

SECTION 9

Pilot's Operating Handbook Supplement AS-27

(restricted) Garmin GFC 500 Autopilot



This supplement is applicable and must be integrated into the Airplane Flight Manual if a (restricted) Garmin GFC 500 Autopilot System is installed into the AQUILA AT01-100B/C or AT01-200C. Information in this supplement compliments or replaces chapters in the basic Airplane Flight Manual.

The technical content of this document is approved under the authority of the DOA ref. EASA.21J.025.

03.03.21

 Date, Signature Office of Airworthiness

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0.1 RECORD OF REVISIONS

Issue	Reason for Change	Affected Pages	Date of Issue
A.01	Initial Issue	all	03.03.2021

0.2 LIST OF CURRENT PAGES

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1 - 21	A.01	03.03.2021

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0.3 TABLE OF CONTENTS

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1. GENERAL

Introduction

The information found in this Airplane Flight Manual Supplement is to be used alongside the basic Airplane Flight Manual.

This Airplane Flight Manual Supplement contains additional information required for the safe operation of an AQUILA equipped with a restricted Garmin GFC 500 Autopilot system.

The chapters of this Airplane Flight Manual Supplement follow the same structure as the basic Airplane Flight Manual. Only the chapters listed in this document are affected by the installation of the restricted Garmin GFC 500 Autopilot system.

For further information and comprehensive operating instructions, please reference the current issue of the Garmin G5 Pilots Guide and the user manuals of the avionic units connected to the Autopilot System. Please keep in mind that the Garmin G5 Pilots Guide must be kept on board the aircraft and be accessible to the pilot at all times. It is the pilot's responsibility to familiarize him or herself with the operation, characteristics and limitations of the Autopilot System before flight.

Installed Interfaces to other units

- PFD (G500TXi)
- GPS / NAV 1 (GTN650/Xi)
- _____
- NAV 2 (optional)

Installed Features

Basic AP Features

- Flight Director
- Overspeed Protection
- Underspeed Protection

Vertical Autopilot Modes

- Pitch (PIT)
- Level (Zero vertical speed)
- Altitude Hold
- Vertical Speed
- Altitude Capture via Altitude Preselect
- Indicated Airspeed (IAS)
- Vertical Navigation (VNAV)
- GPS Approach Glidepath *
- ILS Glidepath*

Yaw Damper (optional)

- Yaw (YD)

Lateral Autopilot Modes

- Roll (ROL)
- Level (Wings Level)
- Heading
- Track
- GPS Navigation
- VHF Navigation
- Approach Mode *
 - GPS*
 - VOR/LOC*

* Use of the Autopilot is restricted to en-route operations \geq 2000ft AGL!

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2. OPERATING LIMITATIONS

System Requirements

The components connected to the restricted Garmin GFC500 Autopilot System must utilize the following or later software versions:

Component (Garmin)	Software Version
G 5 Stand-by Attitude Indicator	6.82 (STC Version only)
GMU 11 Magnetometer	2.00
GSA 28 (certified) Servos	4.80
GMC 507 Mode Controller	2.90
GAD 29B Analog/Digital Converter	3.30
G500 TXi PFD	3.12
GTN650 / Xi; GNC; etc.	current

Autopilot Operating Limitations

Operation of the restricted GFC500 Autopilot system is permitted only:

- after successfully passed preflight-test (PFT)
- at altitudes \geq 2000ft AGL
- with ALT1 and ALT2
- at airspeeds between 60 KIAS and 150 KIAS
- with flaps UP (cruise)
- if Pitch-Trim advises on the G500 / G5 are complied with in intervals of max. 2 seconds cont. actuation of the trim motor

WARNING

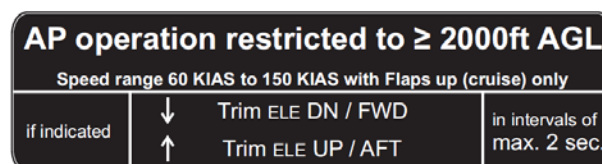
Do not fly with the Garmin GFC 500 Autopilot System if you are unfamiliar with its use and limitations!

Kinds of Operation Limits / Minimum Equipment

There is no change regarding the information in the basic Pilot's Operating Handbook.

Placards for Operation Limits

On the instrument panel near the GFC 507 Mode Controller:



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3. EMERGENCY PROCEDURES

Introduction

If required the restricted Garmin GFC500 Autopilot System can be disconnected from power supply immediately by switching the **AP** Main switch OFF.

NOTE

The display of messages and status symbols in the status box of the Autopilot can appear differently on the G5 and G500TXi. Only the display of the G5 is described here.

Autopilot Malfunction / or (manual) electrical trim runaway

The airplane deviates unexpectedly from the planned flight path:
(no message in the status box of the Autopilot, no disconnect tone)

- | | | |
|----|--------------------------|--|
| 1. | Control Stick | GRIP FIRMLY and HOLD Position |
| 2. | AP DISC | PRESS AND HOLD
Be prepared for high control forces! |
| 3. | Flight Attitude | MAINTAIN / REGAIN Level Flight |
| 4. | Elevator Trim | TRIM as required if possible |
| 5. | Autopilot AP Main switch | OFF |
| 6. | AP DISC | RELEASE |

WARNING

*Do not release **AP DISC** before **AP** Main switch is OFF.*

Do not turn the Autopilot back on until the cause of the malfunction has been corrected.

Autopilot Failure / Abnormal Disconnect

(red AP in the status box of the Autopilot, continuous disconnect tone)

- | | | |
|----|---|--|
| 1. | Control Stick | GRIP FIRMLY and HOLD Position |
| 2. | Flight Attitude | MAINTAIN / REGAIN Level Flight |
| 3. | AP DISC or G5 Knob | PRESS AND RELEASE
(To cancel disconnect tone) |
| 4. | Elevator Trim
in case of a red AFCS Message: | TRIM as required |
| 5. | Autopilot AP Main switch | OFF |

NOTE

If a red AFCS message is displayed in the Autopilot status box, the Flight Director will not be available and the Autopilot cannot be re-engaged.

If the disconnect is accompanied by a yellow AP with a red X displayed in the Autopilot status box, the Flight Director will still be functional.

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Yaw Damper Failure / Abnormal Disconnect (if installed)

(red AP in the status box of the Autopilot, continuous disconnect tone)

1. Flight Attitude MAINTAIN / REGAIN Level Flight
2. AP DISC or G5 Knob PRESS AND RELEASE
(To cancel disconnect tone)

NOTE

If the disconnect is accompanied by a yellow YD with a red X displayed in the Autopilot status box, the Yaw Damper is not available. The Autopilot is still functional, but without Yaw Damper.

Overspeed Protection (MAXSPD)

(yellow MAXSPD in the status box of the Autopilot, continuous „AIRSPEED – AIRSPEED“ aural voice alert)

1. Throttle REDUCE
2. Flight Attitude MONITOR
if airspeed is within normal operating range:
3. Autopilot RESELECT vertical and lateral Modes (if necessary)
4. Throttle AS REQUIRED

NOTE

The Overspeed Protection Mode provides a “nose up” pitch command to keep the aircraft at the allowed maximum of 150KIAS.

Underspeed Protection (MINSPD)

(yellow MINSPD in the status box of the Autopilot, continuous „AIRSPEED – AIRSPEED“ aural voice alert)

1. Throttle INCREASE
2. Flight Attitude MONITOR
if airspeed is within normal operating range:
3. Autopilot RESELECT vertical and lateral Modes (if necessary)
4. Throttle AS REQUIRED

NOTE

The Underspeed Protection Mode provides a “nose down” pitch command to keep the aircraft at the allowed minimum of 60KIAS.

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Electrical System Malfunctions

In addition to the procedures described in the Airplane Flight Manual, the restricted Garmin GFC500 Autopilot System has to be disconnected from power supply immediately by switching the **AP** Main switch OFF.

WARNING

*Operation of the restricted Garmin GFC500 Autopilot System is only permitted with two functioning alternators **ALT1** and **ALT2**.*

(manual) Trim Control System Failures

In addition to the procedures described in the Airplane Flight Manual, the restricted Garmin GFC500 Autopilot System has to be disconnected from power supply immediately by switching the **AP** Main switch OFF.

WARNING

Operation of the restricted Garmin GFC500 Autopilot System is only permitted with functioning elevator trim system.

Inadvertent Release and Opening of the Canopy in flight

In addition to the procedures described in the Airplane Flight Manual after stabilization of level flight attitude, the restricted Garmin GFC500 Autopilot System has to be disconnected from power supply by switching the **AP** Main switch OFF.

WARNING

Operation of the restricted Garmin GFC500 Autopilot System is only permitted with closed canopy.

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3A. PROCEDURES in case of AUTOPILOT MALFUNCTIONS

3A.1 Autopilot Pre-Flight Test Fail

(Yellow AP in the status box of the Autopilot)

The automatic Pre-Flight test of the Autopilot failed.

The test should be repeated only **once** by switching the **AP** Main switch OFF and back to ON again. If it fails again the restricted Garmin GFC500 Autopilot System has to be disconnected from power supply by switching the **AP** Main switch OFF.

WARNING

Before any further operation of the Autopilot the problem must be solved!

3A.2 Loss of Navigation Information

(Yellow AP with red X and for 5 seconds yellow flashing GPS/VOR/LOC in the status box of the Autopilot)

- | | | |
|----|-------------------------|---|
| 1. | GMC 507 Mode Controller | SELECT HDG Mode and SET desired heading |
| 2. | NAV Source | SELECT a valid NAV source |
| 3. | GMC 507 Mode Controller | PRESS NAV |

NOTE

If a navigation signal is lost while the Autopilot is tracking it, the Autopilot will roll the aircraft wings level and default to roll hold Mode (ROL).

3A.3 Loss of Airspeed Data (G5)

(Yellow AP with red X in the status box of the Autopilot)

- | | | |
|----|---------------------------|--|
| 1. | AP DISC or G5 Knob | PRESS AND RELEASE
(To cancel disconnect tone) |
| 2. | Flight Attitude | MAINTAIN / REGAIN Level Flight |
| 3. | Elevator Trim | TRIM as required |

NOTE

If airspeed data is lost while in IAS Mode, the Autopilot will default to pitch hold Mode (PIT). IAS Mode cannot be re-selected.

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3A.4 Loss of Altitude Data

(Yellow AP with red X in the status box of the Autopilot)

1. Autopilot SELECT different vertical Mode

NOTE

If altitude data is lost while in ALT Mode, the Autopilot will default to pitch hold Mode (PIT). ALT Mode cannot be re-selected.

3A.5 Loss of GPS Information

(Yellow AP with red X and for 5 seconds yellow flashing GPS in the status box of the Autopilot)

1. Autopilot SELECT different vertical or lateral Mode

NOTE

If a navigation signal is lost while the Autopilot is tracking it, the Autopilot will roll the aircraft wings level and default to roll hold Mode (ROL). For NAV Mode valid GPS information is required at all times even when tracking VOR or LOC.

If the GPS information is lost in an approach Mode, the Autopilot will default to pitch hold Mode (PIT).

3A.6 Heading Data Source Failure

1. Autopilot SELECT different lateral Mode

NOTE

If heading information is lost while in HDG Mode, the Autopilot will default to track Mode (TRK). HDG Mode cannot be re-selected.

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4. NORMAL PROCEDURES

WARNING

The specific operating limitations specified in Chapter 2 must be observed for the operation of the restricted Garmin GFC500 Autopilot System described here!

NOTE

The display of messages and status symbols in the status box of the Autopilot can differ on the G5 and G500TXi. Only the display of the G5 is described here.

Power Up

The autopilot and its components are powered by turning the **AP** Main switch ON. Subsequently the Pre-Flight Test (PFT) of the autopilot starts automatically.

Automatic Pre-Flight Test (PFT)

(white PFT in the status box of the Autopilot)

After a successful pre-flight test, PFT is no longer shown in the status box of the autopilot and the autopilot is ready for operation, but completely inactive.

Only by pressing the AP or YD key (if installed) on the GMC507 mode controller one or more servos intervene in the aircraft control system according to default or any other active modes.

Also the automatic speed limiter (60 to 150 KIAS) is only activated by pressing the AP or YD (if installed) key on the GFC507 mode controller.

CAUTION

*All servos can be overpowered by the pilot at any time, but without additionally pressing **AP DISC**, the autopilot remains active and takes over control again after the pilot input.*

NOTE

For planned autopilot operations the Pre-Flight Test (PFT) has to be performed before take-off, to rule out any faults early.

In case of unplanned autopilot operations the Pre-Flight Test may be performed also in-flight, but there is an increased risk for a Pre-Flight Test Fail (see chapter 3A.1)

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Before Take-off Check List (only if **AP** Main switch is ON)

To ensure error-free operation during take-off with the autopilot switched on and not activated, the following checks are to be performed:

1. GMC 507 Mode Controller PRESS **AP**, PRESS **YD**
2. Control Stick CHECK, if PITCH and ROLL servos
Can be overpowered
3. **AP DISC** PRESS AND RELEASE
CHECK, if Autopilot disengages
CHECK, if YAW damper disengages (if installed)
4. Flight Director SET for Take-off (IAS or VS Mode)
or
GMC507 Mode Controller PRESS **FD**, to turn off the Flight Director

WARNING

Activation of the Autopilot is only permitted above 2000ft AGL!

Autopilot Disengagement

If required, the Autopilot can be disengaged by one of the following methods:

1. **AP DISC** PRESS AND RELEASE
2. GMC507 Mode Controller PRESS **AP** and **YD** (if installed)
3. **AP** Main switch OFF

WARNING

*Always before disengaging the Autopilot GRIP FIRMLY the control stick and HOLD its position.
High control forces may occur!*

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VERTICAL MODES**Altitude Hold Mode (ALT), Manual Capture**

When at desired altitude:

1. GMC507 Mode Controller **PRESS ALT**

NOTE

At high climb / sink rates the selected altitude will be captured only after over- / undershoot. The altitude reference is displayed in the status box of the autopilot and can be adjusted via the UP/DN Wheel by +/- 200ft maximum.

The Autopilot utilizes the Garmin G5 displayed altitude only.

Altitude Hold Mode (ALT), Automatic Capture (ALTS)

Selection of VS or IAS Mode activates Selected Altitude Capture Mode (ALTS) automatically:

1. GMC507 Mode Controller **TURN ALT SEL**
SET desired altitude
2. GMC507 Mode Controller **PRESS VS or IAS**
TURN UP/DN Wheel
ADJUST climb / sink rate or climb / sink airspeed reference as required

NOTE

A white ALTS Symbol in the status box of the autopilot indicates the Armed ALTS Mode. Approximately 50ft before the selected altitude the ALTS Symbol changes into a green ALT symbol, the climb is ended and the altitude is kept in Altitude Hold Mode (ALT)

Vertical Speed Mode (VS)

1. GMC507 Mode Controller **TURN ALT SEL**
SET desired altitude
2. GMC507 Mode Controller **PRESS VS**
Autopilot synchronizes to the aircraft's current vertical speed
3. GMC507 Mode Controller **TURN UP/DN Wheel**
ADJUST vertical speed reference as required
if desired altitude is captured:
4. G5, Autopilot status box **CHECK**, if green ALT symbol

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Indicated Airspeed Mode (IAS)

- | | | |
|----|---|--|
| 1. | GMC507 Mode Controller | TURN ALT SEL
SET desired altitude |
| 2. | GMC507 Mode Controller
Autopilot synchronizes to the aircraft`s current indicated airspeed | PRESS IAS |
| 3. | GMC507 Mode Controller | TURN UP/DN Wheel
ADJUST airspeed reference as required |
| 4. | Throttle

if desired altitude is captured: | REDUCE for descend
INCREASE for climb |
| 5. | G5, Autopilot status box | CHECK, if green ALT symbol |

Manual Pitch Trim with Autopilot engaged

(Yellow TRIM UP or TRIM DOWN in the status box of the Autopilot)

Because the restricted Garmin GFC500 Autopilot System is installed without a Trim servo, during normal operation, if the Pitch servo reports continuous torque required for steady deflections, a yellow Symbol TRIM DOWN (G500TXi shows ELE↓) or TRIM UP (G500TXi shows ELE↑) is displayed on the G5, requesting the pilot to trim manually acc. the requested direction.

- | | | |
|----|----------------------|---------------------------|
| 1. | G5, TRIM UP Symbol | TRIM manually „Nose up“ |
| 2. | G5, TRIM DOWN Symbol | TRIM manually „Nose down“ |

WARNING

If significant out-of-trim conditions occur, GRIP FIRMLY the control stick and HOLD its position, to cover a concurrent Pitch servo disengagement (also possible by malfunction!). High control forces may occur!

The Pitch-Trim advises on the G5 are to be complied with in intervals of max. 2 seconds cont. actuation of the trim motor, to rule out significant out-of-trim conditions!

if indicated	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="margin-bottom: 10px;">↓</div> <div style="margin-bottom: 10px;">Trim ELE DN / FWD</div> <div style="margin-bottom: 10px;">↑</div> <div>Trim ELE UP / AFT</div> </div>	in intervals of max. 2 sec.
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GPS – Navigation Mode (NAV)

- | | | |
|----|------------------------|-----------------------------------|
| 1. | Navigation Source | SELECT CDI to GPS |
| 2. | Waypoint | SELECT on Navigation Source |
| 3. | Course Pointer | VERIFY CDI set to desired course |
| 4. | Intercept Heading | ESTABLISH in HDG, TRK or ROL Mode |
| 5. | GMC507 Mode Controller | PRESS NAV |

NOTE

If the Course Deviation Indicator (CDI) is greater than one dot from center, the autopilot will only arm the GPS mode when the NAV key is pressed. The pilot must ensure that the current heading will result in a capture of the selected course. If the CDI is one dot or less from center, the autopilot will enter the capture mode when the NAV key is pressed.

5. PERFORMANCE

No change to the basic POH.

6. WEIGHT AND BALANCE

No change to the basic POH.

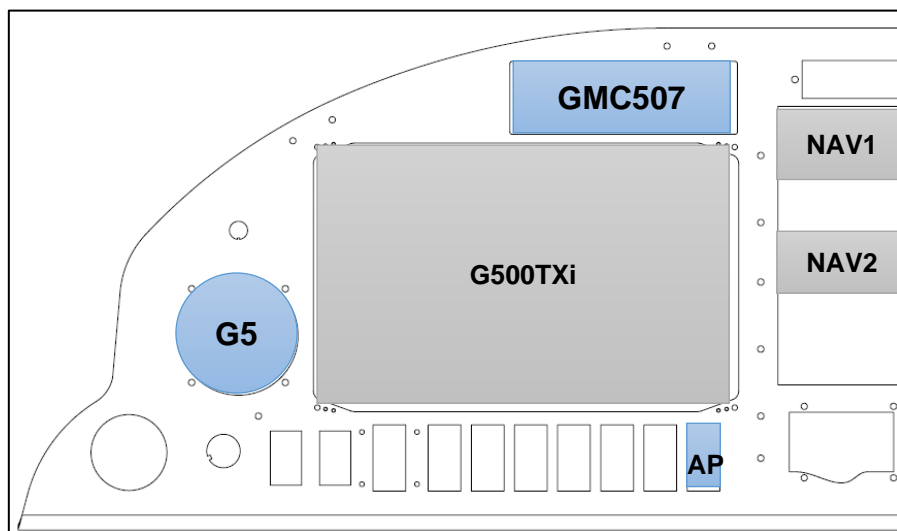
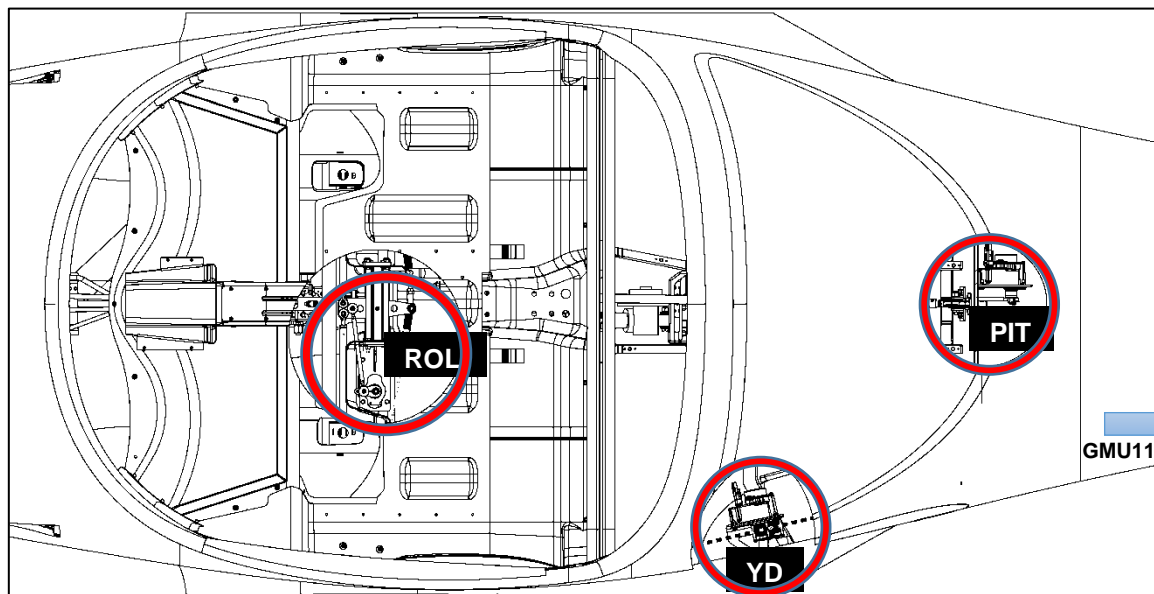
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7. SYSTEMS DESCRIPTION

Integration into the AQUILA

The restricted Garmin GFC500 Autopilot System is connected to the power supply of the AQUILA through the aircraft's MAIN BUS via a rocker switch also acting as circuit breaker (8A) which is marked **AP**.

Besides the Garmin GMC507 Mode Controller and the Garmin G5 visible at the instrument panel, two GSA28 servos for Pitch and Roll, a GPS antenna, a GMU11 magnetometer, a GAD29B analog/digital converter and an **AP DISC** button on each of the two control sticks are part of the system. Optionally an additional GSA28 servo can be installed as Yaw Damper.



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G5 with GFC500 Autopilot

The Garmin G5 sends attitude, turn rate and acceleration data via CAN-Bus to the GSA28 servos. As an additional aid for computing of the Flight Director as well as for the control and monitoring of the Autopilot, G5's indicated airspeed (IAS), vertical speed (VS), pressure altitude and GPS information is used.

Flight Director (FD) / Autopilot (AP)

The Flight Director is computed by the Garmin G5 and displayed as command bars (single cue) or separate bars for lateral and vertical attitude indications (dual cue).

The Autopilot provides control commands according to the target values of the Flight Director via a PITCH, ROLL and (optional) YAW servo.

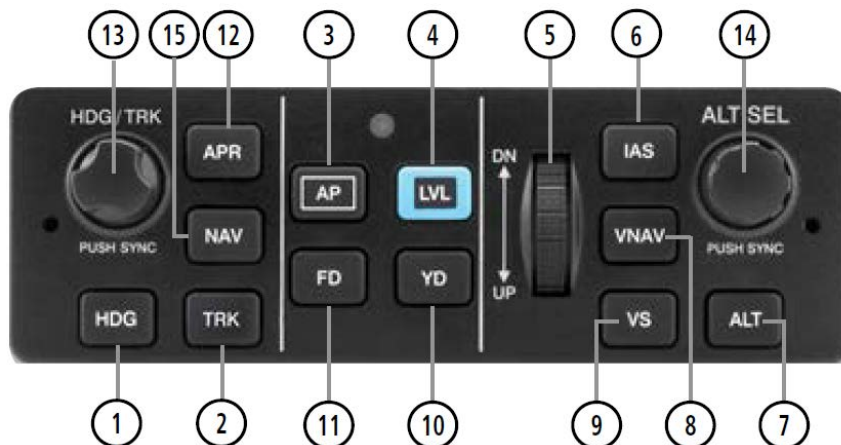


- | | | |
|------------------------------|---------------------------------|------------------------------------|
| 1 Airspeed Indicator | 11 Slip/Skid Indicator | 21 Selected Vertical Speed |
| 2 Attitude Indicator | 12 Turn Rate Indicator | 22 Navigation Course |
| 3 Pitch Scale | 13 Altimeter Barometric Setting | 23 Vertical Speed Mode |
| 4 Current Airspeed | 14 Selected Vertical Speed | 24 Current Heading or Ground Track |
| 5 Command Bars | 15 Vertical Speed Indicator | 25 Auto Pilot Mode |
| 6 Aircraft Symbol | 16 Current Altitude | 26 Rate of Turn Triangles |
| 7 V-speed Reference | 17 Vertical Speed Bug | 27 GPS Mode |
| 8 Course Deviation Indicator | 18 Altimeter | 28 Battery Status |
| 9 Ground Speed (GS) | 19 Selected Altitude | 29 True Airspeed |
| 10 Outside Air Temperature | 20 Altitude Select Mode | |

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GMC507 Mode Controller

The primary user interface of the Autopilot and the Flight Director is the GMC507 Mode Controller. The GMC507 has internal sensors to measure and calculate attitude, turn rate and acceleration. These sensors are completely independent from the sensors of the G5 and the rest of the Autopilot system. They are not used for the Flight Director or the Autopilot, instead they serve for independent monitoring of the GFC500 System.



1	HDG Key	Select / Deselect Heading Mode
2	TRK Key	Select / Deselect Track Mode
3	AP Key	Engage / Disengage Autopilot
4	LVL Key	Engage / Disengage Autopilot in Level Mode (vertical+lateral)
5	NOSE UP/DN Wheel	Adjust the reference for vertical Modes
6	IAS Key	Select / Deselect Indicated Airspeed Speed Mode
7	ALT Key	Select / Deselect Altitude Hold Mode
8	VNAV Key	Select / Deselect Vertical Navigation Mode
9	VS Key	Select / Deselect Vertical Speed Mode
10	YD Key	Engage / Disengage Yaw Damper (if installed)
11	FD Key	Activate / Deactivate the Flight Director Press 1x for display of the default Mode Press again to Deactivate
12	APR Key	Select / Deselect Approach Mode (Usage not permitted! See Chapter 1.)
13	HDG/TRK Knob	Adjust Heading Bug
14	ALT SEL Knob	Adjust Altitude Bug
15	NAV Key	Select / Deselect Navigation Mode

See the latest Garmin G5 Pilots Guide for further information.

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FD / AP Modes

The Flight Director / Autopilot Modes are displayed on the G5 in the status box of the Autopilot. Active Modes are shown in green, Armed Modes in white.

The transition to an Armed Mode is indicated by blinking for 10 seconds before the now armed Mode symbol turns white. The transition from an Armed Mode is indicated by blinking for 10 seconds before the now active Mode symbol turns green.



















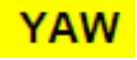
GMC507 Control	Modes Selected	
	Lateral	Vertical
FD	Roll Hold (default) ROL	Pitch Hold (default) PIT
AP		
ALT		Altitude Hold ALT
VS		Vertical Speed VS
VNAV		Vertical Navigation VNAV
IAS		Indicated Airspeed IAS
APR*	Approach GPS/VOR/LOC/ILS	Pitch Hold (default) PIT
NAV	Navigation GPS/VOR/LOC	
HDG	Heading Select HDG	
TRK	Track Select TRK	
LVL	Level Hold LVL	Level Hold LVL

* Usage not permitted! See Chapter 1.

Roll Hold Mode (default) ROL:		Pitch Hold Mode (default) PIT:
Bank Angle	Action	Limits from Flight Director (min/max ALT, IAS, ...)
< 6°	Roll Wings level	
6 bis 20°	Hold Bank Angle	
> 20°	Limits Bank to 20°	

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GFC500 Alert Messages and Symbols

Message	Description
AFCS Controller Key Stuck	The system has sensed a key input on the GMC507 for 30 seconds or longer
AFCS Controller Audio Database Missing	The audio database is missing from the GMC 507
Servo Clutch Fault	One or more autopilot servos has a stuck clutch. The servo needs service
Symbol G5 / G500TXi	
	Autopilot has failed
 / 	Autopilot normal disconnect (manually)
	Autopilot abnormal disconnect (automatically)
	The autopilot is inoperative. Flight Director modes may still be available
	Autopilot Overspeed Protection ist active, commands „Nose up“
	Autopilot Underspeed Protection ist active, commands „Nose down“
	automatic preflight test in progress
	automatic preflight test failed
 	Autopilot reports high „Nose down“ force required, The pitch trim needs to be adjusted nose down
 	Autopilot reports high „Nose up “ force required, The pitch trim needs to be adjusted nose up
 	Yaw Damper normal disconnect (manually)
 	Yaw Damper is inoperative. Autopilot may still be available
 	Yaw Damper abnormal disconnect (automatically)

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8. HANDLING, SERVICING AND MAINTENANCE

Operation of Avionics

To maximize the lifetime of the Autopilot System it should be turned off while starting or shutting down the engine. During this phase voltage peaks can occur, which might damage the system.

Maintenance of the Autopilot System

Refer to latest Maintenance Manual of the AQUILA AT01-100/200.

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