



GRC-4000

GENESYS ROTORCRAFT CONTROLS
4-AXIS AUTOPILOT
PILOT GUIDE

Precise Performance.
Proven Experience.
Personalized Attention.



Pilot Operating Guide and Reference

Genesys Rotorcraft Controls
4-Axis Autopilot (GRC-4000)

Doc No 64-000135

This pilot guide provides additional system information for the GRC-4000. It can only be used in conjunction with the Federal Aviation Administration (FAA) approved Rotorcraft Flight Manual (RFM) or Rotorcraft Flight Manual Supplement (RFMS). Refer to the applicable RFM or RFMS for aircraft specific information, such as unique ground tests, limitations, and emergency procedures.

©2024 Genesys Aerosystems. All Rights Reserved.

Information contained in this document is subject to change without notice. No part of this document may be reproduced in any form, or by any means, without prior written consent of Genesys Aerosystems.

Printed in the United States of America. Genesys Aerosystems and S-TEC logo are registered trademarks of Genesys Aerosystems. All other brand names and trademarks are the property of their respective holders.

For service or repairs, contact an authorized Genesys Aerosystems dealer. For product support, contact Genesys Aerosystems.

One S-TEC Way, Municipal Airport, Mineral Wells TX 76067
Phone: (800) 872-7832
www.genesys-aerosystems.com

Revision Record

Revision Number	Revision Date	Notes/Pages changed, added, or deleted by current revision
1st Ed	Oct 2024	

Table of Contents

Section 1 System Description

1.1. Introduction	1-1
1.2. GRC-4000 Installation	1-2
1.3. Manual/Autotrim Annunciations (only applicable to non-hydraulically boosted helicopters)	1-6

Section 2 GRC-4000 Modes

2.1. SAS Mode	2-1
2.1.1. Recommended Technique with SAS	2-1
2.1.2. Closely Monitor the Controls	2-2
2.2. Heading (HDG) Mode	2-2
2.3. Altitude (ALT) Mode	2-3
2.4. Speed (SPD) Mode	2-4
2.5. Navigation (NAV) Mode	2-5
2.5.1. VOR (HDG is Not Active) Fixed Intercept Angle	2-6
2.5.2. VOR Selected Intercept Angle	2-7
2.5.3. Navigation (NAV) Mode – GPS	2-7
2.5.3.1. GPS Preprogrammed Intercept Angle	2-7
2.5.3.2. GPS Selected Intercept Angle	2-7
2.5.4. NAV:HVR Mode	2-7
2.6. Glide Slope (GS) Mode	2-8
2.7. Go-Around	2-9
2.8. Level Mode	2-9
2.9. Terrain Avoidance Mode	2-10
2.10. Non-Control Panel Switch Functions	2-10

Section 3 Glossary

Section 1 System Description

1.1. INTRODUCTION

The Genesys Aerosystems Rotorcraft Controls (GRC-4000) 4-Axis Autopilot is an attitude-command-attitude-hold system which maintains aircraft attitude by applying corrective inputs to the cyclic control, along with inputs to the pedal and collective controls. Stability Augmentation System (SAS) mode maintains helicopter attitude in all flight conditions by applying corrective inputs to the cyclic control to maintain the commanded or reference attitude. Autopilot (AP) modes provide altitude-hold (ALT), heading-hold (HDG), navigation signal tracking (NAV), speed-hold (SPD), and glide slope (GS) guidance features. The GRC-4000 is a parallel, fly-through system. It does not interfere with the manual control system and only a small amount of force, by the pilot, is required to override the system. Only a small amount of force at the controls is required to override the system for maneuvering when engaged.



NOTE:

The following system description includes a primary system and a backup system, to include a backup control panel. Some installations may only include a primary system or have a backup system that provides SAS mode only (without backup control panel). With single collective and yaw servos, the backup system is 2-axis (cyclic control) only.

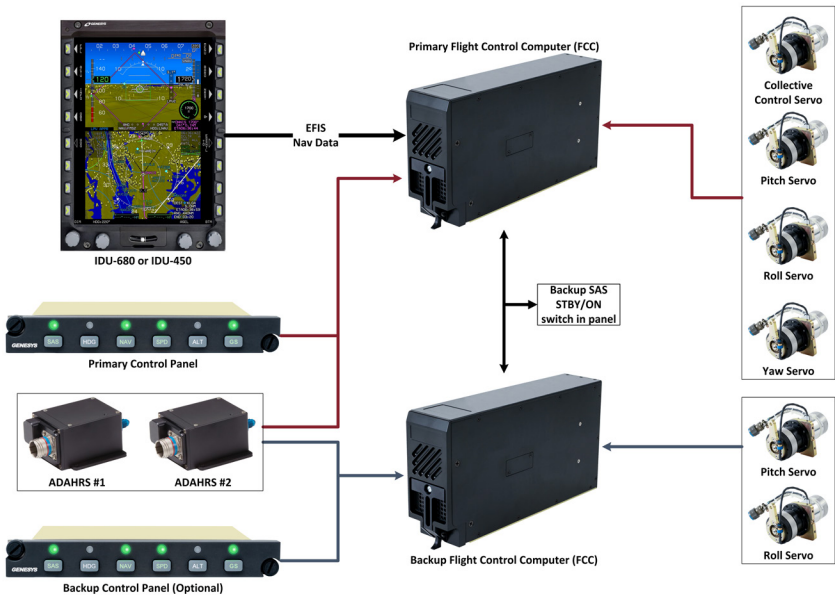


Figure 1-1: Typical GRC-4000 System Components

The GRC-4000 major components consist of six electromechanical servo-actuators (primary pitch, backup pitch, primary roll, backup roll, yaw and collective), two flight control computers (primary FCC and backup FCC), two control panels (primary control panel and backup control panel), a backup SAS switch/annunciator, a yaw damper switch/annunciator, (eight) cyclic and collective switches, servo (pitch, roll, yaw, and collective) installation, and the system interconnecting electrical cables (see Figure 1-1).

SAS/AP modes are selected and deselected by pushing buttons on the control panel (see Figure 1-2). White LEDs and EFIS annunciations indicate the system is in standby or the mode is armed. Green LEDs and EFIS annunciations indicate the system or mode is engaged.



Figure 1-2: Control Panel



NOTE:

Button references are for the primary control panel, unless otherwise noted.

1.2. GRC-4000 INSTALLATION

The GRC-4000 installation is a full autopilot interface to the Genesys Aerosystems (IDU-450 or IDU-680) EFIS displays including mode annunciations; trim annunciations; ALT and IAS pre-select; beep trim for HDG, ALT, AGL, IAS, and VS bugs; autopilot upper mode source selection (navigation source, heading source, approach source, etc.); and guidance signals driven via the digital data bus. Attitude and air data information is provided to the GRC-4000 from the Genesys Aerosystems Air Data Attitude Heading Reference System (ADAHRS).

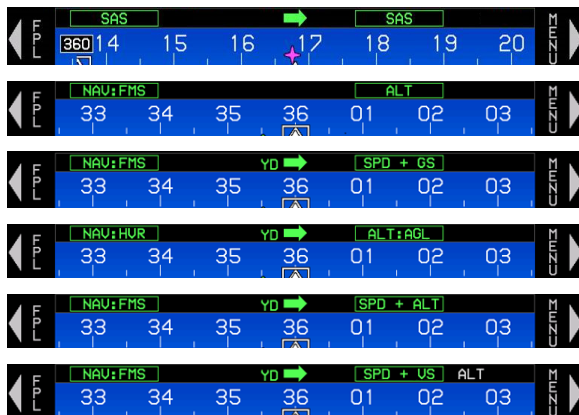


Figure 1-3: EFIS Annunciations (Examples)

When the system is engaged, the primary FCC senses aircraft attitude, heading, angular rates and linear accelerations using the ADAHRS plus sensors in the computer. The FCC sends signals to the pitch/roll servo-actuators to apply small corrections to the cyclic as required to maintain the commanded or reference attitude in SAS mode, to the pitch/roll/collective servo-actuators for AP modes, and to the yaw servo-actuator to provide yaw damper and turn coordination. AP modes provide altitude hold/acquire, heading hold, airspeed or vertical speed hold, navigation signal tracking, and vertical (approach) navigation features. Additionally, safety monitors automatically disengage the system if a malfunction is detected. System disconnect alerts are provided via an aural warning, voice alerts, LEDs on the control panels, and EFIS annunciations.

When power is applied to the avionics bus, the primary and backup systems accomplish a sequence of internal tests to verify proper system operation prior to allowing SAS and autopilot engagement. When the ADAHRS is aligned, the backup system automatically engages in SAS mode and serves to stabilize the cyclic during engine start. When ready to fly, press **SAS** or press the FTR switch on the cyclic to transfer to the primary SAS and place the backup system in standby mode (primary SAS LED and EFIS annunciations are green, backup SAS LED is white). The yaw damper is engaged automatically with primary SAS engagement. Primary system (4-axis) AP modes are available in hover/low speed flight (below 44 KIAS) and in forward flight (above 50 KIAS).

The FTR switch is used to either reset the trim pitch and roll attitude when in primary SAS mode, or to engage the system. It can also be used to resynchronize altitude or airspeed hold. A push of the FTR switch for at least 1.25 seconds engages the primary system (a hands-on-controls alternate to pushing the control panel button).

**NOTE:**

For system interfaces with a shared FTR switch (UH60), the GRC may be configured to utilize the AP DISC switch. Push the AP DISC for at least 1.25 seconds to engage SAS mode.

In primary SAS mode, a momentary push of the FTR switch resets trim to the attitude at which the switch is released. The system does not trim to attitudes greater than 15° in pitch, or 20° in roll. Pitch and Roll attitudes are with respect to the zero reference of the attitude indicator. In backup SAS/AP modes, the FTR switch does not function unless both the primary system and the beep trim switch are not operational.

To disengage the yaw damper, momentarily press the yaw cut off switch. Yaw damper disengagement is accompanied by four 600 Hz beeps. To engage the yaw damper, push the YDR switch for 1.25 seconds.

To disengage all autopilot modes but keep SAS engaged, push the AP DISC switch on for less than 1.25 seconds. To disengage both the autopilot and SAS, push the AP DISC switch again (or push for more than 1.25 seconds). The primary system becomes mechanically disconnected from the flight

control system. SAS disengagement is accompanied by four 600 Hz beeps for two seconds. Un-commanded AP mode disengagement is accompanied by a single 600 Hz beep for one second. The AP DISC switch drops AP modes of the backup system but does not disconnect the backup system itself. In both the primary and backup SAS modes, use the beep trim switch (four-way momentary switch) to proportionally modify the trim pitch and roll target attitudes. The EFIS displays green UP/DN/LT/RT annunciations of beep trim inputs. The maximum trim attitudes are the same as the FTR switch.

In primary autopilot modes, use the beep trim and collective beep switches to adjust the HDG, ALT, AGL, VS, and IAS EFIS targets (bugs) for the system. In backup autopilot modes, only the beep trim switch is available.

- In HDG mode, move the beep trim switch left or right to change the EFIS heading bug in the same manner as using the right knob on the Primary Flight Display (PFD) or the HDG knob on the Remote Bugs Panel (RBP).
- In NAV:HVR mode, move the collective beep switch right or left to move the EFIS HDG bug right or left.
- In ALT:AGL mode, move the collective beep switch up or down to adjust the EFIS AGL bug.
- In SPD+ALT modes, move the collective beep switch forward or aft to change the filled EFIS ALT bug down or up.
- In SPD+VS modes, move the collective beep switch forward or aft to increase or decrease the filled EFIS VS bug in the same manner as using the right knob on the PFD or the data set knob on the RBP.
- In SPD:IAS, SPD+VS, SPD+GS, or SPD+ALT modes with an active IAS bug, move the beep trim switch forward or aft to increase or decrease the EFIS IAS bug in the same manner as using the right knob on the PFD or the data set knob on the RBP.
- In SPD:VS modes with an active VS bug, move the beep trim switch forward or aft to increase or decrease the EFIS VS bug (same manner as using the right knob on the PFD or the data set knob on the RBP).



NOTE:

All the bug changes are displayed on the PFD.

A low airspeed protection feature is included in ALT and GS pitch-only modes. If airspeed decreases below 50 KIAS, the aircraft pitches down to gain airspeed and a two beep 600HZ audio tone sounds at 5 second intervals.

A high airspeed protection feature is included in ALT and GS pitch-only modes. Approaching V_{NE} , the aircraft pitches up to reduce airspeed and a two beep 600HZ audio tone sounds at 5 second intervals. Additionally, the AP modes disengage if V_{NE} is exceeded.

Turn coordination and rate damping functions are provided by the yaw damper and the associated servo attached to the pedal controls. The yaw damper is engaged along with the primary SAS when the yaw damper

switch/annunciator is set to Auto (in). The yaw damper may also be engaged by use of the YDR switch discussed previously. The switch can be used to disengage the YD or allow the YD to engage/disengage automatically with the primary SAS. The annunciator indicates whether the YD is ON or OFF. EFIS also displays a YD annunciation indicating the yaw damper is engaged. Yaw damper disengagement is accompanied by four 600 Hz beeps.

For systems incorporating a backup SAS, the cockpit interfaces related to transitions between the primary SAS/AP and backup SAS/AP (backup SAS switch/annunciator with two positions and two annunciations) are:

- Auto (in): Automatic switching between the primary SAS/AP and the backup SAS/AP. Disengagement of the primary SAS/AP automatically engages the backup SAS/AP. Engagement of the primary SAS/AP automatically disengages the backup SAS/AP. If the backup SAS switch/annunciator is set to Auto, the annunciator displays STBY (white) while the primary SAS is engaged and changes to ON (green), if the primary SAS/AP is not engaged for any reason.
- Off (out): Backup system is disabled. This should only be used if there is reason to believe that the backup SAS/AP is not functional. If the backup SAS switch/annunciator is Off, the annunciator is dark.

**NOTE:**

Flight without the backup SAS/AP is restricted to hands on the cyclic.

To disengage the primary SAS/AP, press **SAS** or the AP DISC switch on the cyclic to switch to the backup SAS/AP. To re-engage the primary SAS/AP, press **SAS** or the FTR switch. The backup SAS/AP reverts to standby.

Press the AP DISC switch for the following (depending on system configuration):

- Primary SAS/AP engaged and backup SAS/AP in standby – If upper modes are engaged, a single press of AP DISC disengages all those modes but leaves the primary SAS operating. EFIS mode annunciations flash at 1Hz for the configured amount (1-5) of seconds following disengagement. Press the switch a second time (or hold it down for more than 1.25 seconds) to disengage the primary SAS/AP and engage the backup SAS/AP.
- Backup SAS engaged – If upper modes are engaged, a single press of AP DISC disengages all modes but leaves the backup SAS operating. AP DISC does not disconnect the backup SAS. If the primary SAS/AP is non-functional and the backup SAS/AP is ON, the only way to disengage the backup SAS/AP is to press the backup SAS switch/annunciator to OFF (out) or pull the circuit breaker.

1.3. MANUAL/AUTOTRIM ANNUNCIATIONS (ONLY APPLICABLE TO NON-HYDRAULICALLY BOOSTED HELICOPTERS)

The trim annunciator panel and the manual/autotrim switch are shown in Figure 1-4. The manual/autotrim switch is normally in the on (in) position which allows the system to enable autotrim. Autotrim is disabled when the manual/autotrim switch is placed in the off (out) position. The manual/autotrim switch displays a green “ENABLE” annunciation when autotrim is enabled.

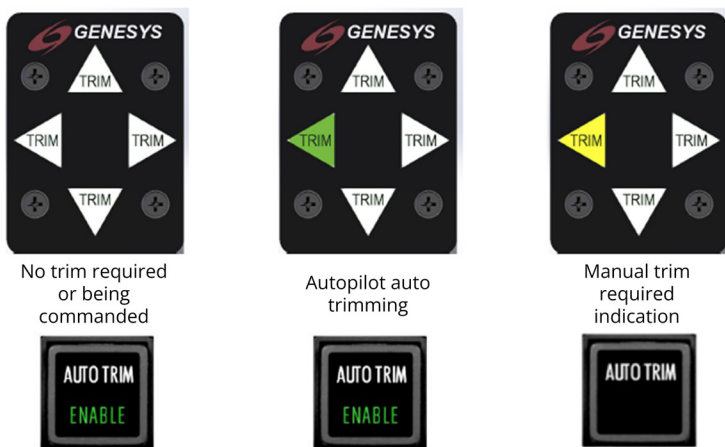


Figure 1-4: SAS/AP Trim System Annunciations

Manual or autotrim annunciations are only provided when the aircraft is in both a lateral and a vertical upper AP mode (HDG and ALT, NAV and SPD, NAV:HVR, etc.) is engaged. When the system senses a load on the pitch or roll servo that exceeds the system threshold, an annunciation in that direction is provided:

- 1) When auto-trim is disabled (manual/autotrim switch is set to off (out), or only one upper mode (HDG without ALT or ALT without HDG) is engaged), the annunciation in that direction is yellow indicating to the pilot that the trim should be manually actuated in that direction to reduce the servo load. If the load continues to be sensed (trimming is needed) continues for more than two seconds, a voice alert of “check roll trim” or “check pitch trim” is provided.
- 2) When auto-trim is enabled (manual/autotrim switch to on (in)), upper AP modes are engaged), a command is sent to the aircraft trim system (pitch or roll trim actuator) to reduce the servo loads automatically. While trimming, an annunciation in that direction is green, indicating to the pilot that trimming is automatically occurring. If automatic trimming continues for more than two seconds, a voice alert of “check roll trim” or “check pitch trim” is provided.

When the load on the pitch or roll servo has been reduced below the set threshold, the trim annunciation/command ceases.

Section 2 GRC-4000 Modes

2.1. SAS MODE

The attitude-command-attitude-hold SAS mode of the GRC-4000 maintains helicopter attitude in all flight conditions by applying corrective inputs to the cyclic to maintain the commanded or reference attitude. Yaw rate/acceleration control and collective friction/position hold is also provided.

When SAS is initially engaged, it maintains the current rotorcraft attitude. The system does not trim to attitudes greater than those defined in the configuration settings.

- Standard: 15° pitch, and 20° bank
- Other: 10° nose-down, 11° nose-up, and 10° bank

If the FTR switch is activated (pressed and released) outside these limits while SAS is engaged, the system returns to the closest limit. For example, if the FTR is pressed and released at a 30° bank angle and the cyclic is released, the helicopter achieves a 20° bank (standard configuration) in the same direction.

In both primary and backup SAS modes, use the beep trim switch to proportionally modify trim pitch and roll target attitudes. This is a four-way momentary switch. The EFIS displays green UP/DN/LT/RT annunciations of beep trim inputs. Maximum trim attitudes are the same as the FTR switch.

Table 2-1: Control Panel SAS Button Functions			
Button Label/ Mode	Control Mode	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
SAS	Stability Augmentation System	Press SAS to engage SAS mode to provide cyclic inputs for pitch and roll attitude-hold, pedal inputs for yaw rate/acceleration control, and collective inputs for electronic friction hold. White: SAS is ready to engage. Green: SAS mode is engaged and active.	

2.1.1. Recommended Technique with SAS

The proper technique for flying with the SAS is to “fly-through” the SAS to achieve the desired attitude and activate the FTR. Activation of the FTR (press and release of the FTR switch on the cyclic) removes the need to apply force on the cyclic grip and the helicopter holds the attitude that existed when the trim switch is released.

To reduce workload when there is residual force on the cyclic, activate the FTR. Avoid holding the FTR switch down while trying to establish a trimmed attitude, as it negates the stabilization provided by the SAS. It is best to fly-through the SAS and activate the FTR when the desired attitude is achieved.

The system uses very small movements of the controls to perform its stabilizing function. If the pilot holds the cyclic grip very tightly or rests feet on the pedals, the stabilizing action could be inhibited. Proper technique requires that the cyclic grip be held loosely so that cyclic can move slightly within the pilot's hand to allow the system to compensate for helicopter instability. This is especially true in hover. Without SAS the hydraulic controls result in no force feedback to the pilot. The SAS provides a force gradient that acts like a centering spring. This is often referred to as a force feel system. When maneuvering with the SAS engaged, there will be some resistance on the controls. This is referred to as "flying through" the system. It is possible to accomplish all normal maneuvering both in low speed and hover and up-and-away by flying through the system. As airspeed changes the force on the cyclic required to hold a given attitude changes. To reduce workload, use the FTR switch or beep trim switch to remove residual force from the cyclic.

2.1.2. Closely Monitor the Controls

The SAS is intended to enhance safety by reducing workload. With the system engaged, it is possible to fly for periods without touching the cyclic. However, since the helicopter is inherently unstable, a disengagement of the SAS due to a failure may result in a rapid roll or pitch excursion that requires immediate pilot takeover to avoid dangerous attitudes. The divergence following a disengagement is significantly more rapid for helicopters with a semi-rigid rotor system, especially at higher airspeeds (e.g., 120 kts and greater). Such helicopters are fitted with a second independent backup system. If the aircraft is equipped with such a system, the backup system automatically engages in SAS mode and holds the attitude that was present when the primary system was disengaged, however, if the backup system is the only stabilization system available, continue to operate with hands on the controls. Other events that require immediate takeover are engine or drive train failures. It is required to have hands on the controls below 200 ft. AGL. It is recommended to have hands on the controls at airspeeds near V_{NE} because a system failure is much more critical near redline.

2.2. HEADING (HDG) MODE

Heading mode intercepts and tracks the EFIS heading bug. Set the Heading Bug to the desired heading and then press **HDG** to engage the heading mode. See Table 2-2. There is no armed heading mode. It is either disengaged or engaged. When heading mode is engaged, the EFIS heading bug changes from hollow to filled white.

The LED above **HDG** illuminates green, and HDG mode annunciation on the EFIS appears when HDG is engaged. The helicopter turns to selected headings with a maximum bank angle of 20°. When making heading changes, it is acceptable to fly-through the system to achieve larger or smaller bank angles.

In HDG mode, move the beep trim switch left or right to change the EFIS heading bug in the same manner as using the right knob on the PFD or the HDG knob on the RBP.

Table 2-2: Control Panel HDG Button Functions			
Button Label/ Mode	Control Mode	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
HDG	Heading Hold	SAS must be engaged first. Press HDG to engage HDG mode. System flies to and maintains heading reference bug. White: N/A Green: HDG mode engaged. To switch to HDG from NAV, press HDG .	N/A

2.3. ALTITUDE (ALT) MODE

When **ALT** is pressed, the combined SPD+ALT mode (pitch+collective) engages to provide the pitch and collective control. Press **ALT** to disengage ALT to utilize the SPD (only) mode. See Table 2-3. In SPD+ALT combined modes, the FTR can be used to resynchronize the airspeed target/bug. The CTR can be used to resynchronize the altitude target/bug.

In ALT mode only (pitch-only), the autopilot uses pitch attitude to control altitude, so airspeed varies with power setting. To change airspeed while ALT mode only is engaged, slowly move the collective to the new power setting. A rapid change in collective causes the helicopter to deviate from the target altitude because collective is a powerful control of vertical rate, and it is not possible for the autopilot to counter rapid power changes with pitch attitude. Nonetheless, the autopilot gradually returns to the reference altitude, albeit at a different airspeed. To reset the target altitude, fly through the autopilot to the desired altitude and activate the FTR switch.

The hover AGL height is held when ALT:AGL mode is engaged. The target height synchronizes to the AGL height at the time **ALT** is pressed. Also, press upper portion of the HVR switch for at least 1.25 seconds to engage ALT:AGL mode and NAV:HVR mode. The collective beep switch may be used to modify the AGL target. In SPD+ALT mode, move the collective beep switch forward (down) or aft (up) to change the filled EFIS altitude bug. To set a new AGL height target, use the collective to fly-through the autopilot to the desired AGL target altitude or press and hold the CTR switch or FTR switch, maneuver to a new AGL height using the collective, and then release the CTR switch or FTR switch at the desired AGL target.

Table 2-3: Control Panel ALT Button Functions

Button Label/ Mode	Control Mode	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
ALT	IAS, Altitude, and AGL Hold	Press ALT to engage IAS and altitude hold combined modes (SPD+ALT) to hold speed based on IAS and altitude based on pressure altitude. To select ALT only mode, press SPD to drop SPD mode from SPD+ALT. To switch to SPD+ALT from SPD+GS, press ALT. If an ALT bug is set while in SPD+ALT, press altitude acquire (ALT-A) button on the RBP to initiate ALT pre-select climb or descent. Mode changes to SPD+VS with ALT armed. After altitude pre-select level off, the system returns to SPD+ALT combined modes. White: ALT if an ALT bug is set in the correct direction (ALT pre-select). Green: SPD+ALT modes or ALT mode engaged.	Press ALT to engage ALT:AGL (above ground height hold) mode. White: N/A Green: ALT when ALT:AGL mode is engaged.

2.4. SPEED (SPD) MODE

Press **SPD** to engage the SPD mode (see Table 2-4).

- In SPD:IAS mode or SPD+ALT modes with an active IAS bug, move the beep trim switch forward or aft to increase or decrease the EFIS IAS bug in the same manner as using the right knob on the PFD or the data set knob on the RBP.
- In SPD+ALT modes, move the collective beep switch forward or aft to change the filled EFIS ALT bug down or up.
- In SPD:VS mode, move the beep trim switch forward or aft to increase or decrease the filled EFIS VS bug in the same manner as using the right knob on the PFD or the data set knob on the RBP.

Refer to ALT mode or GS mode sections for information on the combined SPD+ALT and SPD+GS modes.

Table 2-4: Control Panel SPD Button Functions			
Button Label/ Mode	Control Mode	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
SPD	Speed Hold and ALT Pre-Select	From SAS without a preselected ALT bug: Press SPD to engage SPD:IAS (pitch control only). From SAS with a preselected ALT bug: Press SPD from SAS to engage SPD+VS with ALT armed (pitch and collective control). From SAS without a preselected ALT bug and with a VS bug set: Press SPD to engage SPD:VS (pitch control only). White: ALT if an ALT bug is set. Green: SPD:IAS, SPD:VS, or SPD+VS modes engaged. See Table 2-7 for beep trim switch functionality. To switch to SPD from SPD+ALT, press ALT to drop ALT mode.	N/A

2.5. NAVIGATION (NAV) MODE

NAV mode tracks an EFIS FMS course, a localizer front course, or a VHF Omni-directional Radio (VOR) course. Press **NAV** to arm or engage NAV mode (see Table 2-5). Select the navigation source with the EFIS Omnibearing Selector (OBS) menu (FMS, VLOC1, or VLOC2) or RBP. If VLOC1 or VLOC2 is selected, select the VOR or Instrument Landing System (ILS) frequency on the appropriate NAV receiver, check for valid signal, and set the desired course on the EFIS. If FMS (GPS) is selected, program an active course (flight planned route), direct-to, or instrument approach procedure. If HDG mode is engaged, set the heading bug to the desired intercept angle. If HDG mode is not engaged, fly on a heading to intercept the selected course. Press **NAV** to arm or engage mode and sub-mode (NAV:FMS, NAV:LOC, NAV:VOR), depending if the conditions for course intercept are met.

To disengage NAV mode, press **NAV** or press the AP DISC switch for less than 1.25 seconds. NAV mode is automatically disengaged when the course navigation signal is lost or when the system detects a failure.

NAV automatically transitions from armed to active at course intercept. NAV LED and EFIS annunciation (NAV:FMS, NAV:VOR, or NAV:LOC) change from white to green at intercept. If HDG is not active, fly to a heading to intercept the selected course. NAV is armed (white) until course intercept (see Table 2-5).

Table 2-5: Control Panel NAV Button Functions

Button Label/ Mode	Control Mode	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
NAV	Lateral Navigation	Press NAV to engage NAV mode to intercept and track lateral deviation signal (VOR, localizer, or GPS) or LNAV roll steering signal. White: NAV mode armed. Green: NAV mode engaged. Press NAV to switch from HDG to NAV. HDG/NAV to intercept: Press HDG and turn heading bug to the desired intercept angle. Press NAV. NAV LED is white, indicating that NAV is armed, and HDG is green, indicating that HDG is active. NAV automatically transitions from armed to active at course intercept. NAV LED changes from white to green and HDG extinguishes at intercept. NAV (direct/stand-alone) to intercept: Press NAV to intercept the selected course at 45°. NAV is green.	Press NAV to engage NAV:HVR modes. Geo-position held with the cyclic, and heading held with the pedals. To set a new position target, press the FTR switch. The beep trim switch may also be utilized to maneuver and set a new position target (See Table 2-7). White LED: N/A Green LED: NAV when NAV:HVR mode is engaged. In NAV:HVR mode, the HDG target/bug syncs to current when the mode is engaged and re-syncs with pedal fly-through and release. YDR switch may also be used to synchronize to a new heading. See Table 2-7 for YDR switch functionality.



NOTE:

When executing a localizer-based approach (ILS, LOC, SDF, LDA) using an EFIS VLOC1 or VLOC2 OBS source, load and activate the approach procedure in the EFIS, because the system uses GPS course lateral deviation from the flight plan to improve capture and tracking of the localizer signal during strong crosswinds. This also allows for automatic switching to the FMS source upon executing the missed approach.

2.5.1. VOR (HDG is Not Active) Fixed Intercept Angle

NAV illuminates green and the autopilot establishes the helicopter on a 45° intercept angle relative to the selected course.

2.5.2. VOR Selected Intercept Angle

To select an intercept angle other than 45°, set the heading bug to achieve the desired intercept angle. Set the selected course arrow to the desired course. Press **HDG** and then **NAV**. HDG annunciation is green, and NAV annunciation is white. As the helicopter approaches the selected course, NAV annunciation changes from white to green, and HDG annunciation changes from green to dark (off). The bank angle at course capture depends on the distance from the VOR, or final approach fix for a localizer, and the selected intercept angle, but is limited 20°.

2.5.3. Navigation (NAV) Mode – GPS

The autopilot follows the GPS roll steering through holding patterns and published course reversals on instrument approach procedures. This is only available if the GPS receiver is GPS/SBAS capable and if roll steering is valid.

2.5.3.1. GPS Preprogrammed Intercept Angle

Ensure that HDG is not engaged and press **NAV** to engage the navigation mode. NAV mode engages (green) and the autopilot follows the GPS roll steering commands to capture and track the active course.

2.5.3.2. GPS Selected Intercept Angle

To select an intercept angle to an active GPS course, set the heading bug to achieve the desired intercept angle. Press **HDG** and then **NAV**. HDG annunciation is green, and NAV annunciation is white (armed). This is useful if being vectored to final for an instrument approach procedure. As the helicopter approaches the selected course, NAV transitions from armed (white) to active (green), and HDG disengages (dark). The autopilot smoothly captures and tracks the active course. The bank angle is limited to 20°. Capture does not occur if the selected heading does not cause the helicopter to intercept the active course.

2.5.4. NAV:HVR Mode

In a hover, NAV:HVR mode position hold utilizes GPS data to apply corrective cyclic inputs to hold the aircraft at the reference position. Use the beep trim switch to initiate a ground speed command, and upon release, the system holds the new hover position target. To set a new reference point, use the cyclic to fly-through the autopilot and then momentarily press the FTR switch, or press and hold the FTR switch, maneuver to the new position, and then release the FTR switch at the desired target. To exit NAV:HVR mode position hold, press **NAV** or press the AP DISC switch for less than 1.25 seconds. NAV:HVR mode utilizes the YD to hold the target heading with pedal inputs. The target heading is the heading at the time NAV:HVR mode is engaged. To set a new heading, use the pedals to fly-through the autopilot to the new desired heading target or move the collective beep switch left or right to adjust the EFIS HDG bug.

In NAV:HVR mode, move the collective beep switch right or left to move the EFIS HDG bug right or left. Use the HVR switch to simultaneously engage both NAV:HVR and ALT:AGL modes.

2.6. GLIDE SLOPE (GS) MODE

GS mode tracks an EFIS FMS VNAV glide path or an ILS glide slope. If EFIS FMS VNAV is planned, the RNAV (Area Navigation) procedure must be active on the EFIS prior to arming or engaging GS mode. GS mode must be armed prior to intercepting glide path or glide slope. GS mode must be armed or engaged before vertical navigation mode can be armed or engaged. Press **GS** to arm or engage GS mode (see Table 2-6).

Table 2-6: Control Panel GS Button Functions

Button Label/ Mode	Control Mode	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
GS	IAS and Glide Slope Hold	In NAV mode, press GS to engage IAS and GS combined modes (SPD+GS) to hold speed based on IAS and to intercept and track vertical deviation signal (VNAV GS or ILS). To select GS only mode, press SPD to drop SPD mode from SPD+GS. To switch to SPD+GS from SPD+ALT, press GS. White: GS mode armed. Green: SPD+GS modes or GS mode engaged. Approaching the runway in NAV and SPD+GS modes, the system transitions to a low approach down the runway at 50 ft. or 65 ft. AGL (as set in the Configuration software) at above 40 KIAS (per the IAS bug setting).	As the runway is approached in NAV and SPD+GS modes, the system transitions to a low approach down the runway at 50 ft. or 65 ft. AGL at above 40 KIAS (per the IAS bug setting)
Armed Modes			
SPD/ ALT/ GS	IAS/ Altitude/ Glide Slope	If in SPD+ALT combined modes or ALT only mode, GS mode is armed (white) until the glide slope capture criteria are met and capture occurs (green). System changes to SPD+GS.	

GS mode does not arm or engage until a valid VNAV glide path or ILS glide slope signal is displayed on the EFIS. Select the navigation source with the EFIS OBS menu (FMS, VLOC1, or VLOC2).

To disengage GS mode, press **GS** or press the AP DISC switch for less than 1.25 seconds. GS mode is automatically disengaged when the glide slope/ glide path signal is lost or when the system detects a failure.

**NOTE:**

GS mode does not engage if vertical deviation is greater than 1 dot above glide slope or glide path.

For ILS approaches the autopilot control laws use GPS ground speed to enhance ILS glide slope tracking. If a GPS receiver is not available, GS still functions, but glide slope tracking is less accurate. It is recommended that the GPS overlay be loaded for ILS and localizer approaches. While this is not essential, it serves two useful purposes. First situational awareness is enhanced by having the final approach course displayed on the moving map. Second, when the GPS overlay is active, the autopilot control laws use GPS-derived track angle to enhance localizer intercept and tracking, especially in crosswinds.

2.7. GO-AROUND

Upon pressing the GA switch, the system drops NAV and SPD+GS (or SPD+ALT if level-off has started) with G/A annunciated on the EFIS and green SAS light on the control panel. Roll holds zero. In pitch, there is an initial pitch up command followed by reactivation of the active pitch+collective commands (indicated by SPD light on the control panel illuminating, EFIS still annunciating G/A) controlling a vertical climb rate (configured to +800fpm in EC145 and UH60). The system captures/maintains the airspeed at the time G/A is initiated if it is between the configured airspeed (set to 70-100 in the EC145 and 80-100 in the UH-60). If airspeed is more, the system decelerates to the top of the configured airspeed. If airspeed is less, it accelerates to the bottom of the configured airspeed. Adjust the IAS targets/bugs as desired. Press the FTR or any subsequent mode change cancels GA. If the GA switch is pressed below 44 KIAS, the upper modes disengage, and the system reverts to SAS mode.

It is recommended to preset the HDG bug to the runway heading and preset the ALT bug to the missed approach altitude as the aircraft is descending the glide slope in SPD+GS (or GS for pitch-only) mode. Once the G/A is executed, and the climb-out has been established, press **HDG** and then **SPD** to place the system in HDG mode to hold the preselected heading bug, and press **SPD** to engage the system in SPD+VS with ALT armed to capture the attitude that was preselected on the descent down the glide path.

2.8. LEVEL MODE

In any backup or primary system mode (SAS or AP), press the LVL switch to engage the primary system to a fully functional state by engaging/resetting to SPD+ALT mode and Level (zero) roll attitude hold modes. The system captures/maintains the airspeed and altitude at the time the aircraft reaches level if it is between the configured airspeed (set to 70-100 in the EC145 and 80-100 in the UH-60). If airspeed is more, the system decelerates to the top of the configured airspeed. If airspeed is less, it accelerates to the bottom of the configured airspeed.

The GRC-4000 FCC includes various voice alerts such as "Check Autopilot Modes" and "SAS Disconnect". When engaging LVL mode from an unusual

attitude, the system to announce “Level Mode” as the aircraft is being commanded to a level condition.

2.9. TERRAIN AVOIDANCE MODE

The system also includes ground proximity protection when in SPD+ALT or SPD+VS 4-axis modes. Upon reaching the minimum altitude (typically configured for 200ft AGL), the system issues a voice alert (“Terrain Avoidance Engaged”), drops SPD+ALT or SPD+VS, and the green SAS light illuminates on the control panel. Roll establishes 0° and in pitch, there is an initial pitch up command followed by reactivation of the active pitch+collective commands (indicated by SPD light on the control panel illuminating) controlling a vertical climb rate (configured to +800 fpm in EC145 and UH60). The system captures/maintains the airspeed at the time the T/A is initiated if it is between the configured airspeed (set to 70-100 in the EC145 and 80-100 in the UH-60). If airspeed is more, the system decelerates to the top of the configured airspeed. If airspeed is less, it accelerates to the bottom of the configured airspeed.

2.10. NON-CONTROL PANEL SWITCH FUNCTIONS

Table 2-7: Non-Control Panel Switch Functions			
Switch	Switch Positions	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
AP DISC Switch	Pressed/Released	Primary system and backup system – If upper modes are engaged, a single press of AP DISC disengages all those modes but leaves the primary SAS operating.	Primary system only – If hover modes are engaged, a single press of AP DISC disengages all those modes but leaves the primary SAS operating.
		Primary system only – Press the switch a second time (or hold it down for at least 1.25 seconds) to disengage the primary system and engage the backup system.	Primary system only – Press the switch a second time (or hold it down for at least 1.25 seconds) to disengage the primary system and engage the backup system.
		For system interfaces with a shared FTR switch (UH60), the GRC may be configured to utilize the AP DISC switch similarly, thus pushing the AP DISC for at least 1.25 seconds may be used to engage SAS mode.	For system interfaces with a shared FTR switch (UH60), the GRC may be configured to utilize the AP DISC switch similarly, thus pushing the AP DISC for at least 1.25 seconds may be used to engage SAS mode.

Table 2-7: Non-Control Panel Switch Functions			
Switch	Switch Positions	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
FTR Switch	Pressed/Released	Press the FTR switch for at least 1.25 seconds to engage the primary system (a hands-on-controls alternate to pressing SAS). In primary SAS mode, a momentary press of the FTR switch resets trim to the pitch and roll attitude at which the switch is released. When pressed, the FTR releases the cyclic, collective and yaw trim (system commands are paused) for easier control movements. In SPD or ALT mode, the FTR can be used to resynchronize the airspeed or altitude hold target/bug. In SPD+ALT or SPD+GS combined modes, the FTR can be used to resynchronize the airspeed targets/bugs. In backup system modes, the FTR switch does not function unless both the primary system and the beep trim switch are not operational.	Press the FTR switch for at least 1.25 seconds to engage the primary system (a hands-on-controls alternate to pressing SAS). In primary SAS mode, a momentary press of the FTR switch resets trim to the attitude at which the switch is released. When pressed, the FTR releases the cyclic and collective trim (system commands are paused) for easier control movements. In NAV:HVR mode, to set a new reference point, use the cyclic to fly-through the autopilot and then momentarily press the FTR switch, or press and hold the FTR switch, maneuver to the new position, and then release the FTR switch at the desired target. In backup system modes, the FTR switch does not function unless both the primary system and the beep trim switch are not operational.

Table 2-7: Non-Control Panel Switch Functions

Switch	Switch Positions	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
YDR Switch	Pressed/Released	Press the YDR switch for at least 1.25 seconds to engage the yaw damper (hands-on-controls alternative to pressing yaw damper switch/annunciator).	Press the YDR switch for at least 1.25 seconds to engage the yaw damper (hands-on-controls alternative to pressing yaw damper switch/annunciator). In NAV:HVR mode, the YDR can be used to resynchronize the heading targets/bug.
HVR Switch	Pressed/Released	Press the HVR switch for at least 1.25 seconds to engage HVR:DCL mode to initiate a deceleration from forward flight into hover, ending in position hold (NAV:HVR) along with ALT:AGL.	Press the HVR switch for at least 1.25 seconds to engage both NAV:HVR mode and ALT:AGL mode (a hands-on-controls alternative to pressing NAV and ALT).
LVL Switch	Pressed/Released	In any backup or primary system mode (SAS or AP), press the LVL switch to engage the primary system to a fully functional state by engaging/resetting to SPD+ALT and Level (zero) roll attitude hold modes. System captures/maintains the airspeed and altitude at the time the aircraft reaches level.	In any backup or primary system mode (SAS or AP), press the LVL switch to revert the system to Level (zero pitch and roll) SAS mode.
Yaw Cut Off Switch	Pressed/Released	Momentarily press the switch to release (disengage) the yaw damper.	

Table 2-7: Non-Control Panel Switch Functions			
Switch	Switch Positions	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
Beep Trim Switch	Fwd/Aft/Lt/Rt	In both primary and backup SAS modes, use beep trim switch to proportionally modify the trim pitch and roll attitudes. In HDG mode, move the beep trim switch left or right to change the EFIS HDG bug. In SPD, SPD+ALT, or SPD+GS modes with an active IAS bug, move the beep trim switch forward or aft to change the EFIS IAS bug.	In both primary and backup SAS modes, use beep trim switch to proportionally modify the trim pitch and roll attitudes. In NAV:HVR mode, use the beep trim switch to initiate a ground speed command and upon release, the system holds the new hover position target.
Collective Beep Switch	Up/Down/Fwd/Aft	In SPD+ALT mode, move the collective beep switch forward or aft to adjust the EFIS ALT bug. Also use the collective beep switch to adjust the VS bug when in SPD+VS mode. In backup autopilot modes, only the beep trim switch is available for adjusting the HDG, ALT, and IAS EFIS targets/bugs.	In ALT:AGL mode, move the collective beep switch forward or aft to adjust the EFIS above ground level (AGL) target/bug. In NAV:HVR mode, move the switch right or left to adjust the HDG targets/bugs.

Table 2-7: Non-Control Panel Switch Functions			
Switch	Switch Positions	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
CTR Switch	Pressed/Released	In SAS mode, a momentary press of the CTR switch resets the collective position hold target to the position at which the switch is released. When pressed, the CTR releases the collective trim (system commands are paused) for easier control movement. Press the CTR switch for at least 1.25 seconds to engage SPD+ALT modes (a hands-on-controls alternative to pressing ALT). In SPD+ALT combined modes, the CTR can be used to resynchronize the altitude target/bug.	In SAS mode, a momentary press of the CTR switch resets the collective position hold target to the position at which the switch is released. When pressed, the CTR releases the collective trim (system commands are paused) for easier control movement. Press the CTR switch for at least 1.25 seconds to engage ALT:AGL (above ground altitude hold) mode (a hands-on-controls alternative to pressing ALT). To set a new AGL height target, use the collective to fly-through the autopilot to the desired target, or press and hold the CTR switch, use the collective to maneuver to a new AGL height, and then release the CTR switch at the desired target.
COL DISC Switch	Pressed/Released	Press the COL DISC switch to drop the AP pitch+collective mode to pitch-only mode. Roll mode selection is unaffected.	In ALT:AGL mode, press the COL DISC switch to disengage the mode and revert to pitch SAS. Roll mode selection is unaffected.

Table 2-7: Non-Control Panel Switch Functions			
Switch	Switch Positions	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
GA Switch	Pressed/ Released	Backup system: When switch is pressed, selected AP modes are disengaged, SAS mode maintains a 0° roll, pitch attitude remains at the current attitude if between 5 ° – 10°, or if current pitch attitude is below 5°, the aircraft pitches up to hold 5°. EFIS indicates GA mode with green G/A annunciation. Press the FTR or any subsequent mode change to cancel GA.	If the GA switch is pressed below 44 KIAS, the upper modes disengage, and the system reverts to SAS mode.
		Primary system: When switch is pressed, system drops NAV and SPD+GS (or SPD+ALT if level-off has started) to G/A annunciated on the EFIS and green SAS light on the control panel. Roll holds zero. In pitch, there is an initial pitch up command followed by reactivation of the active pitch+collective commands (indicated by SPD light on the control panel and G/A annunciating on EFIS) controlling a vertical climb rate (configured to 800fpm in EC145 and UH60) while maintaining airspeed. Adjust IAS targets/bugs as desired. Press FTR or any subsequent mode change to cancel GA.	

Table 2-7: Non-Control Panel Switch Functions			
Switch	Switch Positions	Forward Flight (Above 50 KIAS)	Low Speed/Hover (Below 44 KIAS)
Backup SAS Switch/Annunciator	In/Out	Use switch to select the backup system to Auto (in) or Off (out). Annunciator indicates the backup system status as STBY (white), ON (green) or Off (no light).	
Yaw Damper Switch/Annunciator	Pressed/Released	Use switch to select the yaw damper to Auto (in) or Off (out). Annunciator indicates yaw damper status. Yaw damper engages automatically when the primary SAS mode is engaged.	

Section 3 Glossary

ADAHRS	Air Data Attitude Heading Reference System
AGL	Above Ground Level
ALT	Altitude-Hold
ALT-A	Altitude Acquire
AP	Autopilot
COL	Collective
CTR	Collective Trim Release
DISC	Disconnect
DN	Down
EFIS	Electronic Flight Instrument System
FAA	Federal Aviation Administration
FCC	Flight Control Computer
FMS	Flight Management System
fpm	Feet per minute
FTR	Force Trim Release
Fwd	Forward
GA, G/A	Go-Around
GPS	Global Positioning System
GRC	Genesys Rotorcraft Controls
GS	Glide Slope
HDG	Heading-Hold
HVR	Hover
HZ	Hertz
IAS	Indicated Airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
KIAS	Knots Indicated Airspeed
Kts	Knots
L, LT	Left
LDA	Localizer Directional Aid Approach
LED	Light Emitting Diode
LOC	Localizer
LVL	Level

SYSTEM DESCRIPTION

GRC-4000 MODES

NAV	Navigation Signal Tracking
OBS	Omnibearing Selector
PDF	Primary Flight Display
R, RT	Right
RBP	Remote Bugs Panel
RFM	Rotorcraft Flight Manual
RFMS	Rotorcraft Flight Manual Supplement
RNAV	Area Navigation
SAS	Stability Augmentation System
SDF	Simplified Directional Facility Approach
SPD	Speed-Hold
STBY	Standby
T/A	Terrain Avoidance
VLOC	VOR/Localizer
V _{NE}	Never exceed speed
VOR	VHF Omni-directional Radio
VS	Vertical Speed
YD, YDR	Yaw Damper

GLOSSARY

