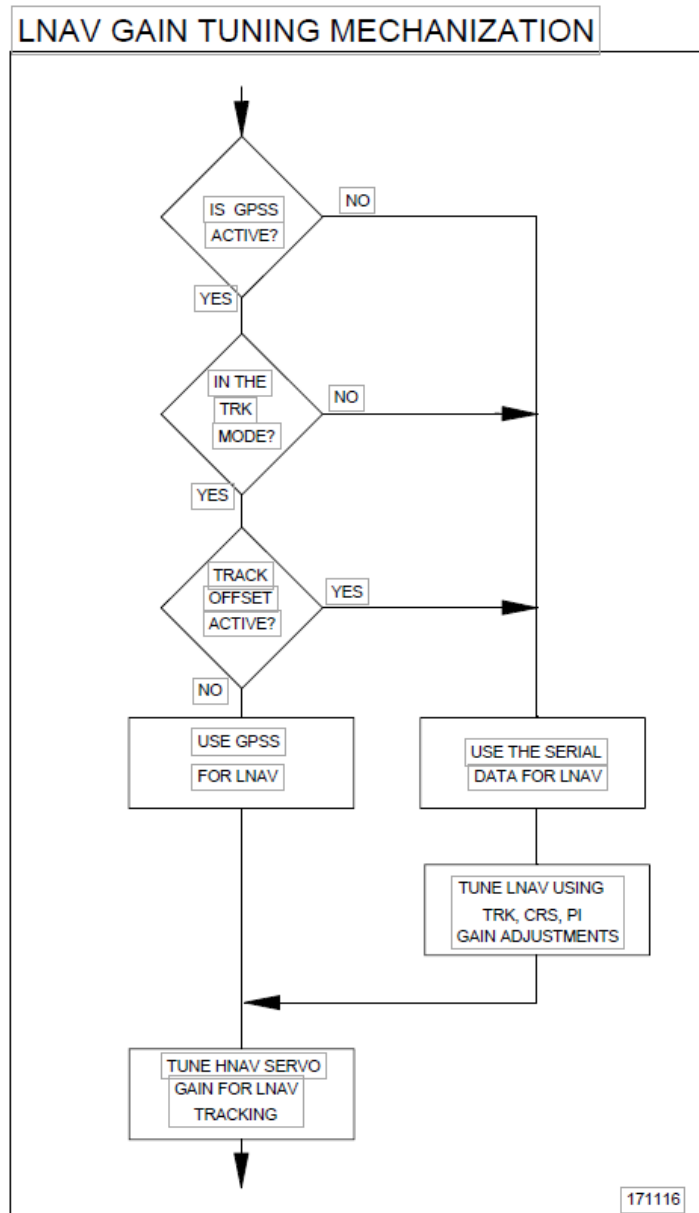
It is important to adjust the CRS gain prior to adjusting the TRK gain. When the CRS gain has been satisfactorily adjusted, do not change it when adjusting the TRK gain.

2. Place the AP in the **CRS** mode and engage the servo. Let the aircraft track stabilize.





3. Enter the **MAINTENANCE SETTINGS** menus by pressing the **ENCODER** and **VMODE** buttons simultaneously, then select the **SET H NAV GAINS** screen.
4. If roll is oscillating adjust the **CRS** setting **UP** or **DOWN** to minimize.
5. If satisfactory tracking is obtained, switch the AP to the **TRK** mode and optimize the tracking using the **TRK** setting (see Section 3.5).
6. If satisfactory performance cannot be obtained return the settings to the factory defaults (TRK = 3, CRS = 3, PI = 9) and proceed to the **HNAV SERVO GAIN ADJUSTMENT** below.





### 3.5 H NAV SERVO GAIN ADJUSTMENT

1. Select the **CRS mode** with the **SERVO ON** and stabilize on a ground track. There may be some oscillation at this point and it should be ignored.
2. Select the **MAINTENANCE SCREENS** and sequence to the **SET SERVO GAINS** menu.
3. Press the **H MODE** button until an arrow is in front of the **HNAV** gain.
4. Use the **ENCODER** to decrease or increase the gain in steps of 4 units until the oscillation stops or is minimized.
  - a. You can fine tune the gain by increasing or decreasing the gain setting by one step after bracketing the gain using 4 units.
  - b. A setting that is too low will cause the AP to stabilize on a course a degree or more on one side of the selected course, or may cause a very long “hunting” from one side of the selected course to the other of more than two degrees.
  - c. A setting that is too high will cause an oscillation of a shorter period across the selected course of two degrees or more.
  - d. The setting is optimized when the selected course is maintained within +/- 1 degree in a very slow oscillatory fashion.

**Note:**

The period of this oscillation should be greater than one (1) minute.

- e. Increase or decrease the gain to suit your personal preference.
- f. The autopilot may track perfectly for several minutes, then wander - 1 degree, back to zero for a minute, etc. Once this is achieved you can repeat the **CRS** gain procedure to further refine the gains.
- g. Exit the **MAINTENANCE SCREENS** menu by pressing and holding the **ENCODER** until the normal navigation screens appear.

**Note:**

**The TRK gain is not used when GPSS is providing lateral navigation.** If GPSS is being used for lateral navigation you will need to enter a track offset when using the TRK mode on the autopilot. This disables the GPSS input and forces the autopilot to use the serial data stream.

5. Select the **TRK** mode.
  - a. **If GPSS is active** enter a left or right 0.10 track offset (press and turn the **ENCODER** in the TRK mode).
  - b. Repeat steps 2, 3, and 4 until the arrow is pointing at the **TRK** gain.
  - c. Minimize the track error (XTK) by adjusting the TRK gain.
  - d. A setting that is too high will cause a slow return to the center line or stabilization at an offset.
  - e. A setting that is too low will cause oscillation back and forth across the DTK line in excess of 0.02 miles.



6. The **PI** (Pull In) is usually OK.
  - a. If the intercept after a switch from the INT mode to the TRK mode is too aggressive, lower this setting.
  - b. If the intercept is “lazy” raise this setting.



## 4.0 V NAV GAIN SETTING

This procedure is a method that should be used to set the Altitude Hold (AH) Vertical Speed (VS) and Airspeed (AS) gains.

### Note:

It is recommended that the auto trim (*experimental only*) be disabled during these procedures. This can be accomplished by minimizing the trim speed setting in the **MAINTENANCE SETTING** screens

### 4.1 ALTITUDE HOLD GAIN SETTING

1. Perform all initial ground checks prior to this test.
2. Place the aircraft in a stable pitch trim neutral cruise configuration.
3. Engage the **Altitude Hold**, AH, mode by pressing the **VNAV** button.
4. If there is any oscillation, enter the **MAINTENANCE SETTINGS** menus as described in Section 3.4 above and select the **VNAV GAIN SETS** display page.
5. Press the **HMODE** button to place the arrow next to the **AH** gain setting.
6. Increase the gain setting five points and evaluate the performance.
7. If the performance is degraded, lower the gain setting 10 points.
8. If the performance improves or there is no noticeable change, increase or decrease the setting an additional five points as required.
9. Continue this process until an optimum value is reached.

### Note:

If satisfactory performance cannot be obtained return the settings to the **Factory Defaults**, as described in Section 3.2 above, and proceed to Section 4.2, **VNAV SERVO GAIN Adjustment** below.

10. Further gain refinement can be achieved as follows:
  - a. Place the aircraft in a pitch neutral configuration and engage the Altitude Hold, AH, mode.
  - b. Engage the left or right AUTO 180 MODE (press and hold either the VNAV or HNAV button for 3 seconds.
  - c. While entering the 180-degree turn, observe altitude loss.
  - d. If the altitude loss is greater than 40 feet, raise the Altitude Hold, AH, gain by 5 points and repeat this process until the altitude loss is within 20 to 40 feet.



## 4.2 V NAV SERVO GAIN ADJUSTMENT

1. Select the **CRS** mode with the **SERVO ON** and stabilize on a specific ground track.
2. Select the **MAINTENANCE SCREENS** and sequence to the **SET SERVO GAINS** menu.
3. Press the **H MODE** button until an arrow is in front of the **VNAV** gain setting.
4. Use the **ENCODER** to decrease or increase the gain in steps of 4 units until the oscillation stops or is minimized. *Example: VNAV=20 to VNAV=24*
5. You can fine tune the gain by increasing or decreasing by one step after bracketing the gain using 4 units.
  - a. A setting that is too low will cause the autopilot to fail to hold the selected altitude.
  - b. The autopilot may oscillate more than 20 feet above or below the selected altitude.
  - c. A setting that is too high will cause an oscillation of a shorter period or result in a divergent altitude situation.
  - d. The setting is optimized when the selected altitude is maintained within 20 to 30 feet in smooth air without noticeable oscillation.
  - e. Once the settings are close you can go back to the Altitude Hold, AH, gain setting in Section 4.1 above to refine the gains.
6. Exit the **MAINTENANCE SCREENS** menu by pressing and holding the **ENCODER** until the normal navigation screens appear.

## 4.3 VERTICAL SPEED GAIN SETTING

1. Perform all initial ground checks and verify that the servo direction settings are correct.
2. Place the aircraft in a stable pitch trim neutral cruise configuration.
3. Select the VS mode.
4. Rotate the ENCODER to set a 500 FPM climb rate.
5. **Select VNAV** on the autopilot controller and activate the climb by pressing the **ENCODER** knob.
6. The VS LED should be on steady orange

### Note:

**The following steps assume the aircraft is PROPERLY TRIMMED for the climb rate selected. The aircraft should be manually trimmed for the selected climb rate. Failure to maintain a relatively good trim may cause the autopilot control system to exhibit a slight “bucking” motion during the climb.**

7. The aircraft should settle into a 500FPM rate of climb within about 10 seconds.



8. If you observe significant deviation in smooth air from the selected climb rate perform the remaining steps.
9. If there is excess oscillation or the vertical rate is not achieving the selected value, enter the **MAINTENANCE SETTINGS** menus and select the **VNAV GAIN SETS** display page
10. Press the **HMODE** button to select the **VS** gain setting.
11. Adjust the gain setting five points up and evaluate the tracking performance. If the performance is degraded, readjust the gain setting 10 points lower. If the performance improves or there is no noticeable change, increase / decrease the setting an additional five points. Continue this process until an optimum value is reached.

#### 4.4 AIRSPEED GAIN SETTING

**Note:**

The aircraft vertical speed when entering the Airspeed, AS, mode must be greater than +/- **200FPM**. If the vertical rate is less than this value, the system will revert to the Altitude Hold, AH, mode on release of the servo disconnect switch.

1. Perform all initial ground checks and verify servo direction settings prior to this test.
2. Place the aircraft in a stable pitch neutral cruise configuration
3. Engage the Altitude Hold, AH, mode
4. Press and hold the remote servo disconnect (**PCS**) switch.
5. The **VNAV LED** will now flash.
6. Place the aircraft in either a climb or descent and release PCS switch at the desired airspeed

**Note:**

**The following steps assume the aircraft is PROPERLY TRIMMED for the selected airspeed.  
The aircraft should be manually trimmed for airspeed.**

7. The aircraft should track the desired airspeed within 2 or 3 knots in smooth air. If there is significant deviation from the selected airspeed, perform the remaining steps.
8. Enter the **MAINTENANCE SETTINGS** menus and select the **VNAV GAIN SETS** display page.
9. Press the **HMODE** button to select the **AS** gain setting.
10. Increase the gain setting five points and evaluate the tracking performance.
11. If the performance is degraded, decrease the gain setting **10 points**.
12. If performance improves or there is no noticeable change, increase or decrease the setting an additional **five points**.
13. Continue this process until an optimum value is reached.



14. Once the airspeed gain is bracketed you can increment or decrement one unit at a time to fine tune the gains.



## 5.0 SERVO ROTATION DETERMINATION

The servos as shipped are set for CW or CCW operation. In the event the servos must be configured for a different rotation an internal jumper provided on the servo Printed Circuit Board (PCB) needs to be fully installed. A spare label provided on the servo cover **must** be installed over the existing label. Refer to the ICA.

It easier to insert the jumper on the PCB before the servo is installed. You must read and understand paragraphs 1 and 2 before installing the servo.

### 5.1 INSTALLING THE SERVO REVERSAL JUMPER

**Note:**

**Exercise caution when performing the following procedure.**

1. Carefully remove the servo cover.
2. Locate the jumper on the PCB directly behind the DB-9 connector on the PCB.
3. The jumper is located on one of the jumper pins, not across both pins.
4. Using a small pair of needle nose pliers or similar tool remove the jumper from the pin on which it is installed by pulling it straight up off the PCB.
5. Relocate the jumper over both the pins on the PCB and install it by pushing it down over both jumper pins.
6. Reinstall the servo cover.
7. Place the PN 31000000 label over the existing 30000000 label.





## 6.0 WIRING HARNESS INSTALLATION

### NOTE

Prior to plugging harness DB9 or DB37 into servos or autopilot control perform a full power, ground, and data test on the harness by ringing the wires from plug to plug using PRO PILOT WIRING HARNESS DWG 413000XX. Refer to Appendix A,

### 6.1 ROLL SERVO HARNESS INSTALLATION

1. Route Trio Harness roll servo wiring to roll servo location.
2. Take care to protect harness pins at end of harness.
3. Terminate supplied DB9 connector per Wiring diagram.
4. Attach DB 9 connector to Trio Roll Servo.
5. Secure harness cable end at the servo end.

### 6.2 PITCH SERVO HARNESS INSTALLATION

1. Route Trio Harness Pitch servo wiring to pitch servo location.
2. Take care to protect harness pins at end of harness.
3. Terminate supplied DB9 connector per Trio diagram.
4. Attach DB 9 connector to Trio Roll Servo.
5. Secure harness cable end at the servo end.

### 6.3 TRIO AUTOPILOT CONTROLLER

1. The Trio autopilot controller is ordered in Panel Mount or Instrument Mount versions.
2. Install the controller using best practices in either panel or hole locations. Refer to AC 43-13 for this step and all following steps.
3. Install the 5 ampere circuit breaker within easy reach of the pilot and label.
4. If a Panel Mount unit is ordered install the supplied power switch and label.
5. Terminate supplied DB37 connector per the Trio drawing 413000XX.
6. If RS 232 is available from GPS terminate RS 232 connections.
7. If ARINC 429 is available from GPS terminate ARINC 429 connections.
8. If an EFIS is installed terminate wiring for EFIS control.
9. Install the supplied PCS button on the left side of the pilots control yoke and label PCS.
10. Install Recover button in an available convenient location within easy reach of the pilot and label AP Recover.
11. Ensure that the analog alarm out is connected to the un-switched audio input on the Audio Panel.

**Note:** If your audio panel does not have un-switched audio input, attach the audio leads to the phone input of your intercom.

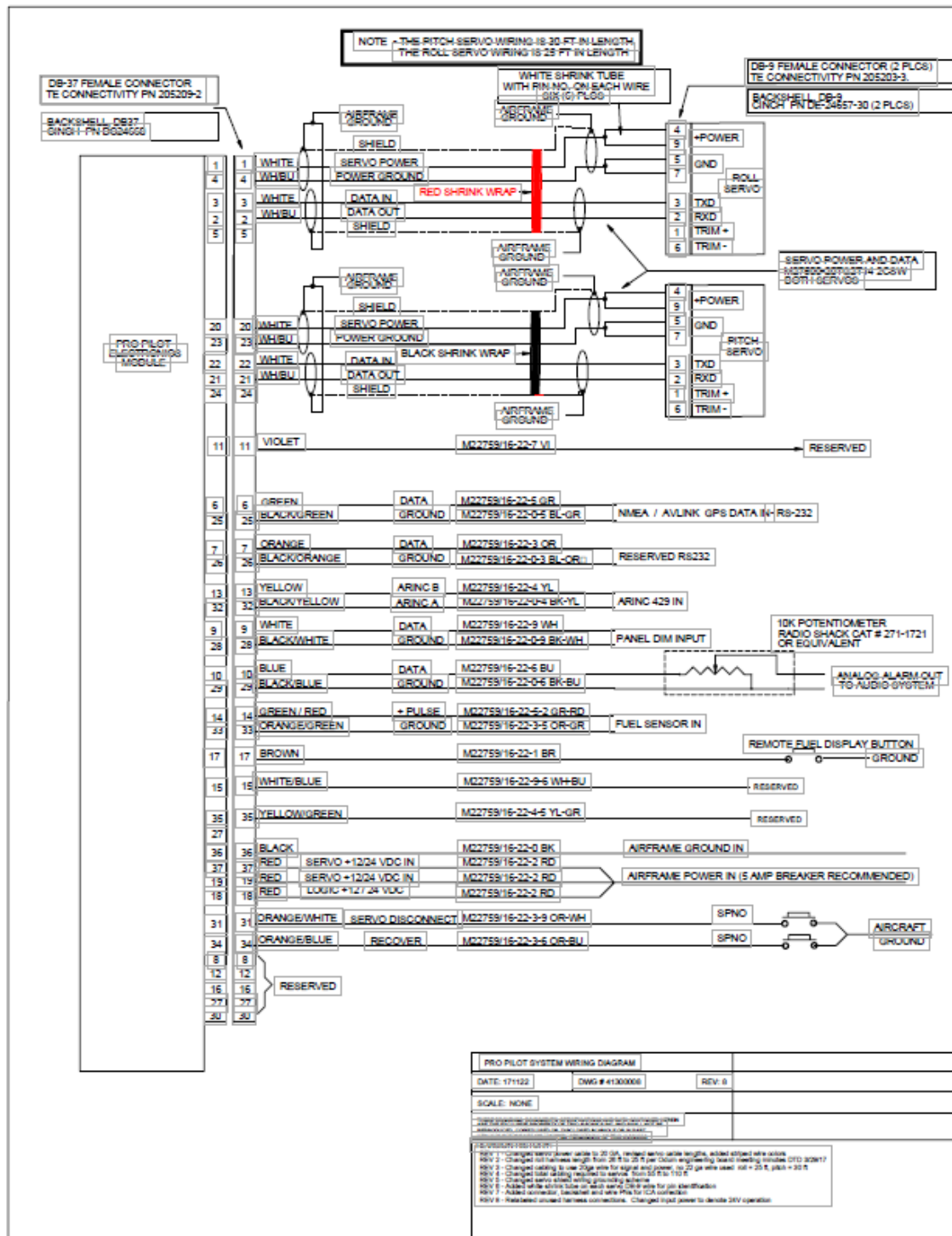


#### **6.4 TRIO AUTOPILOT DATA CONNECTIONS**

1. For the RS-232 connection set the output at the GPS unit to "Aviation w/ no altitude" or NMEA 0183 OUT.
2. If your aircraft is equipped with a GPS that has ARINC 429, set unit to output "GAMA" Low Speed. The Trio Autopilot can run at Low and High Speed ARINC.
3. If your aircraft is equipped with an EFIS contact The STC Group LLC for specific installation instructions.
4. Prior to making the connections to the GPS unit in the aircraft determine what else is connected. It may be necessary to parallel the connections. If parallel connections are required, verify that the lines you are connecting to use, or can use, the same data format that is required. Both the RS-232 and the ARINC 429 can be paralleled with like connections.



## 7.0 APPENDIX A - PRO PILOT SYSTEM WIRING DIAGRAM





## 8.0 QUESTIONS AND ANSWERS FROM THE FIELD

### ARINC 429 and RS-232

We use both signals for the various modes in the autopilot. The RS-232 AVIATION format needs to be present at pin 6 of the autopilot.

The autopilot lateral gains (TRK, CRS, PI and HNAV SERVO GAIN) should always be accomplished before using the GPSS as the lateral navigation source. All these baseline gain settings use the serial data, not the GPSS input. In our field experience if the tracking is SAT after tuning the TRK, CRS, PI and HNAV SERVO GAIN using the serial link, the GPSS should work without any adjustment of the servo gain. In other words, the serial tuning is a baseline for using GPSS.

The TRK gain is only effective when using the serial link as the lateral navigation source. However, if the GPSS is active, GPSS automatically becomes the selected lateral navigation source in the TRK mode. GPSS provides a simple bank left - bank right control signal to the autopilot. The only way to manipulate this input is to do CRS, or INT functions so these two modes only use the serial inputs data. The TRK mode GPSS tracking tuning is only a function of the HNAV servo gain, nothing else. In order to force the serial data as the lateral tracking source in the TRK mode you can use the track offset function. Whenever there is a track offset lateral navigation is forced to the serial data. In this configuration you can adjust the TRK gain. The attached graphic helps explain the implementation

### CRS Mode

*Q We didn't see any interface to the Directional Gyro for the Heading bug. I guest this is built into the autopilot computer/control head. Please confirm.*

*A The CRS mode on the autopilot allows flying vectors using GPS as the reference. It will also receive heading bug from an EFIS system. (Aspen/G5) Please refer to Avionics Compatibility List for approved GPS units and EFIS systems.*



### **Trim UP / DN LED's**

*Q Can you hook up LED's to the autopilot for Trim Messages?*

A In theory you could use a set of LEDs driven by pins 1 and 6 of the pitch servo to give you a trim indication. These pulses are of a variable duration (10ms - 990ms / sec) depending on the settings used in the trim drive setups. Since you would be driving LEDs rather than a trim motor you could set the trim pulse width to a maximum setting, so the LED would be readable.

These bi-polar signals work as follows:

NO TRIM REQD - Both pins 1/6 at ground potential

TRIM UP Pin 1 at ground, pin 6 at airframe power\*

TRIM DN Pin 6 at ground, pin 1 at airframe power\*

\* these can be reversed in the trim drive setups.

Depending on the airframe voltage and the LED current drive requirements you would have to select a current limiting resistor in series with the LED to control the LED current

A basic description other circuit would be:

Pin 1(6) ----->current limiting resistor---->LED anode-----LED cathode----->ground

*We have never used the outputs like this so we cannot guarantee they would satisfy your requirements.*

### **Automatic Trim**

The Trio pitch servo generates a bi-polar DC trim motor drive signal on pins 1 and 6 of the DB-9 connector. The problem with implementation is regulatory, not technical. Adding this feature to a certified airframe is not allowable under the current STC.

The STC group has had discussions with the FAA regarding implementing auto trim and the FAA indicated to do this would require opening up the existing STC to add this feature. This process would likely result in a complete re-evaluation of the current STC and would be a very timely and costly process. The STC Group LLC is not actively seeking an auto trim STC amendment.



## **AVIONICS COMPATIBILITY**

*Q What Avionics can work with the Trio Autopilot?*

A Refer to Trio Autopilot Avionics Compatibility List Document 1006001 Rev E or latest FAA approved revision.

## **WIRING DIAGRAMS**

*Q I only see basic wiring in the installation manual do you have specific wiring for my configuration?*

A <https://www.thestcgroupllc.com/pages/documentation>



## **9.0 AVIONICS GROUND TESTING - INSTRUCTIONS FOR GROUND TESTING OF THE TRIO AUTOPILOT SERVO INSTALLATION**

Perform the following testing after the autopilot system has been installed to verify correct servo operation and control authority.

1. Turn OFF the GPS attached to the autopilot.
2. Apply power to the autopilot system
3. When ELEVATION set is displayed, set the current field elevation and then press the ENCODER knob
4. Simultaneously press the ENCODER knob and the V MODE buttons
5. When MAINTENANCE SCREENS appear release the ENCODER and VMODE buttons.

### **9.1 VNAV Servo Testing**

1. Using the ENCODER sequence to the VNAV SERVO SETS screen either by pressing the ENCODER or rotating the ENCODER clockwise.
2. Once on the VNAV SERVO SET screen press the lower left HMODE button.
3. An arrow should appear on the lower right display field before NM (or RV).
4. Move the elevator control to place the number field in the display to approximately 00.0.
5. Turn on the VNAV servo by pressing the upper right VNAV button.
6. The angular display should read 0.00 +/- 1.0 degrees.

#### **NOTE**

The elevator loads on the ground may cause the servo to slip when the servo is turned ON. In this case you will need to counterbalance the elevator to unload the imbalance. You may also manually place the elevator control at approximately 0.00 degrees and observe that the pitch servo motor is not running (servo clutch is not slipping).

7. Rotate the ENCODER clockwise and observe that the elevator is driven in a direction that puts the aircraft in a climb (yoke drives rearward).
8. This verifies that the servo direction is correct.
9. Rotate the ENCODER counterclockwise and observe that the elevator is driven in a direction that puts the aircraft in a dive (yoke drives forward).
10. This verifies that the servo direction is correct.
11. Press the ENCODER button. This drives the elevator control back to a zero-servo angle.



## NOTE

The following steps verify that the servo slip clutch is functioning correctly and that the servo drives the control system adequately.

12. Manually move the controls forward to the control system mechanical stop.
13. The servo will run with the clutch slipping when overridden.
14. Release the controls.
15. Verify the controls return to the zero position
16. Manually move the controls rearward to the control system mechanical stop.
17. The servo will run with the clutch slipping when overridden.
18. Release the controls.
19. Verify the controls return to the zero position.
20. Turn the VNAV servo OFF by pressing the VNAV button.
21. Press the HMODE button to remove the arrow from the display screen.

## 9.2 HNAV Servo Testing

1. Using the ENCODER sequence to the LNAV SERVO SETS screen either by pressing the ENCODER or rotating the ENCODER clockwise.
2. Once on the LNAV SERVO SET screen press the lower left HMODE button.
3. An arrow should appear on the lower right display field before **NM** (or **RV**).
4. Move the roll control to place the number field in the display to approximately 00.0
5. Verify that the ailerons are in their neutral position.
6. **If not, perform the following steps. Otherwise proceed to step 27.**
7. Move the roll control to place the ailerons in their exact neutral (**in trail**) position.
8. Observe that the **angular display readout is +/- 5.00 degrees**.
9. **If the reading in step 26 is more than five degrees**, the roll linkage should be shortened or lengthened to obtain less than 5 degrees.
10. This can usually be accomplished by adjusting the rod end bearings on the roll servo control linkage.
11. Repeat steps 20 through 26 until this reading is as specified.
12. Turn on the HNAV servo by pressing the upper right HNAV button.
13. The angular display should read 0.00 +/- 1.0 degrees.
14. Rotate the ENCODER clockwise and observe that the controls are driven in a direction that puts the aircraft in a right turn.
15. This verifies that the servo direction is correct.





16. Rotate the ENCODER counterclockwise and observe that the controls are driven in a direction that puts the aircraft in a left turn.
17. This verifies that the servo direction is correct.
18. Press the ENCODER button.
19. This drives the roll controls back to a zero-servo angle.

### NOTE

The following steps verify that the servo slip clutch is functioning correctly and that the servo drives the control system adequately.

20. Manually move the controls full right to the control system mechanical stop.
21. The servo will run with the clutch slipping when overridden.
22. Release the controls.
23. Verify the controls return to the zero position.
24. Manually move the controls full left to the control system mechanical stop.
25. The servo will run with the clutch slipping when overridden.
26. Release the controls.
27. Verify the controls return to the zero position.
28. Turn the HNAV servo OFF by pressing the HNAV button.
29. Press the HMODE button to remove the arrow from the display screen.