



SkyView

Autopilot In-Flight Tuning Guide

This product is not approved for installation in type certificated aircraft

Document 102064-000, Revision B

For use with firmware version 10.0

March, 2014

Copyright © 2009-2014 by Dynon Avionics, Inc.

Permission to print this this manual is granted to third parties



Copyright

©2008-2014 Dynon Avionics, Inc. All rights reserved. No part of this manual may be reproduced, copied, transmitted, disseminated or stored in any storage medium, for any purpose without the express written permission of Dynon Avionics. Dynon Avionics hereby grants permission to download a single copy of this manual and of any revision to this manual onto a hard drive or other electronic storage medium to be viewed for personal use, provided that such electronic or printed copy of this manual or revision must contain the complete text of this copyright notice and provided further that any unauthorized commercial distribution of this manual or any revision hereto is strictly prohibited.

Information in this document is subject to change without notice. Dynon Avionics reserves the right to change or improve its products and to make changes in the content without obligation to notify any person or organization of such changes. Visit the Dynon Avionics website (www.dynonavionics.com) for current updates and supplemental information concerning the use and operation of this and other Dynon Avionics products.

Revision History

Revision	Revision Date	Description
A	June 2013	Initial release
B	March 2014	Updated for SkyView v10.0: - Added BANK ANGLE LIMIT - Mention of SV-AP-PANEL only active in EXPERT mode

Table 1–SkyView Autopilot In-Flight Tuning Guide Revision History

Table of Contents

Copyright	ii
Revision History	ii
1. Overview	1-1
Purpose.....	1-1
Things to Look For	1-2
Resetting Autopilot Defaults	1-2
2. Flight Test Preparation	2-1
Overview.....	2-1
Disconnecting the Autopilot	2-1
Accessing Autopilot Setup	2-1
3. Roll Axis – TRK and Turns Procedure	3-1
Overview.....	3-1
Flowchart	3-2
BANK ANGLE LIMIT	3-3
4. Pitch Axis – IAS Hold Procedure	4-1
Overview.....	4-1
Flowchart	4-2
5. Pitch Axis – Altitude Hold and Capture Procedure	5-1
Overview.....	5-1
Flowchart	5-2
6. Turbulence Tuning Procedure	6-1
Overview.....	6-1
Flowchart	6-2



7. Roll Troubleshooting	7-1
Roll Troubleshooting Procedure	7-1
Roll Performance Troubleshooting Procedure	7-2
Appendix A: Autopilot Settings –Defaults	8-1

1. Overview

Purpose

The goal of the AP tuning procedure is to maximize the performance of the Autopilot in your aircraft. The steps described accomplish this systematically and reduce guesswork, so follow them carefully.

All procedures in this guide should be exercised regardless of how the autopilot is intended to be used in the aircraft. In particular, if you are using the vertical navigation features of the autopilot, pay special attention to the IAS Hold tuning procedure. Tuning this well will give the best results when using vertical guidance.

Once IAS hold is well tuned, the AP will be able to get the best performance during normal climbs and descents in either expert or simplified modes, and the altitude capture and hold procedure should be used to finalize vertical performance.

Once you have configured the autopilot to capture and hold airspeeds and altitudes, you may wish to adjust the ride quality in turbulence, particularly on the glideslope.

Similarly, the Roll Axis TRK and Turns Procedure will ensure best performance both in normal turns and when following lateral guidance on approaches.



It is critical that once tuned, you familiarize yourself with AP procedures, and verify the performance of the autopilot on approaches in VMC before use in IMC.



Performance of the AP is degraded by excessive servo slippage. If during verification of approach performance you find that the servo is slipping, verify that you have the torque set to the maximum value, and if slips continue, contact Dynon for advice on servo sizing.



HDG mode performance is only as good as your compass calibration. If you have concerns about your compass, refer to the compass calibration guide in the SkyView System Installation Guide.



The SV-AP-PANEL is enabled when AP CONTROLS are set to EXPERT mode. For tuning procedures performed in SIMPLIFIED mode, the buttons on the SV-AP-PANEL will not be active.



Things to Look For

Most autopilot problems come down to two things: SLIP and SLOP. Be alert for the SLIP **PITCH SLIP** / **ROLL SLIP** indication on either axis. While either SLIP indications are being displayed NOBODY IS FLYING THE AIRPLANE. Resolve SLIP issues on either axis before proceeding, either by increasing torque, switching to a larger servo, or contacting Dynon for service.

Lost motion (SLOP) between the servo and the control surface will have a negative impact on performance. Verify that the control surface cannot move more than one degree (total motion) while the servo is holding position.

The Flight Director provides a valuable tool for evaluating the performance of the AP. If the autopilot is not able to keep up with Flight Director command bars, sensitivity should be increased. If the autopilot can keep up, but gets a late start and lags behind the flight director, PITCH GAIN or ROLL GAIN can be used to speed up response. Use sparingly! Excessive PITCH GAIN and ROLL GAIN can result in rough performance.

Resetting Autopilot Defaults

A final note on tuning the autopilot: Less is more. Before changing any settings, try each procedure and determine if performance is acceptable as-is; often you will have to make only minor changes. If you find that you've turned all the settings all the way up, you've probably gone too far. Stop and review the procedures, and then go back to the defaults and re-evaluate performance.

If you feel you need to reset the settings in the Autopilot Settings menu back to their defaults, see Appendix A: Autopilot Settings –Defaults for the default values.

2. Flight Test Preparation

Overview

The flight test should be conducted on a clear, VFR day. Before commencing the flight test, ensure that you have adequate altitude, clear weather, no traffic, no obstructions in the flight path, great visibility, no airspace conflicts, etc. It is recommended that clearing turns be performed before executing each procedure.



It is highly recommended that you bring someone along on the first autopilot test flight. At many points, the pilot's attention will be divided between documentation, configuring SkyView, and maintaining situational awareness.

Disconnecting the Autopilot

If autopilot behavior, performance, or interference with the controls is cause for concern while flying, remember that the autopilot can be disconnected the following ways:

- Press the Autopilot servo Disconnect button
- Within the Simplified AP Controls: Press the OFF button
- Within the Expert AP Controls: Press the AP button
- On the SV-AP-PANEL Autopilot Control Panel, push the AP button (if SV-AP-PANEL is enabled – AUTOPILOT CONTROL set to EXPERT)
- Pull the autopilot circuit breaker or remove the autopilot fuse

Accessing Autopilot Setup

In the following instructions, the setup menus for Autopilot tuning are accessed by

Pushing Buttons 7+8

Then, select AUTOPILOT SETUP (and click the knob to the right, once). You will then be in AUTOPILOT SETUP.

3. Roll Axis – TRK and Turns Procedure

Overview

This procedure tunes the roll autopilot servo and thus, the flight characteristics of the aircraft in heading holds and turns. This procedure should be performed with the autopilot roll axis in track (TRK+ALT) mode, where the purpose of the autopilot is to keep the aircraft's GPS ground track aligned with the track bug (as well as hold altitude). Before executing this procedure:



The autopilot controls should be changed to SIMPLIFIED mode (SETUP MENU > AUTOPILOT SETUP > AUTOPILOT CONTROLS)

The Roll Axis tuning process can be summarized as follows:

Change TRK command by approximately 90 degrees, and observe the results. The AP should promptly roll into a turn towards the new TRK and smoothly reach the commanded TRK with little or no overshoot.



Note: be sure to observe ground track (TRK) and not heading (HDG) during this procedure.

If the AP is slow to respond to the TRK changes, increase the ROLL AXIS SENSITIVITY and watch for improvement. In some cases this may require a fair amount of increase, but be cautious about changing it too quickly. Sensitivity adjustments alone may not completely eliminate overshoot. If increasing sensitivity no longer improves performance, ROLL GAIN may be used to fine tune the roll axis. Too much sensitivity may cause AP responses to be "twitchy". Reduce ROLL SENSITIVITY if this occurs. Too much ROLL GAIN will result in a rough ride.

In particular, if the autopilot cannot keep up with the flight director roll command bar, ROLL SENSITIVITY should be increased. At some point the AP will track the command bars, but follow behind them. ROLL GAIN will reduce the gap.



Caution: Large changes in ROLL SENSITIVITY with the autopilot engaged can result in large servo movements.



Flowchart

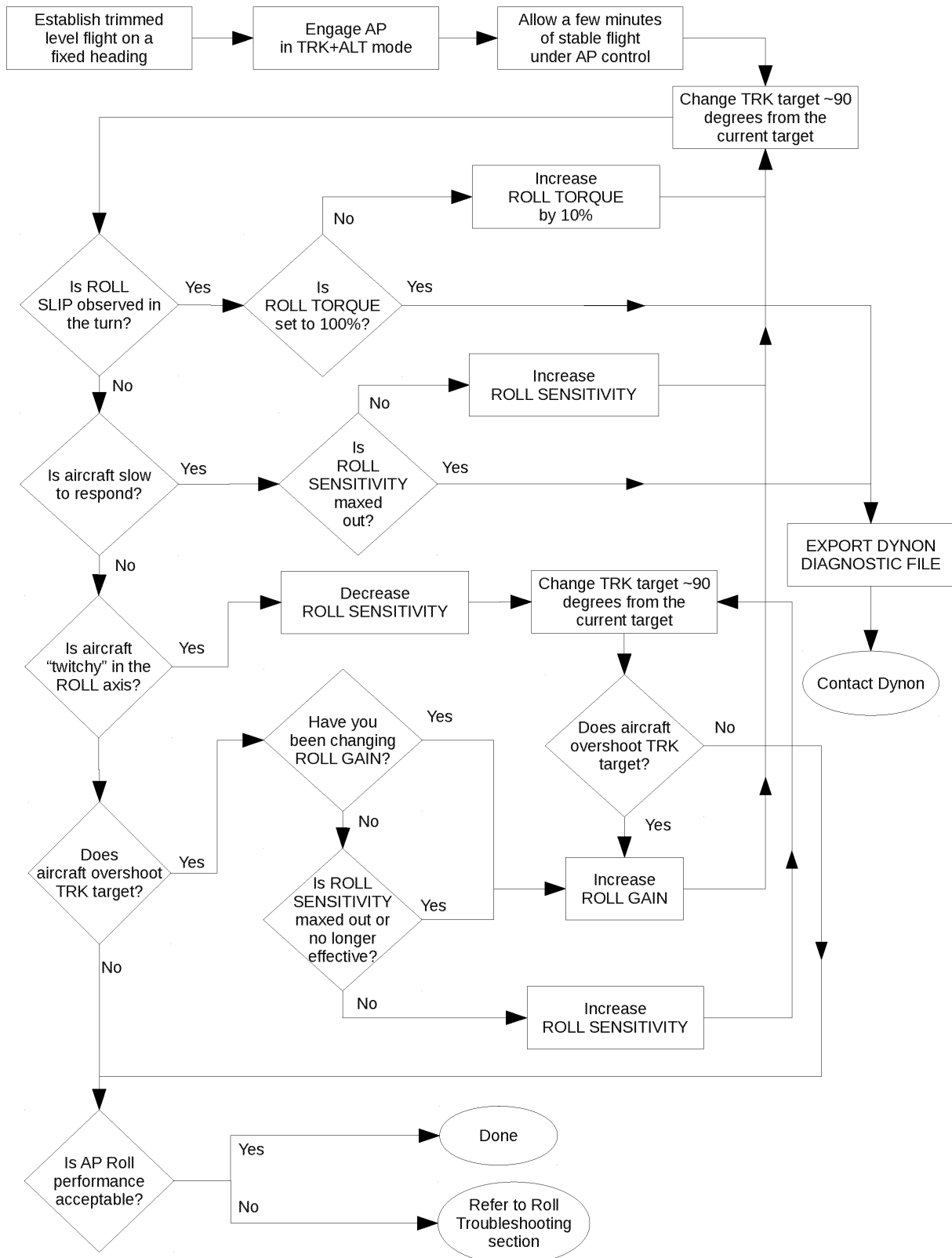


Figure 1 – Roll Axis – TRK and Turns Procedure

BANK ANGLE LIMIT

After Roll Axis tuning is complete, BANK ANGLE LIMIT should be set to a value that results in a bank angle in AP that is comfortable for your plane and your preferences. A place to start is to set BANK ANGLE LIMIT to a value that yields a standard rate turn at typical cruise speed.

The default BANK ANGLE LIMIT is 30°.



The SkyView AP will always obey BANK ANGLE LIMIT. However, if BANK ANGLE LIMIT is set too low (such as 5°), the SkyView AP will be unable to turn.

4. Pitch Axis – IAS Hold Procedure

Overview

The goal of tuning IAS Hold is to give the AP the best possible pitch axis performance. Crisp speed control is a prerequisite for good altitude and glideslope control. Although IAS hold is only available in EXPERT mode, tuning will benefit SIMPLIFIED mode greatly, so even if you don't intend to use EXPERT mode, this procedure is essential for good performance.

The procedure which follows can be used both for initial tuning and for troubleshooting problems which may arise in your system. Like any checklist or procedure, be sure to follow each step.



The autopilot controls should be changed to EXPERT mode (SETUP MENU > AUTOPILOT SETUP > AUTOPILOT CONTROLS)



The ALT bug should be set to an altitude many thousands of feet above or below the intended flight testing altitude. This is to keep the autopilot in IAS Hold mode throughout the procedure, and prevent the autopilot from capturing the target altitude.

The Pitch Axis IAS Hold tuning process can be summarized as follows:

Increase or decrease airspeed command by 10 knots, and observe the results. The AP should promptly change pitch to change speed, and smoothly reach the commanded speed with little or no overshoot (above the target if increasing; below the target if decreasing).

If the AP is slow to respond to the airspeed changes, increase the PITCH SENSITIVITY and watch for improvement. In some cases this may require a fair amount of increase, but be cautious about changing too quickly. Sensitivity adjustments alone may not completely eliminate overshoot. If increasing sensitivity no longer improves performance, PITCH GAIN may be used to fine tune IAS Hold. Too much sensitivity may cause AP responses to be "twitchy". Reduce PITCH SENSITIVITY if this occurs. Too much PITCH GAIN will result in a rough ride.

In particular, if the autopilot cannot keep up with the flight director pitch command bar, PITCH SENSITIVITY should be increased. At some point the AP will track the command bars, but follow behind them. PITCH GAIN will reduce the gap.



Caution: Large changes in PITCH SENSITIVITY with the autopilot engaged can result in large servo movements.



Flowchart

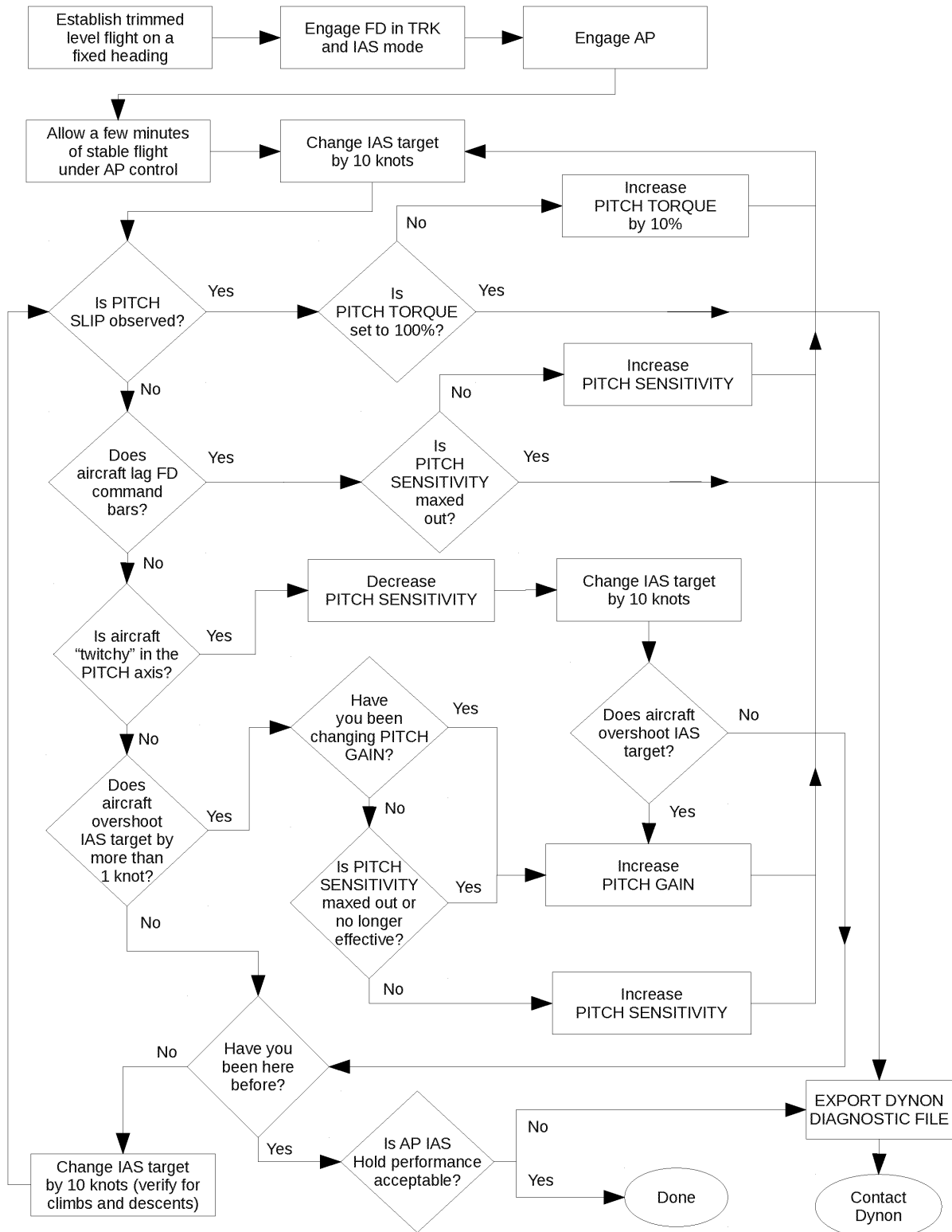


Figure 2 – Pitch Axis – IAS Hold Procedure

5. Pitch Axis – Altitude Hold and Capture Procedure

Overview

Both holding and capturing altitude are related but distinct parts of the autopilot. The Altitude Hold Procedure which follows will address common problems, and once those are resolved, direct you to the Altitude Capture Procedure, which will tune your system to capture and hold vertical speed and capture altitude targets without overshoot.



You must complete the IAS HOLD tuning procedure before performing this procedure.



The autopilot controls should be changed to SIMPLIFIED mode (SETUP MENU > AUTOPILOT SETUP > AUTOPILOT CONTROLS)



Flowchart

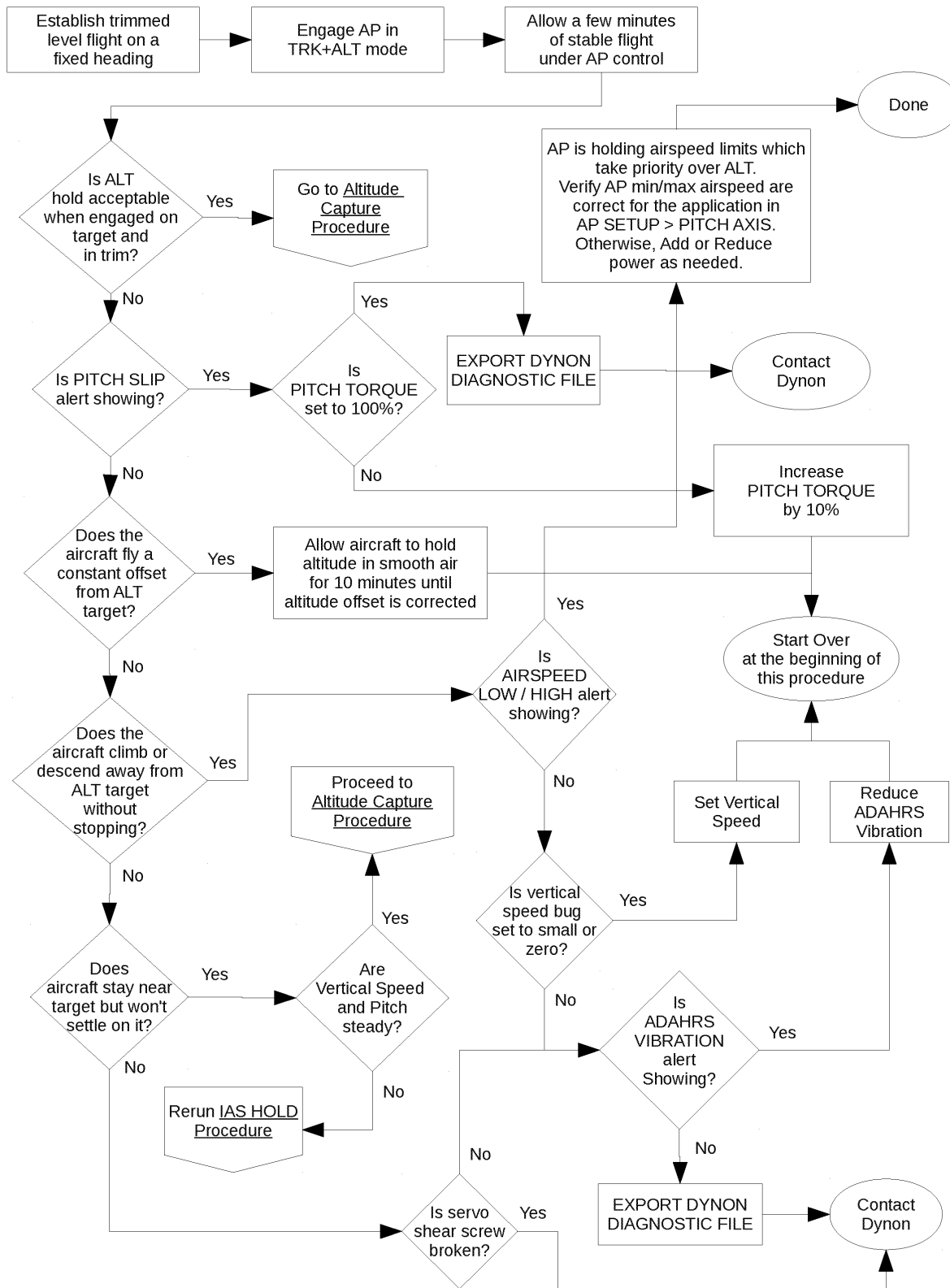


Figure 3 – Pitch Axis – Altitude Hold Procedure

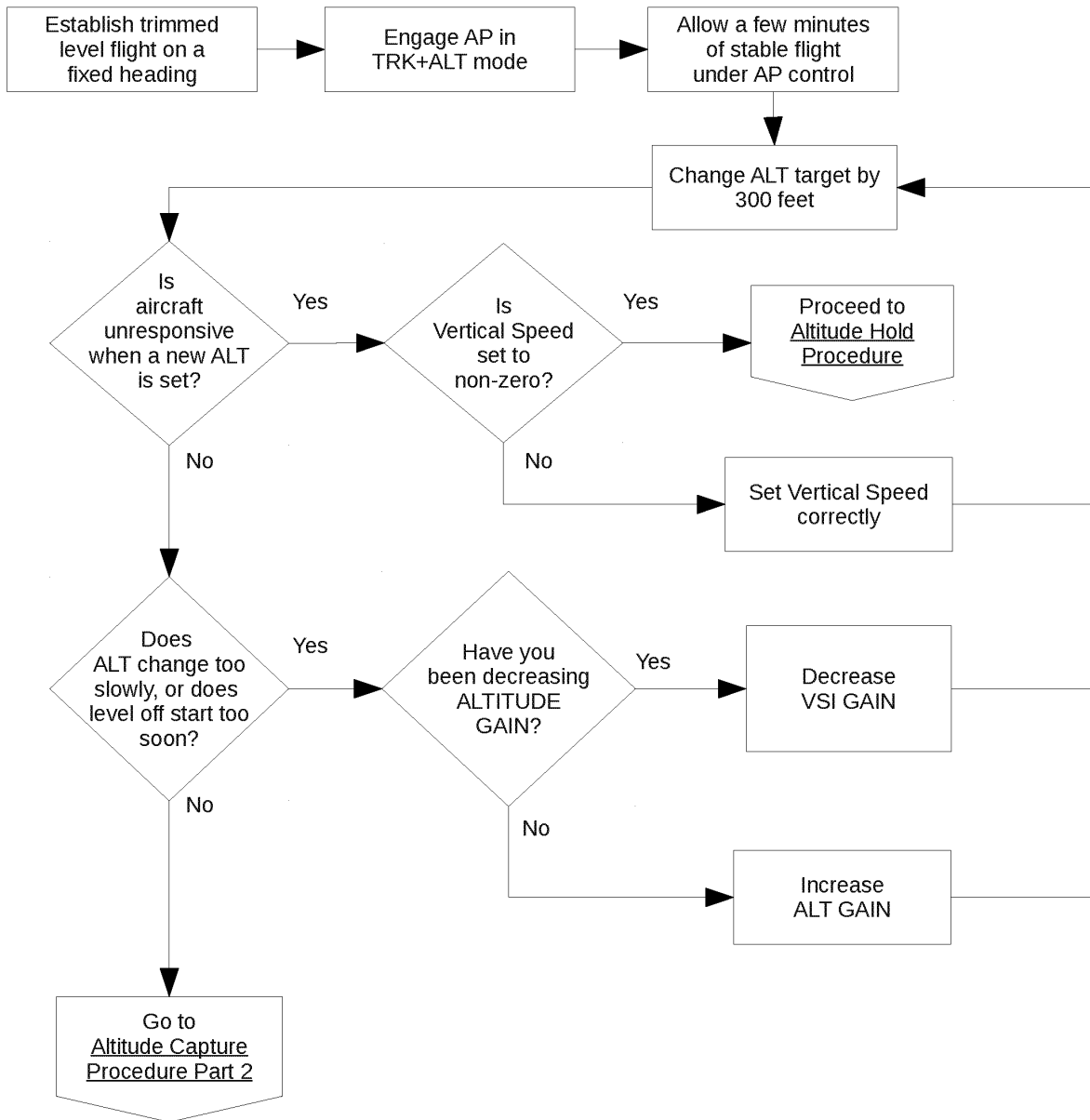


Figure 4 – Altitude Capture Procedure (Part 1 of 2)

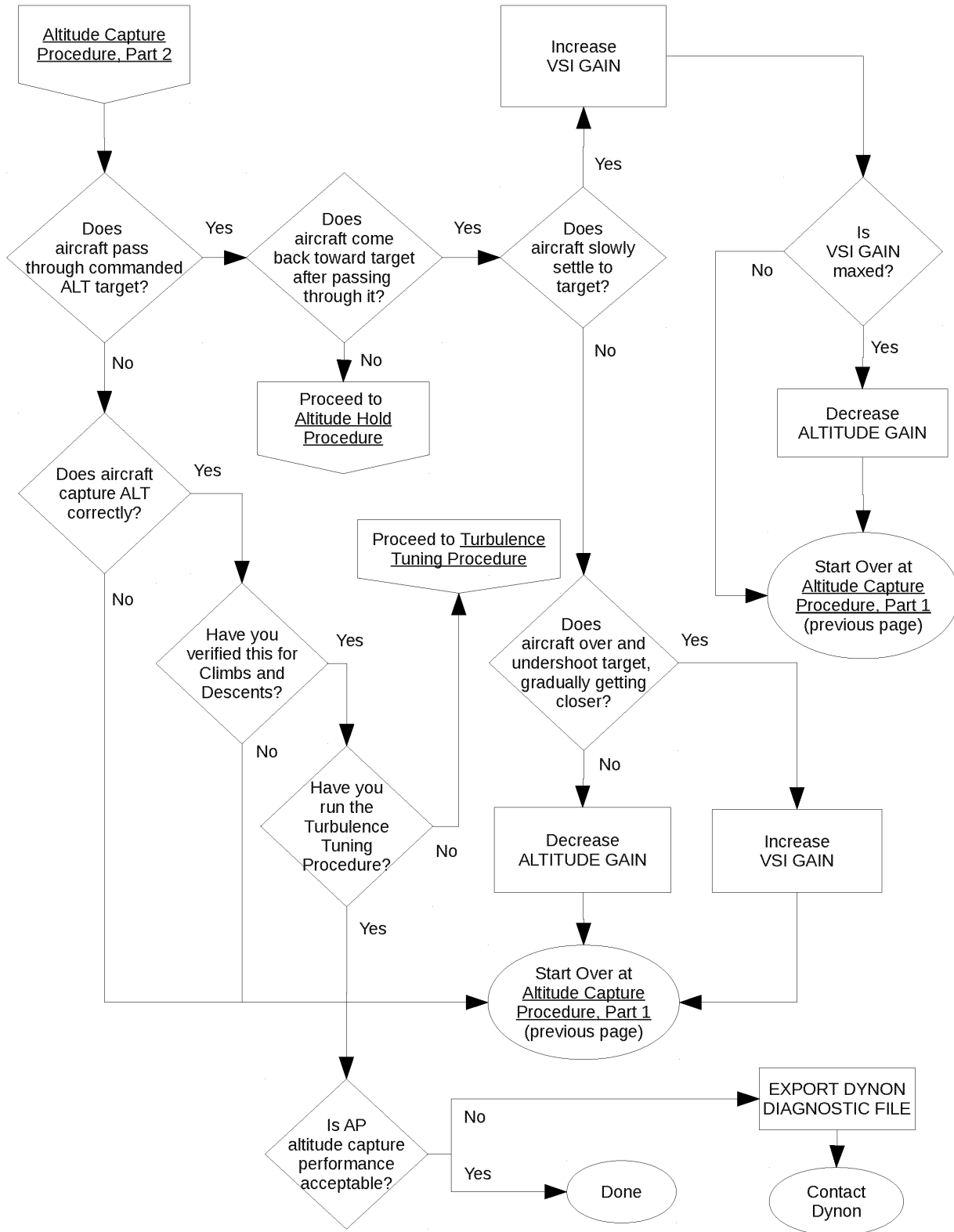


Figure 5 – Altitude Capture Procedure (Part 2 of 2)

6. Turbulence Tuning Procedure

Overview

Once you have configured your autopilot to capture and hold airspeeds and altitudes, you may wish to adjust the ride quality in turbulence, particularly on the glideslope.

In general, the autopilot will attempt to maintain a constant G-loading through bumps by pulling or pushing G to oppose G generated by "air pockets". The amount of G the autopilot will apply is limited by G ERROR LIMIT. If, for example, you encounter a 0.5 G updraft, and G ERROR LIMIT is set to 0.25, the most the AP can do to attenuate the bump is reduce it by 0.25 G.

The amount the autopilot will apply up to that limit is determined by G ERROR GAIN. If this is set to 1, for every 1/10 G the airplane is bumped, the AP will apply 1/10 of a G. Increasing G ERROR GAIN will make response more rapid, but also more abrupt, so use this setting with care.



Flowchart

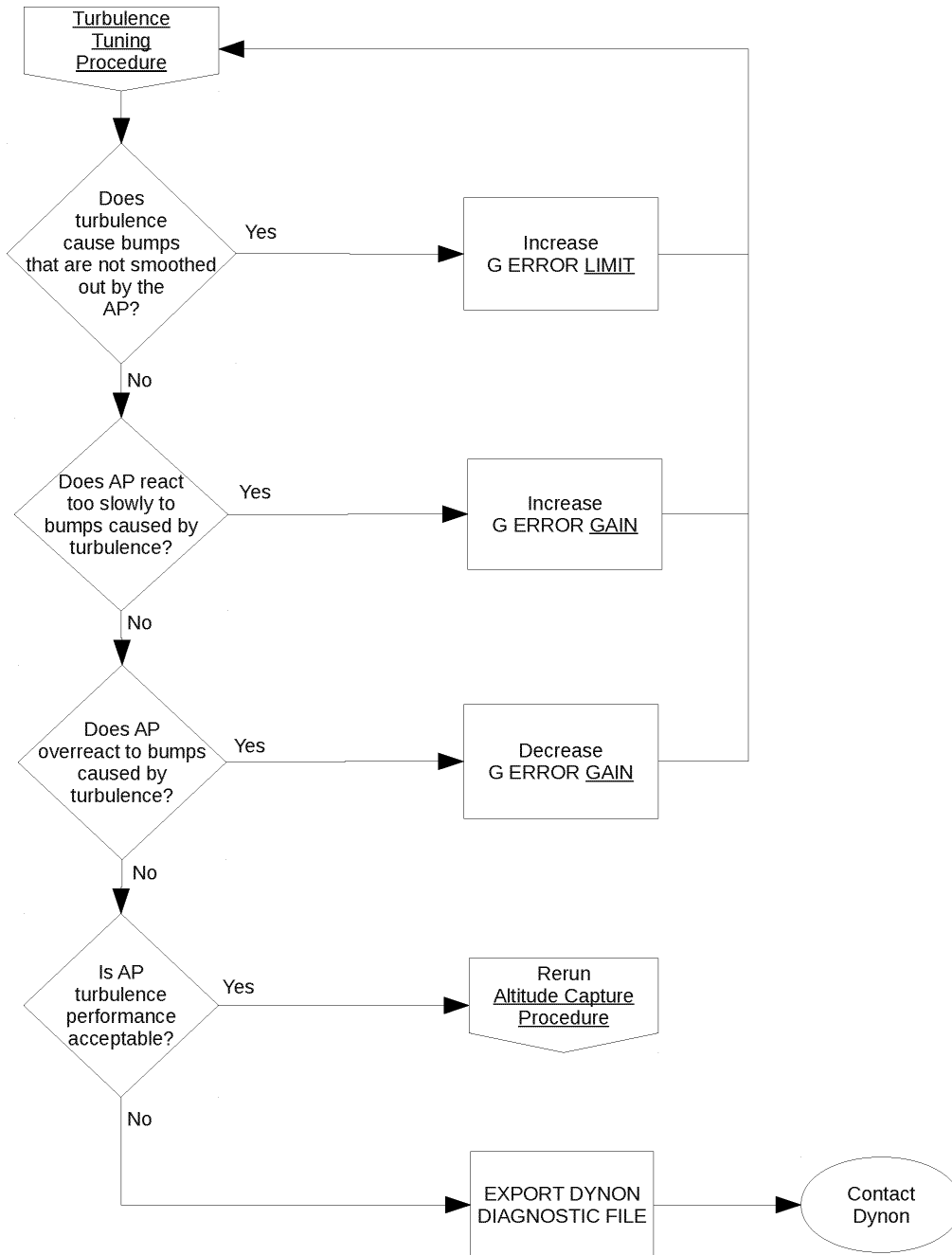


Figure 6 – Turbulence Tuning Procedure

7. Roll Troubleshooting

Roll Troubleshooting Procedure

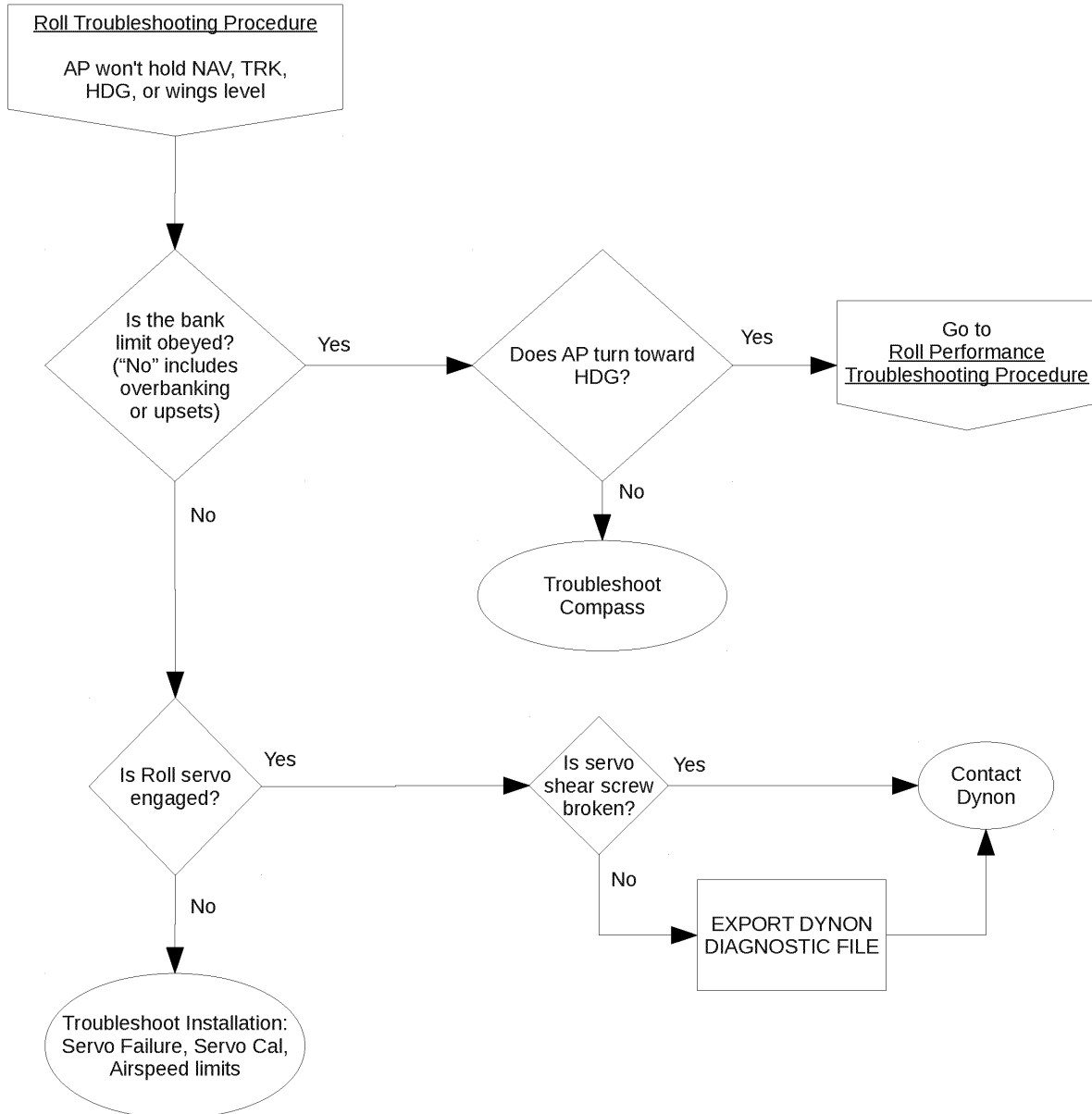


Figure 7 – Roll Axis – Roll Troubleshooting Procedure



Roll Performance Troubleshooting Procedure

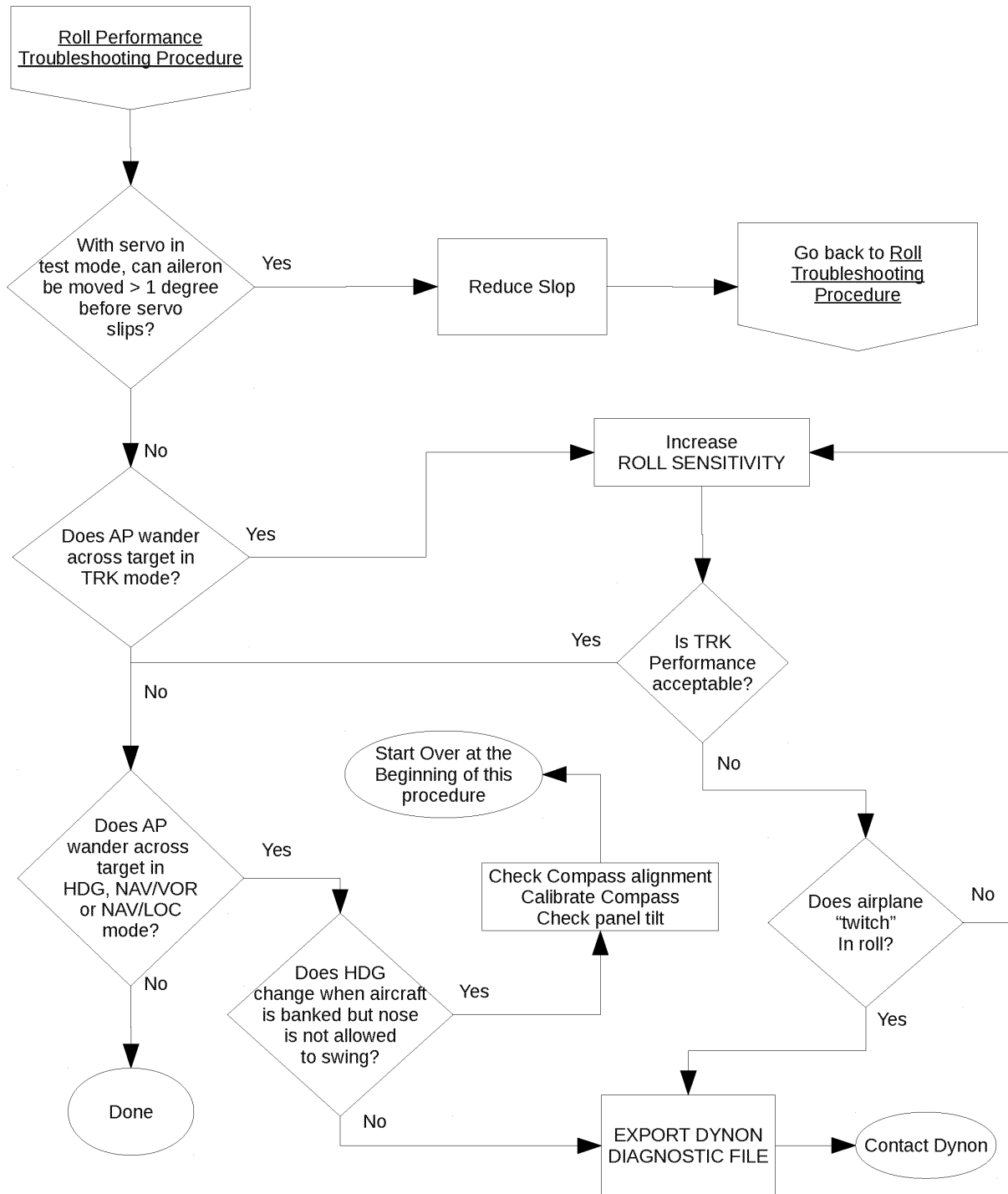


Figure 8 – Roll Axis – Roll Performance Troubleshooting Procedure

Appendix A: Autopilot Settings –Defaults

ROLL Axis Setting	Minimum	Maximum	Default
TORQUE	10%	100%	100%
SENSITIVITY	1	24	10
ROLL GAIN	0.0	5.0	0.0
BANK ANGLE LIMIT	5	45	30

PITCH Axis Setting	Minimum	Maximum	Default
TORQUE	10%	100%	100%
SENSITIVITY	1	24	10
PITCH GAIN	0.1	3.0	2.0
ALTITUDE GAIN	0.1	2.5	0.6
PULL RATE	1.0	2.0	1.0
VSI GAIN	0.10	2.50	0.6
G ERROR GAIN	0.0	4.0	1.0
G ERROR LIMIT	0.10	1.00	0.25
DEFAULT CLIMB VERT SPD	100 ft/min	3000 ft/min	500 ft/min
DEFAULT DESCENT VERT SPD	100 ft/min	3000 ft/min	500 ft/min
MAXIMUM AIRSPEED	1.30 * Vs1	0.95 * Vne	0.95 * Vne
MINIMUM AIRSPEED	1.30 * Vs1	0.95 * Vne	1.30 * Vs1