STC GROUP LLC
480 RUDDIMAN DRIVE
MUSKEGON, MICHIGAN 49445

REPORT NO: 1024002 REV A

TRIO AUTO PILOT INSTALLATION INSTRUCTIONS

PIPER AIRCRAFT CORPORATION PA-24

	Original Issue 06/07/2021
DATE:	11/9/2022
WRITTEN BY:	Ahmed J. Abdulshafi
APPROVED BY:	Jeffrey Odum

REVISIONS

Rev.	Date:	By:	Checked By:
-	7 JUNE 2021	Ahmed J. Abdulshafi	Mark F. Sullivan
A	9 NOVEMBER 2022	Ahmed J. Abdulshafi	Jeffrey Odum
ER No: 1006			

Revision:	Description
All	Initial Release
REV A	Sections 3, 4, & 5, Appendix A

TABLE OF CONTENTS

LIST OF FIGURES

REFERENCES

The following documents form a part of this report. Unless a specific revision of one of these documents is specified, the revision in effect at the time of original issue of this document shall apply.

DWG 413000XX Trio Pro Pilot System Wiring Diagram

Piper Aircraft Corporation PA-24 Service Manual

Piper Aircraft Corporation PA-24 Parts Catalog

Industry Specifications and Standards:

1. MMPDS-09 Metallic Materials Properties Development and Standardization
2. AC 43.13-1B ACCEPTABLE METHODS, TECHNIQUES, AND PRACTICES – AIRCRAFT INSPECTION AND REPAIR

Other Data:

ER1006 – STC GROUP LLC Program Engineering Record.

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ASSY	Assembly
Autopilot	Trio Pro Pilot Autopilot
C.G.	Center of Gravity
ER	Engineering Record
FAA	Federal Aviation Administration
F.S.	Fuselage Station
ICA	Instructions for Continued Airworthiness
INCH	Inches
LH	Left Hand
OEM	Original Equipment Manufacturer
OUTBD	Outboard
PCS	Pilot Controlled Steering
Recover	Recover Button
RH	Right Hand
Servo	Trio Gold Standard Servo
STC	Supplemental Type Certificate
WS	Wing Station

1.0 GENERAL

Thank you for your purchase of the TRIO Pro Pilot Autopilot for your aircraft. This document is written to ensure your installation is simple, safe, and professionally completed. Before you begin: Read All Instructions!

This installation procedure provides information and data necessary to install the Trio Auto Pilot Controller along with the Pitch and Roll servos in a Piper Aircraft, Inc. PA-24 aircraft.

You may contact The STC Group LLC for hardware and servo installation questions. Contact Trio Avionics, Inc with all autopilot related questions.

Check all items included in the kit to ensure all parts are accounted for. You may compare the contents of the kit with the Illustrated Parts Catalog. Please contact us if there are missing items.

The STC Group Technical Support is available 0800 to 1700 Monday through Friday Pacific Time:

+1 (231) 220-9296 or +1 (888) 350-2998

Trio Avionics may be reached Monday through Saturday at +1 (619) 448-4619

NOTE:

Care should always be taken to avoid marring or scratching of any surfaces of autopilot assemblies including anodized surfaces. Painters tape may be used to prevent damaging hardware surfaces.

The STC Group LLC recommends that a flight test of the subject aircraft be conducted to assess aircraft rigging and handling characteristics prior to autopilot installation. Use Test 4 of The STC Group LLC Flight Test Cards, document F-1006-43. Documents can be found at The STC Group LLC website at www.thestcgroupllc.com/documents.

2.0 PREPARE THE SERVOS

2.1 Remove the Pitch and Roll servos from the shipping boxes.

2.2 Enlarge the 4 corner mounting holes on only the ***pitch*** servo baseplate using a #16 drill bit and deburr.

2.3 Loosely attach all cable clamps to both servo bridle cables. For both installations, the bridle cable sits above the primary cable. See applicable Illustrated Parts Catalog.

2.4 Do not remove the flagged pin from the capstans.

WARNING:

Removing the capstan drum lock pin before the bridle cable clamps are installed in the center of primary control cable travel may result in damage to the servo. If the pin was removed before the clamps were installed in the center of primary control cable travel, then contact The STC Group before installing the bridle cable clamps.

3.0 PREPARE THE AIRCRAFT FOR THE INSTALLATION

3.1 Pitot and static system leak checks are recommended to be performed on the aircraft before any work begins. {i.e. FAR §43 Appendix E, Paragraph (a)}.

3.2 Remove any previously installed autopilot, servos, and harnesses. Record the station position of each component removed and weigh each component. This information will be used to update Weight & Balance data.

3.3 Remove seats and interior, as needed, for wiring installation and access to areas of modification. Refer to Figure 3-1 through 3-4.

3.4 Remove interior panels and carpet to gain access to the control cables bay under the pilot's side floor panel. Refer to Figure 3-2 & 3-4.

3.5 Remove interior panels to gain access to F.S. 184 for pitch servo installation. Refer to Figure 3-3 & 3-4.

3.6 Verify pitch, roll, and yaw control system rigging and cable tensions are correct in accordance with the applicable Type Certificate Data Sheet and Maintenance/Service Manual.

3.7 Record pitch and roll control system cable tensions for reference later.
Pitch Cable Tension: _____
Roll Cable Tension: _____

3.8 Route the roll and pitch servo wire bundles to their corresponding areas. Refer to Section 5.0 and Trio Pro Pilot Wiring Diagram Appendix A.

3.9 If the bracket shown in Figure 3-5 is installed in your aircraft, then it must be removed before installing the roll servo.

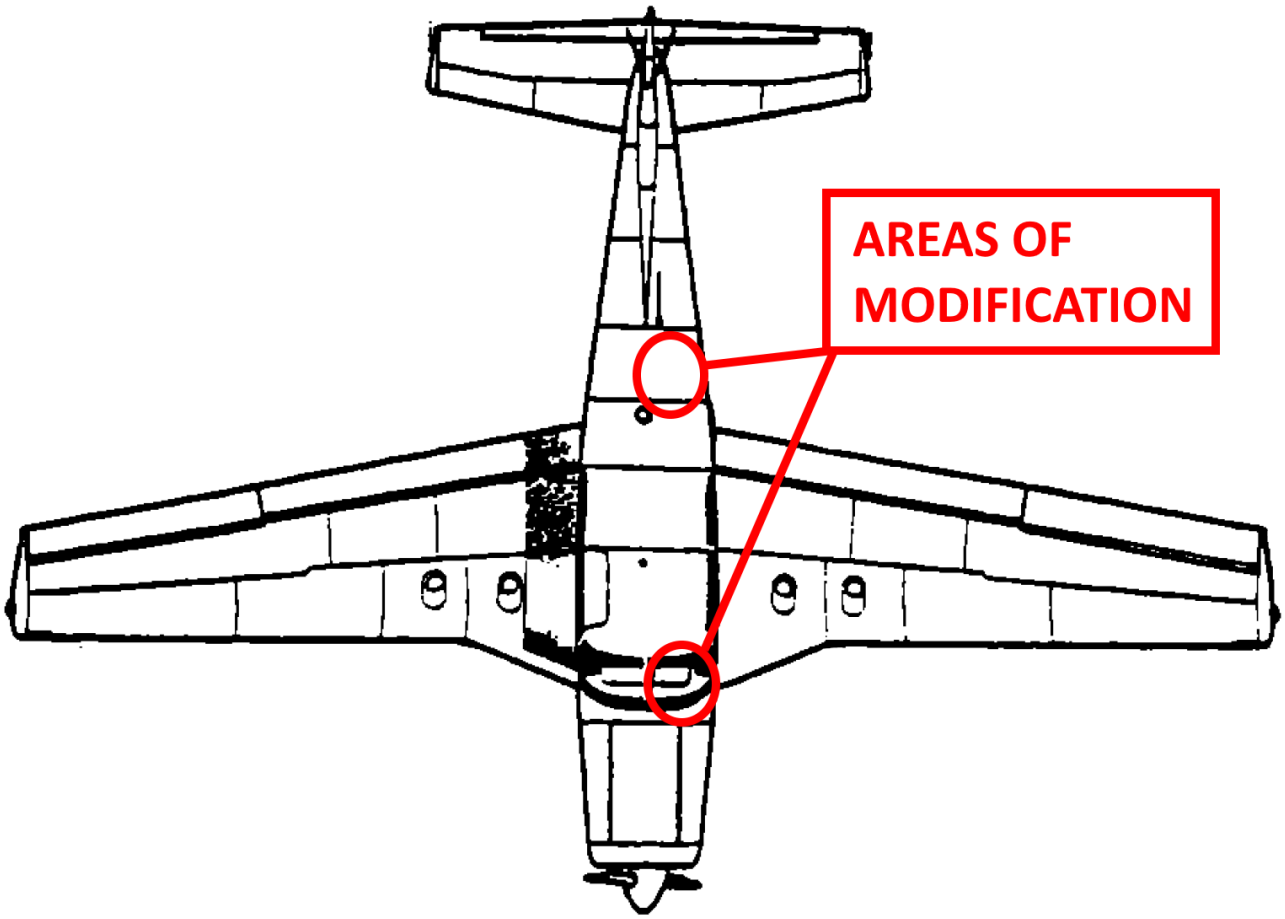


FIGURE 3-1 AREAS OF MODIFICATION

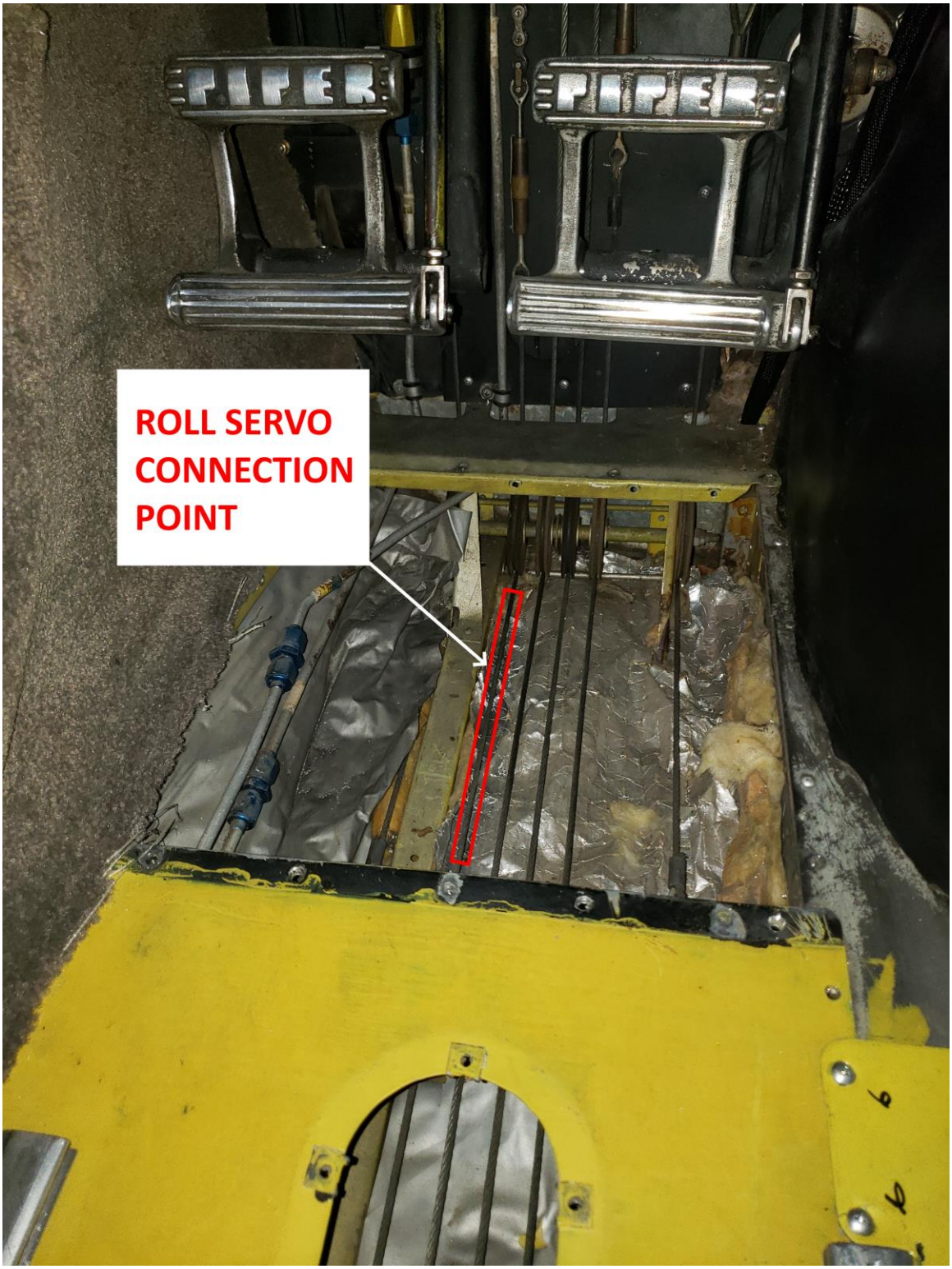


FIGURE 3-2 PILOT SIDE UNDER FLOOR ACCESS

FIGURE 3-3 PITCH SERVO LOCATION

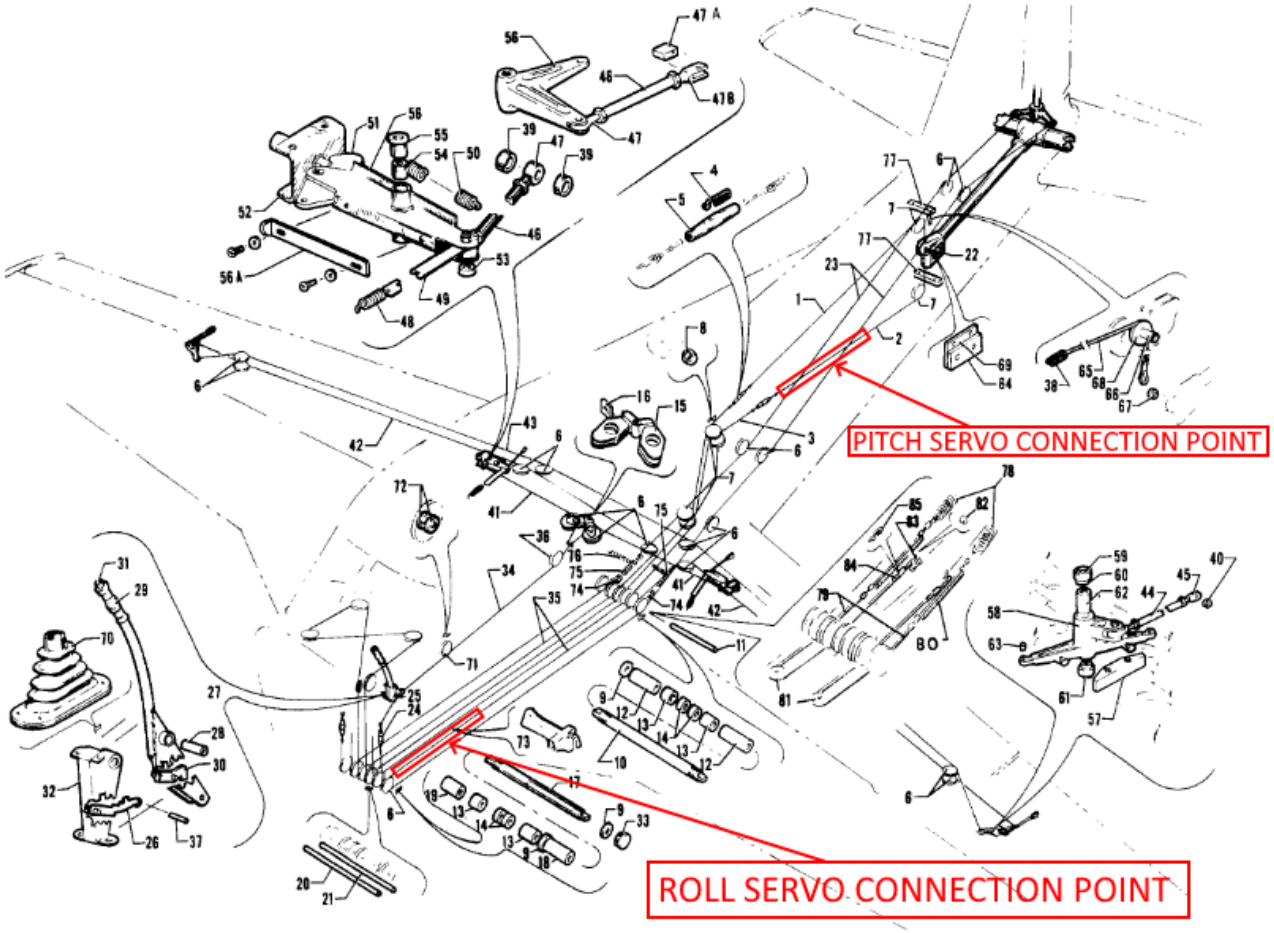


FIGURE 3-4 CONTROL SYSTEMS REFERENCE

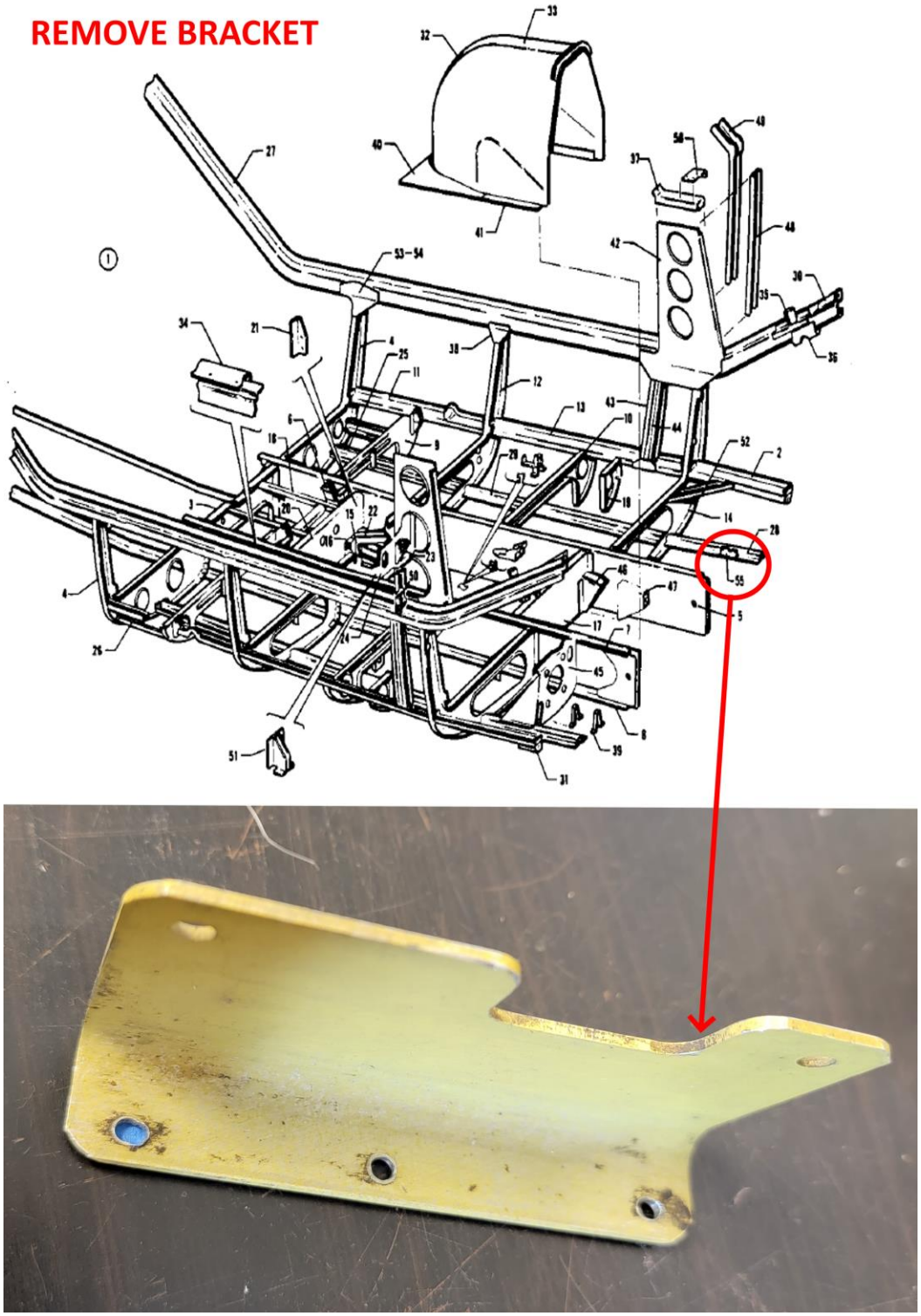


FIGURE 3-5 REMOVE BRACKET (IF INSTALLED)

4.0 SERVO INSTALLATIONS

4.1 ROLL SERVO INSTALLATION

4.1.1 This roll servo installation references The STC Group LLC Illustrated Parts Catalog Document # 1024900 and Drawing # 1024802.

FIGURE 4-1 ROLL SERVO INSTALLATION

4.1.2 Align the forward mounting bracket so that the inboard edge is at the forward right hand corner of the floor opening. The bracket ***will not*** be up against the nose wheel well structure.

NOTE:

The forward bracket airframe mounting screw holes must be vertically centered in the forward floor structure lip.

4.1.3 Pick up the 3 screw holes on the forward floor structure lip with a #30 drill bit then oversize to a #16.

4.1.4 Alternatively, mark the 3 holes, center punch, and drill pilot holes with a #40 drill bit then oversize to a #16.

4.1.5 Install the forward bracket with the hardware supplied.

4.1.6 Insert the aft mounting bracket between the lower rib bulkhead (F.S. 66) and the aft floor skin panel.

4.1.7 Align the inboard edge of the bracket to right hand aft corner of the floor opening. Do not drill mounting holes yet.

4.1.8 Mount the roll servo to the roll servo inboard and outboard mounting brackets (U-channels) with the capstan facing outboard using the screws provided and lock washers.

4.1.9 Loosely attach the roll servo u-channels to the forward and aft mounting brackets.

4.1.10 Ensure the capstan drum is centered above the outboard aileron control cable and does not contact the lower fuselage stringer.

4.1.11 The servo will be at a slight angle to accommodate the bridle cable grooves in the capstan drum. Ensure that the bridle cable grooves of the capstan drum align along the same axis as the aileron control cable to alleviate any bridle cable binding or unnecessary wear of the capstan drum. Refer to Figure 4-2.

4.1.12 Tighten the forward and aft u-channel screws to the brackets.

4.1.13 Clamp the aft mounting bracket in place.

NOTE:

If your aircraft does not have a hole where the center mounting screw on the aft bracket goes, then add this hole between the existing screw holes using a #40 drill bit then oversizing to a #16. This hole should go through the floor skin and the lower rib bulkhead F.S. 66.

4.1.14 Center punch and drill the 3 mounting holes with a #40 drill bit.

4.1.15 Remove the servo & u-channel as an assembly.

4.1.16 Remove the aft bracket and oversize the pilot holes using a #16 drill bit.

4.1.17 Depending on the model of your aircraft, the center mounting screw on the aft bracket may be a countersunk screw (supplied). If your aircraft does not have a nutplate where the center screw goes then use the supplied locknut to secure the center mounting screw. Refer to Figure 4-3.

4.1.18 The countersunk center mounting screw on the aft bracket will be installed before the floor panel is re-installed.

4.1.19 The remaining 2 screws on the aft bracket are the same screws that attach the floor panel cover. If the roll servo will be engaged for testing, then the 2 floor panel screws can be temporarily installed until the floor panel is re-installed.

4.1.20 Install the 90 degree backshell and terminate pins on the roll servo DB9 connector.

4.1.21 Install the DB9 connector onto the servo.
4.1.22 Before proceeding, the Trio controller must be completely installed. Refer to Section 5.0.
4.1.23 Fix the ailerons in their neutral position (using blocks or equivalent method) and loosely fasten the bridle cable clamps to the outboard aileron control cable.
4.1.24 Install the roll servo with u-channels on the forward and aft mounting brackets.

WARNING:

Removing the capstan drum lock pin before the bridle cable clamps are installed in the center of primary control cable travel may result in damage to the servo. If the pin was removed before the clamps were installed in the center of primary control cable travel, then contact The STC Group before installing the bridle cable clamps.

4.1.25 For the next step, ensure that the bridle cables go in the correct direction and do not contact the capstan retainer or bushings. For ease of installation, temporarily taping the bridle cables to the servo is acceptable. Refer to Figure 4-4.
4.1.26 Pull the two bridle cable clamps away from each other and temporarily tighten both FWD & AFT clamp bolts/nuts. (The roll servo and rails together can be disconnected and moved aside for this step)
4.1.27 With the ailerons centered; torque the forward cable clamp bolts/nuts.
4.1.28 Remove the capstan pin.
4.1.29 Putting tension on the aft cable clamp; torque the aft cable clamp bolts/nuts.
4.1.30 Power up the Trio control head.
4.1.31 Press the encoder knob in once to get past the SET ELEVATION screen.
4.1.32 Simultaneously press and hold the encoder knob and V MODE button for 3 seconds to enter the MAINTENANCE SETTINGS screen. Refer to Figure 5-1.
4.1.33 Scroll over to the LNAV SERVO SET page.
4.1.34 Ensure the reading is within +/- 1 degrees of zero with the ailerons centered.
4.1.35 If the reading is not within this tolerance, then adjust the cable clamps until the reading is within the tolerance.
4.1.36 If the correct tolerance cannot be reached, then contact The STC Group before proceeding.
4.1.37 It is recommended that the forward cable clamp bolts be torqued first.
4.1.38 To achieve the correct bridle cable tension, loosen the aft cable clamp so it may slide on the primary cable.
4.1.39 Use a pull force gauge to pull the aft cable clamp against the swage 15 +/-2 lbs while tightening one of the aft clamp bolts. This can be accomplished by wrapping rope or cable between the primary and bridle cables on the forward side of the clamp. Alternatively, you can loosen the aft bolt and hook the force gauge to it while tightening the forward bolt.
4.1.40 Repeat steps 4.1.28 through 4.1.34 then proceed.
4.1.41 Torque all bridle cable clamp bolts/nuts to 25 in-lbs.
4.1.42 Remove the device(s) that were used to center the ailerons in step 1.1.23.

NOTE:

Due to manufacturing differences between aircraft, the bridle cable clamps must be installed in a manner that assures clearance from aircraft structures.

NOTE:
The roll servo clutch is preset, from Trio, at 39 +/- 5 lbs linear force.

FIGURE 4-2 ROLL SERVO CAPSTAN ALIGNMENT

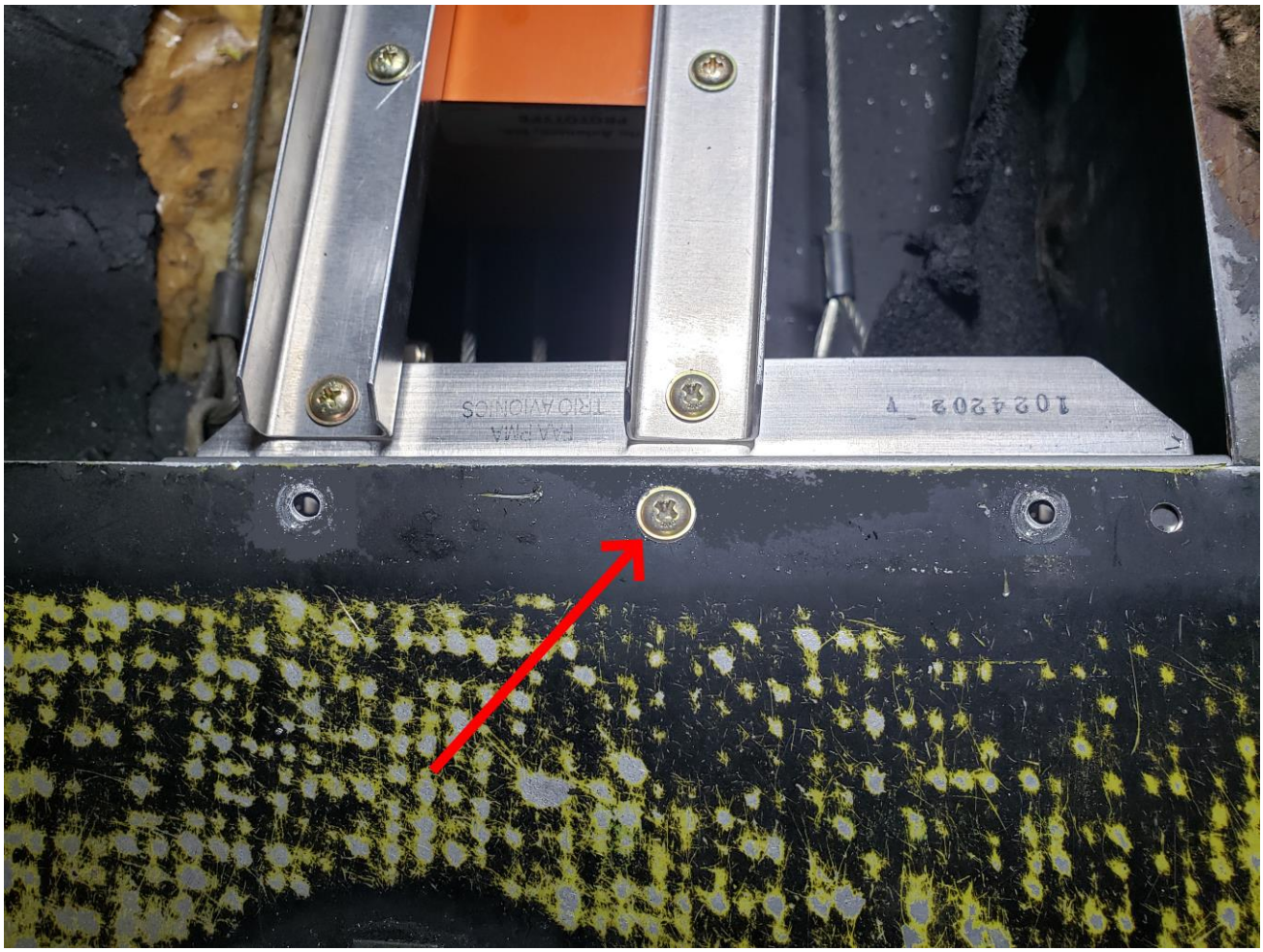


FIGURE 4-3 ROLL SERVO AFT MOUNTING BRACKET

FIGURE 4-4 CAPSTAN BRIDLE CABLE REFERENCE

4.2 PITCH SERVO INSTALLATION

4.2.1 This pitch servo installation references The STC Group LLC Illustrated Parts Catalog Document # 1024900 and Drawing # 1024803.

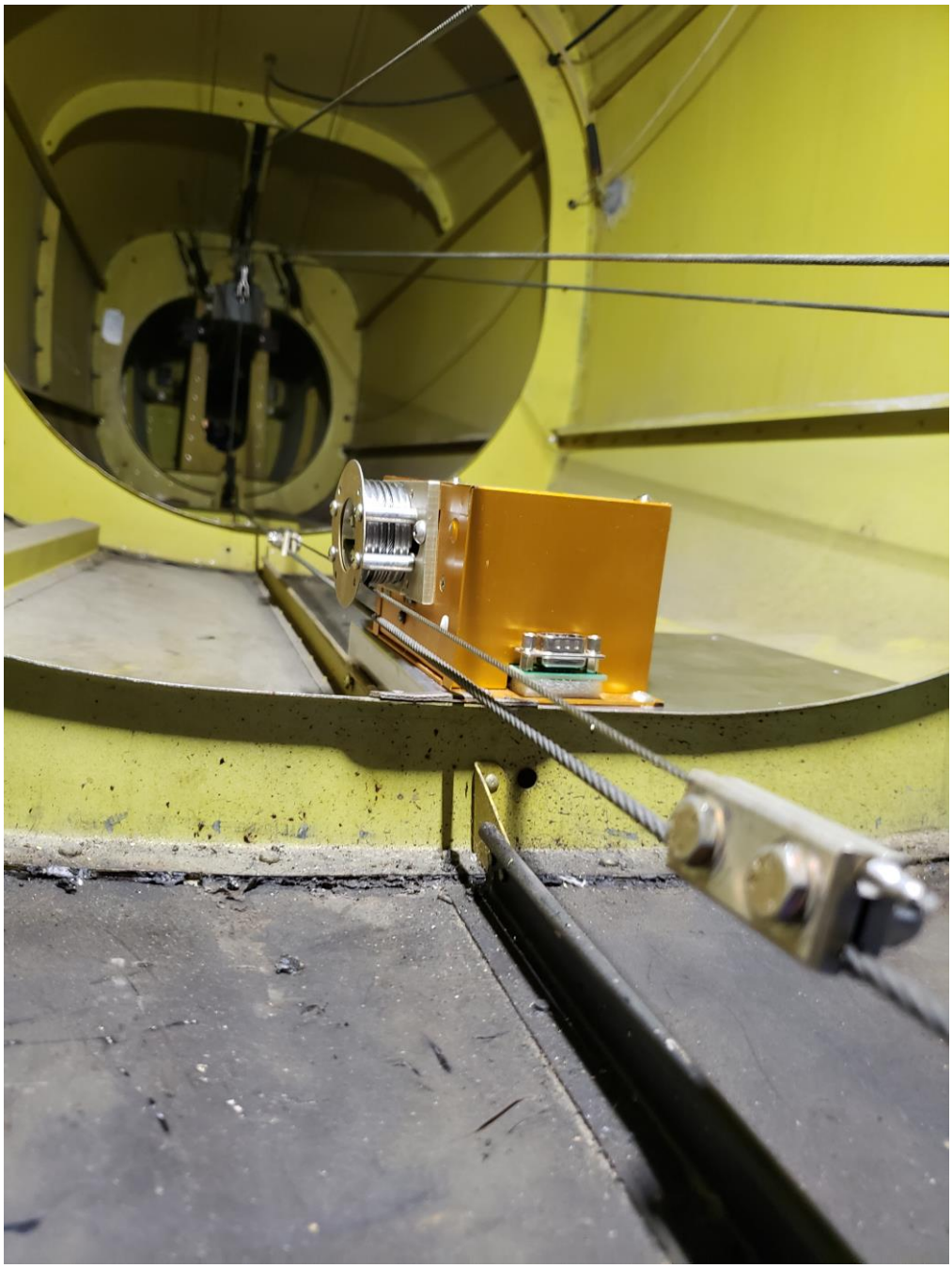


FIGURE 4-5 PITCH SERVO INSTALLATION

4.2.2 Position the pitch servo tray on the left side of the aircraft outboard of the center stringer and approximately 1" aft of F.S. 184.

4.2.3 The outboard edge of the pitch tray should align with the outboard edge of the left stringer.

4.2.4 Pick up the 2 center stringer screw holes or alternatively, mark the locations and pilot drill with a #40 drill bit in the center of the center stringer, then oversize to a #16.

4.2.5 Install the two center stringer attach screws.

CAUTION:

The next step could potentially damage the fuselage belly skin. Do not drill more than ½" into the stringer.

4.2.6 Use a #40 drill bit and cleco's to pick up the 3 pre-drilled pilot holes on the outboard side of the bracket.

4.2.7 Remove the pitch servo tray.

4.2.8 Oversize the 3 pilot holes on the pitch servo tray using a #16 drill bit.

CAUTION:

The next step could potentially damage the fuselage belly skin. Do not drill more than ½" into the stringer.

4.2.9 Oversize the 3 pilot holes on the outboard stringer using a #2 drill bit.

4.2.10 On the outboard stringer holes, use a needle file to file the 3 rivnut hole keys to a length of ~0.055". Refer to Figure 4-7.

4.2.11 Install the 3 rivnuts in the stringer with an 8-32 rivnut puller. Refer to Appendix B for recommended tools.

4.2.12 Install the pitch servo onto the pitch tray.

4.2.13 Install the straight backshell and terminate pins on the pitch servo DB9 connector.

4.2.14 Before proceeding, the Trio controller must be completely installed. Refer to Section 5.0.

4.2.15 Install the DB9 connector onto the servo.

4.2.16 Install the pitch tray & servo in the fuselage.

4.2.17 Before the next step is accomplished you must first determine where the **center of pitch cable travel** is **(Not flight neutral**). Two different methods are shown in Figure 4-6.

4.2.18 Once the center of travel is found, fix the pitch control system to stay at the MIDDLE OF TRAVEL location. A hose clamp around the yoke or tail stand under the stabilator can be used if another person is not available for this step.

WARNING:

Removing the capstan drum lock pin before the bridle cable clamps are installed in the center of primary control cable travel may result in damage to the servo. If the pin was removed before the clamps were installed in the center of primary control cable travel, then contact The STC Group before installing the bridle cable clamps.

4.2.19 For the next step, ensure that the bridle cables go in the correct direction and do not contact the capstan retainer bushings. For ease of installation, temporarily taping the bridle cables to the servo is acceptable. Refer to Figure 4-8.

4.2.20 Pull the two bridle cable clamps away from each other and temporarily tighten the clamp bolts/nuts.
4.2.21 Remove the capstan pin.
4.2.22 Power up the Trio control head.
4.2.23 Press the encoder knob in once to get past the SET ELEVATION screen.
4.2.24 Simultaneously press and hold the encoder knob and V MODE button for 3 seconds to enter the MAINTENANCE SETTINGS screen. Refer to Figure 5-1.
4.2.25 Scroll over to the V NAV SERVO SET page.
4.2.26 Ensure the reading is within +/- 1 degrees of zero with the stabilator in the center of travel.
4.2.27 If the reading is not within this tolerance, then adjust the cable clamps until the reading is within the tolerance.
4.2.28 If the correct tolerance cannot be reached, then contact The STC Group before proceeding.
4.2.29 It is recommended that the aft cable clamp bolts be torqued first.
4.2.30 To achieve the correct bridle cable tension, loosen the forward cable clamp so it may slide on the primary cable.
4.2.31 Remove the device that was used to center the stabilator.
4.2.32 Use a pull force gauge to pull the forward cable clamp against the swage 15 +/-2 lbs while tightening one of the forward clamp bolts. This can be accomplished by wrapping rope or cable between the primary and bridle cables on the aft side of the clamp. Alternatively, you can loosen the forward bolt and hook the force gauge to it while tightening the aft bolt.
4.2.33 Repeat steps 4.2.22 through 4.2.28 then proceed.
4.2.34 Torque all bridle cable clamp bolts/nuts to 25 in-lbs.

NOTE:

Due to manufacturing differences between aircraft, the bridle cable clamps must be installed in a manner that assures clearance from aircraft structures.

NOTE:

The pitch servo clutch is preset, from Trio, at 15 +/- 3 lbs linear force.

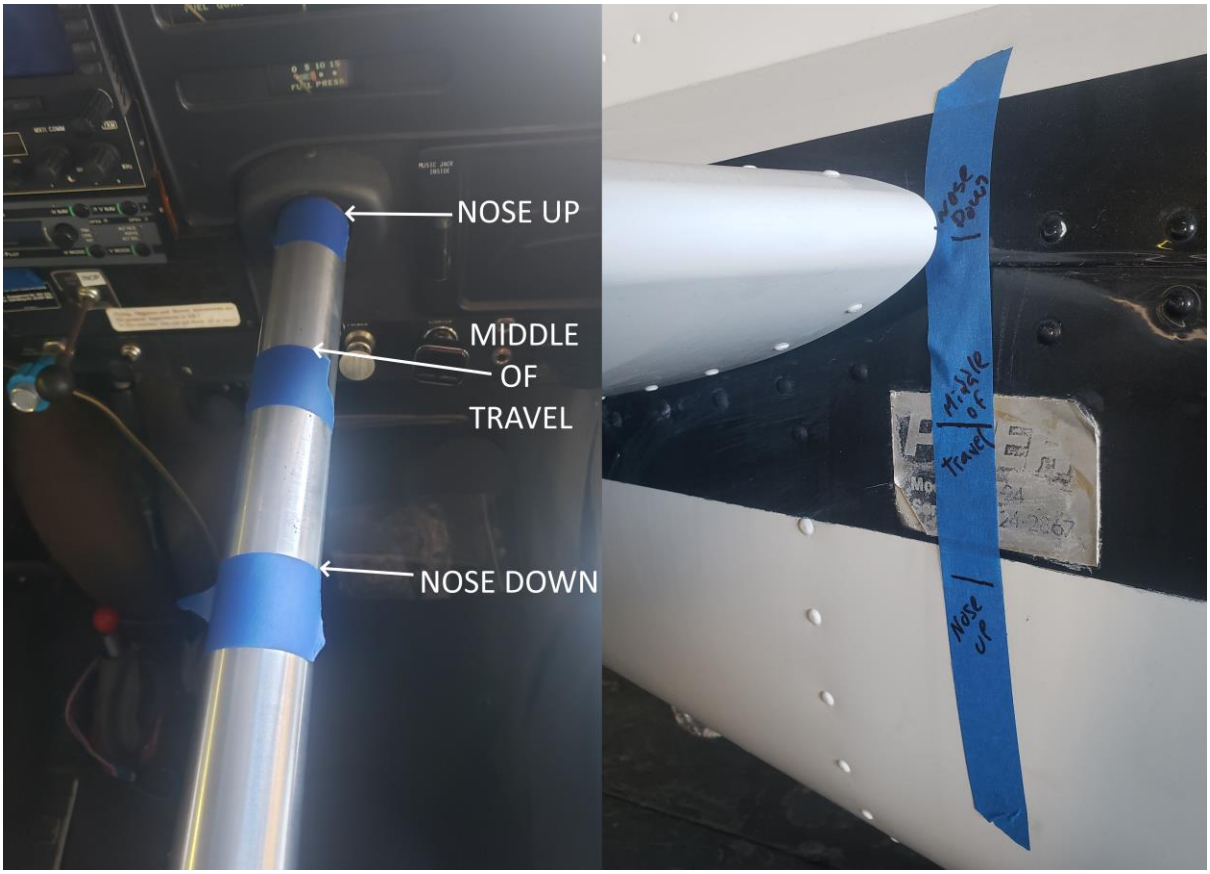


FIGURE 4-6 FINDING PITCH CENTER OF TRAVEL

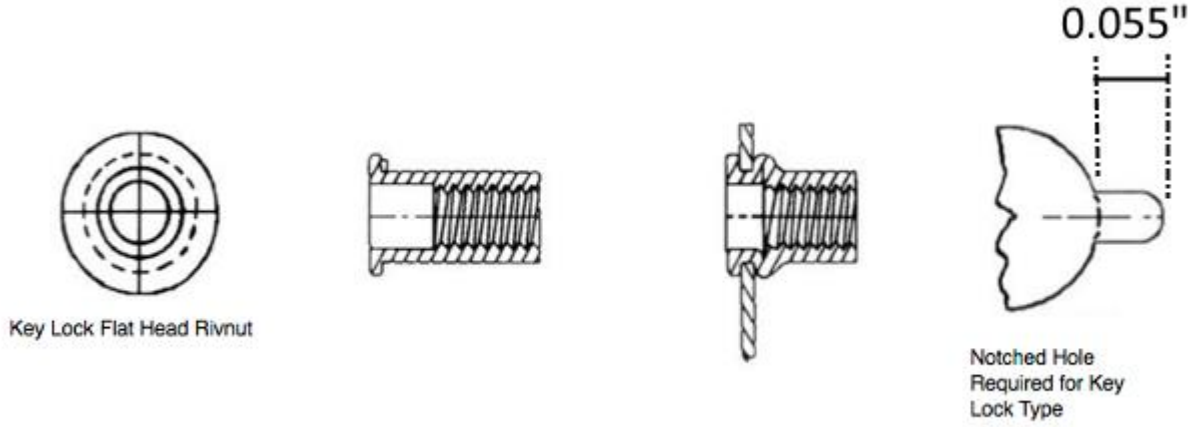


FIGURE 4-7 RIVNUT & KEY DIAGRAM

FIGURE 4-8 PITCH SERVO CAPSTAN CABLE REFERENCE

5.0 PRO PILOT INSTALLATION & WIRING

NOTE:

Prior to connecting the wiring harness DB9 or DB37 connectors into the servos or autopilot control head perform complete power, ground, and data pinout tests on the harness.

Reference the STC Group LLC Avionics Addendum for information not mentioned here.

5.1 SERVO WIRE HARNESSES INSTALLATION

5.1.1 Route Trio servo wire harnesses along same path and using the same clamps as factory autopilot wiring. If there was no previously installed autopilot, then use best practices for routing wires. Typically, the roll servo harness is routed from the control head down the left side of the fuselage and the pitch servo harness is routed along the right side of the fuselage with existing wire bundles ending two bays behind the baggage compartment.
5.1.2 Take care to protect harness pins at the end of the harnesses.
5.1.3 Terminate supplied DB9 connectors per latest revision Trio Wiring Diagram.
5.1.4 Install the DB9 connectors onto the servos.
5.1.5 Secure the harnesses, as necessary.

5.2 TRIO AUTOPILOT CONTROLLER

5.2.1 The Trio autopilot controller is ordered in Panel Mount or Instrument Mount versions. Refer to Figure 5-3.
5.2.2 The Trio autopilot controller will support 12 to 30 volt inputs.
5.2.3 Install the autopilot controller using best practices in either panel or instrument hole locations. Refer to AC 43-13 for this step and all following steps.
5.2.4 Utilize Trio Wiring Diagram for the following steps. Refer to Appendix A.
5.2.5 Install Klixon 7274-2-5 (or equivalent) 5 ampere circuit breaker within easy reach of the pilot and label.
5.2.6 If installing a Panel Mount unit then install the supplied power switch and label.
5.2.7 Install the supplied Red Disconnect button on the left side of the pilots control yoke and label “AP DSC” “PCS” or “Autopilot Disconnect.”
5.2.8 Install the supplied Recover button (Black) in an available convenient location within easy reach of the pilot and label AP Recover.
5.2.9 Install Limitation Placard in plain view of Pilot.

5.3 PITOT AND STATIC PORTS

5.3.1 The Trio Pro Pilot autopilot controller is provisioned with Pitot and Static ports on the rear of the controller.
5.3.2 The controller pitot and static ports must be integrated (plumbed) into the aircraft pitot and static systems.

5.3.3 Every aircraft pitot and static system is different. The following are for example only as the aircraft systems will vary.

5.3.4 The following components, or equivalent, will be used in most installations:
Tygon tubing. 2 each x 24" pieces. Aircraft Spruce P/N: 05-00944.
Nylo Seal tubing. 2 each x 6" pieces. Aircraft Spruce P/N: 44-P
Nylo Seal "T" fittings. 2 each. Aircraft Spruce P/N: 264-N04.
Nylo Seal Inserts. 8 each. Aircraft Spruce P/N: 259-N04.

5.3.5 Extend the pitot & static hoses & cable connector through the tray (if applicable) and out through the front of the instrument panel or radio rack to allow for ease of servicing.

5.3.6 Mate the pitot and static hoses to the control head.

5.3.7 Secure pitot and static connections at the rear of the autopilot controller.

5.3.8 Mate the DB37 connector to the control head using the screws provided.

5.3.9 If using an Instrument mount control head secure the control head using #6 brass instrument screws.

5.3.10 For the instrument type controller mounting screws, the maximum screw length should not be more than the panel thickness plus 0.25". Installing longer screws may cause damage to the controller mounting inserts.

5.3.11 If using a Panel mount control head slide the control head into the tray, then tighten the securing 1.5mm allen screw. Do not over tighten control head in the tray.

5.3.12 It is required that pitot and static system leak tests and inspections be performed after autopilot installation. Refer to your local authorities' regulations. {i.e. FAR §43 Appendix E, Paragraph (a)}

5.4 TRIO AUTOPILOT DATA CONNECTIONS

5.4.1 For most RS-232 connections, set the output of the GPS unit to "Aviation w/ no altitude" or NMEA 0183 OUT.

NOTE:

1) The RS-232 connection is required in all installations.

2) For Avidyne IFD Series GPS Navigators use "Aviation" format.

5.4.2 If your aircraft is equipped with a GPS that has ARINC 429, set unit to output "GAMA" Low or High Speed.

5.4.3 Prior to making the connections to the GPS unit in the aircraft determine what else is connected.

5.4.4 It may be necessary to parallel the connections.

5.4.5 If parallel connections are required, verify that the lines you are paralleling use, or can use, the same data format that is required.

5.4.6 Both the RS-232 and the ARINC 429 can be paralleled with like connections.

5.4.7 Ensure that the analog alarm output is connected to the un-switched audio input on the Audio Panel.

FIGURE 5-1 MAINTENANCE SETTINGS

FIGURE 5-2 PITCH SERVO EXAMPLE

INSTRUMENT MOUNT CONTROLLER 3.125"

PANEL MOUNT CONTROLLER 6" X 2" X 4"

FIGURE 5-3 CONTROLLER TYPES

5.5 TRIO INITIAL SETUP AND CHECKS

5.5.1 Refer to the STC Group Avionics Addendum for initial checks and setup of the autopilot installation.

5.5.2 Complete applicable portions of the STC Group Post Installation Flight Checks Document No. F-1006-43.

5.5.3 Individual aircraft may require fine tuning of servo gains on the first few flights. The following rough gain sets are a common starting point for Piper PA-24 aircraft:

SET SERVO GAINS
HNAV=16 VNAV=20

NOTE:

Gains are not to be changed by the aircraft owner / operator / pilot without contacting Trio Avionics or The STC Group LLC in advance for guidance.
The procedures for “fine tuning” gains are in the Avionics Addendum available on The STC Group LLC website: www.thestcgroupllc.com/documents.

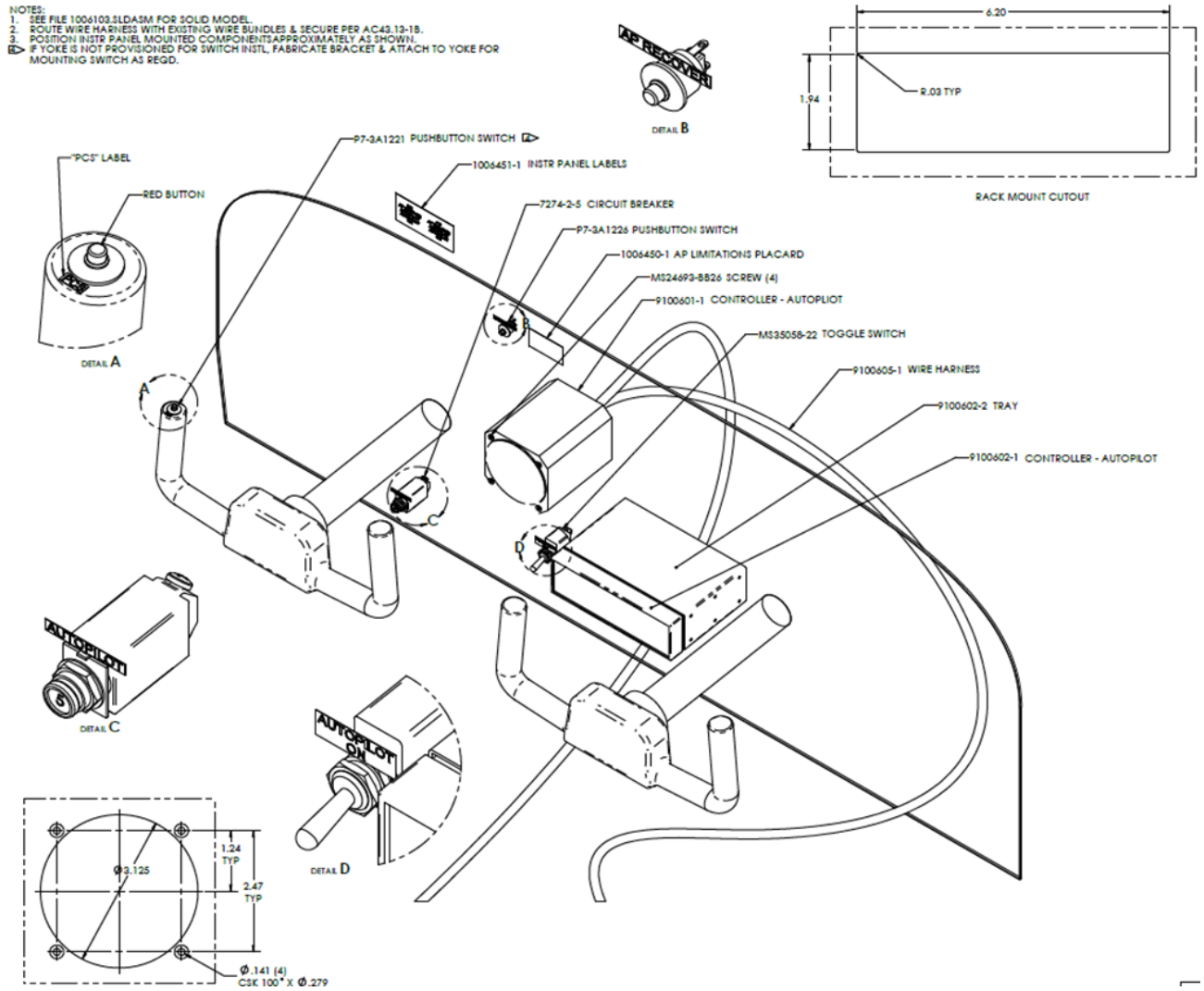


FIGURE 5-4 TYPICAL COCKPIT INSTALLATION

6.0 CLOSEUP

6.1 Install all items removed in Sections 3.3 through 3.5 of this document.

6.2 It is required that pitot and static system leak tests and inspections be performed after autopilot installation. Refer to your local authorities' regulations. {i.e. FAR §43 Appendix E, Paragraph (a)}

6.3 Amend the Weight & Balance and Equipment List.

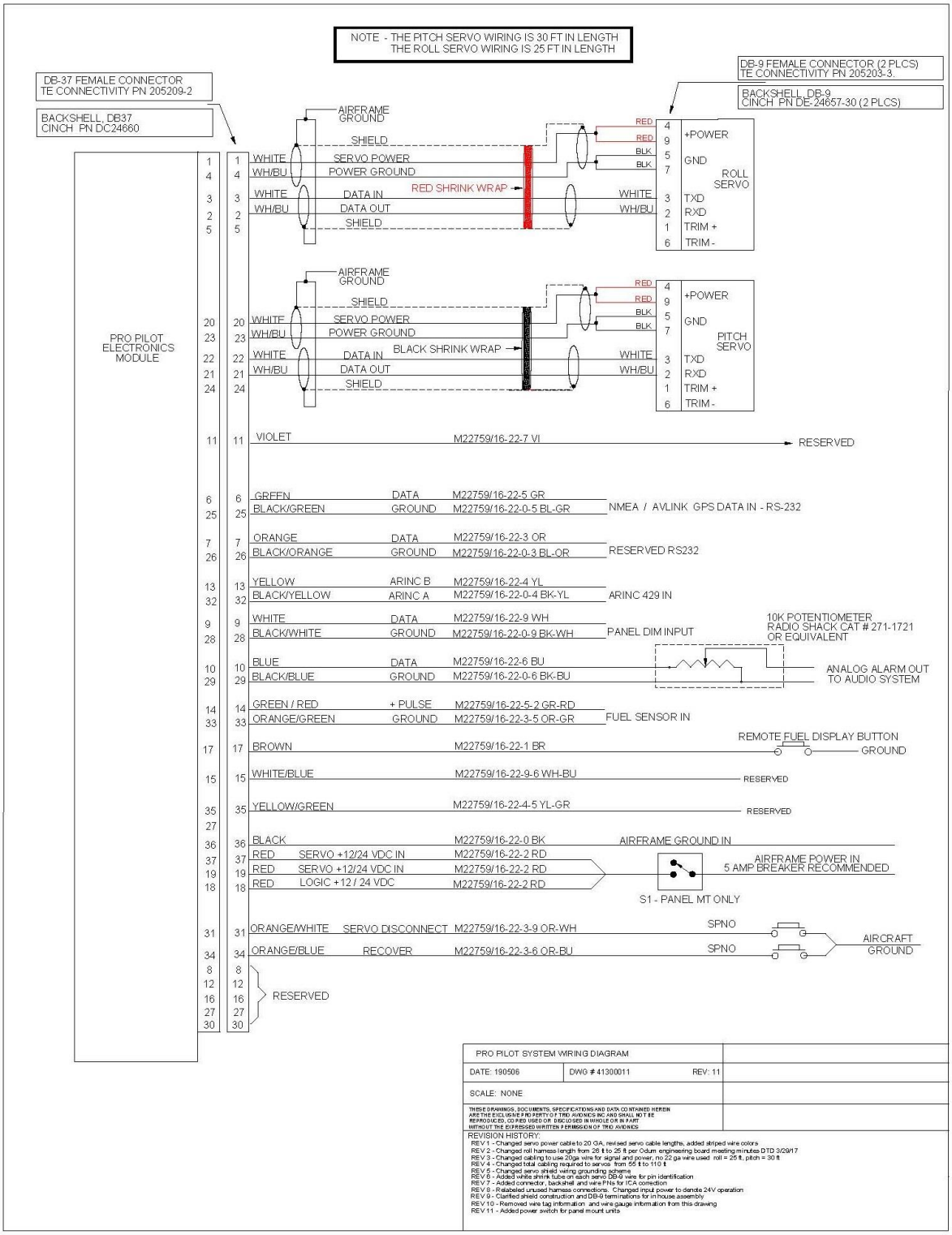
6.4 Install FAA Approved Aircraft Flight Manual Supplement into the AFM, POH, or applicable flight manual for the aircraft.

6.5 Complete all logbook entries as required to return the aircraft to service.

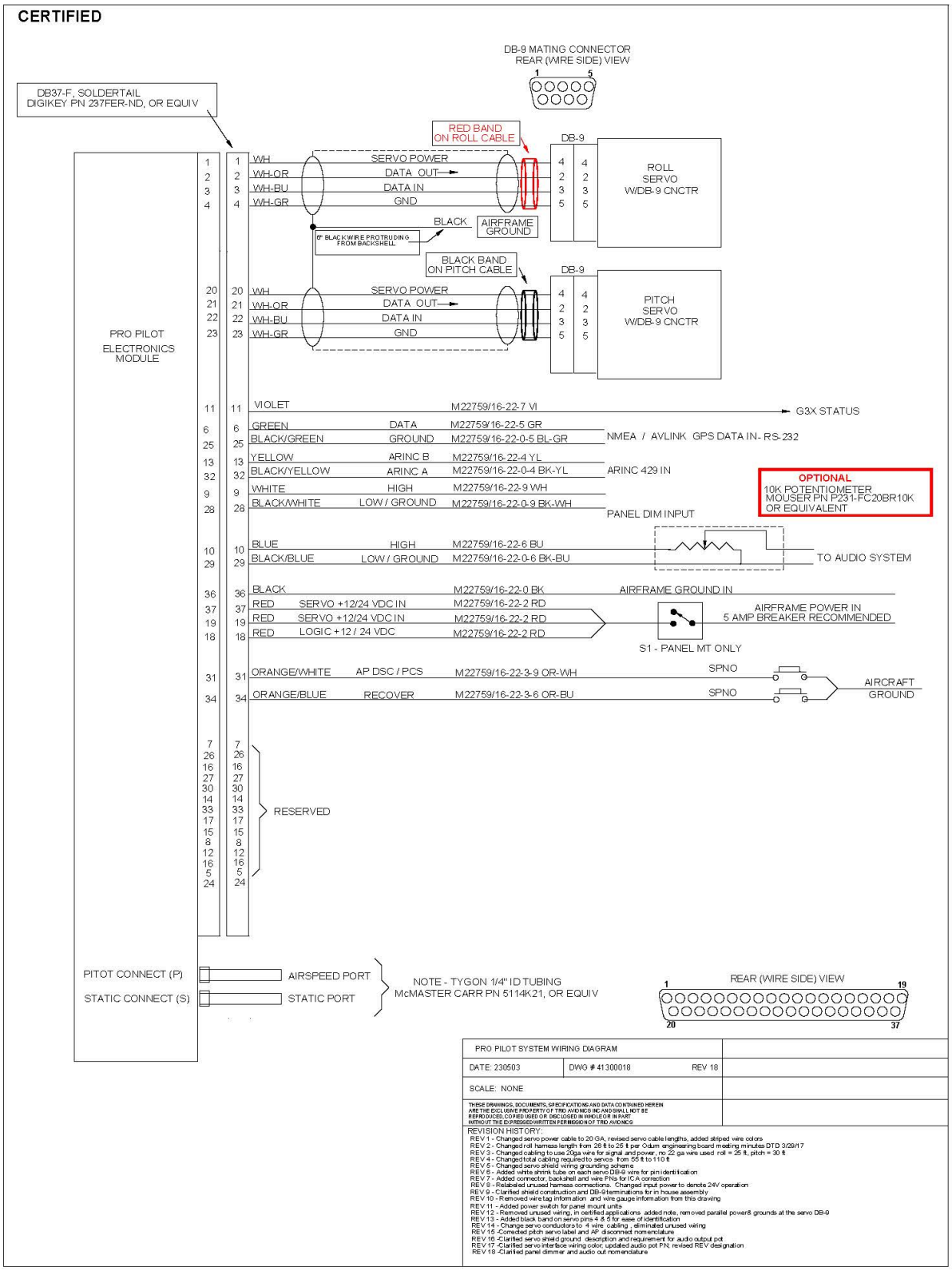
6.6 Submit applicable paperwork in accordance with local authority regulations. (i.e. FAA Form 337)

APPENDIX A PRO PILOT SYSTEM WIRING DIAGRAM

ORIGINAL WIRING DIAGRAM



NEW WIRING DIAGRAM (CURRENT DIAGRAM SHIPPED WITH HARNESS)



APPENDIX B RECOMMENDED INSTALLATION TOOLS

Cleco P Series Temporary Fasteners

QTY	PART NUMBER	DIAMETER	COLOR CODE	GRIP	DRILL SIZE	PRICE EACH
	20-101	3/32	Zinc	0-1/4	#40	$0.50
	20-102	1/8	Copper	0-1/4	#30	$0.50
	20-103	5/32	Black	0-1/4	#21	$0.50

Rivnut Pullers