DFC90 DIGITAL AUTOPILOT WITH VANTAGE12

Pilot's Guide

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with Vantage12 Pilot Guide

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1 System Overview

The DFC90 is a digital autopilot that delivers precise flight control and safety features on Vantage 12 equipped Cirrus aircraft. As an attitude-based autopilot it leverages the output of the Air Data and Attitude-Heading Reference System (ADAHRS) embedded in the PFD and provides noticeably improved performance over a rate-based autopilot.

This manual assumes that the pilot is appropriately licensed, is proficient in operation of the aircraft and its equipment, and is in compliance with all Federal Aviation Regulations (FARs).

All images contained in this manual are for reference use only and are subject to change.

This manual presumes that the flap position sensor wiring has been installed.

Avidyne strongly recommends that pilots use the DFC90 system only under VFR conditions until completely familiar with its operation and use.

Boxed areas marked as **NOTE** within this manual identify certain situations or areas of operation having safety implications. While it is important for the operator to be familiar with all of the information in the manual, it is essential to the safe use of the DFC90 that pilots give careful attention to the material contained within these **NOTE**s.

Boxed areas marked as **WARNING** within this manual identify certain situations or areas of operation having unique and heightened safety implications.

Figure 1: DFC90 Digital Flight Control System

In order to avoid a diversion of attention from the task of safely taxiing, pilots should avoid performing the described cockpit tasks while the aircraft is in motion on the airport surface. It remains the pilot's duty to monitor the autopilot for proper function upon activation and during use.

Internal DFC90 data logs are property of Avidyne.

FUNCTIONAL OVERVIEW

The Avidyne DFC90 autopilot supports the following functions:

- Flight Director
- Heading Capture & Hold
- NAV Tracking
- GPSS Mode
- Approach Mode (includes LOC, ILS, VOR, BC, LPV, LP, LNAV/VNAV, LNAV+V)
- Altitude Hold
- Altitude Capture
- Vertical Speed Hold
- Indicated Airspeed Hold
- Straight and Level
- Speed-based Envelope Protection (EP™)
- Full-time Envelope Alerting (EA™)
- Pilot Selectable Intercept Angles
- Control Wheel Steering (not available in all aircraft)

NOTE

Envelope Protection vs. Envelope Alerting
There is a distinction between Envelope Protection (EP™) and Full-time Envelope Alerting (EA™). Envelope Protection (EP™) will result in active driving of the flight control surfaces by the autopilot. Full-time Envelope Alerting (EA™) will only provide visual and aural alerting but it is up to the pilot to manually make any control changes.

GENERAL AUTOPILOT OPERATIONS

The Digital Flight Control (DFC) DFC90 autopilot is a required component of the Avidyne Vantage 12 system.

The DFC90 uses the Vantage 12 Air Data Computer and the Attitude-Heading Reference System (AHRS) embedded in the PFD or MFD.

The pilot should not attempt to provide “active assistance” to the autopilot by utilizing yoke controls when engaging the autopilot or while the autopilot is engaged in AP mode.

ALWAYS A VERTICAL AND LATERAL MODE ENGAGED

When coupled, the DFC90 will always have both a lateral and vertical mode engaged. If a specific lateral mode has not been selected by the pilot, then the system defaults to Roll Hold mode. If a specific vertical mode has not been selected by the pilot, then the system defaults to Pitch Hold mode.

SINGLE PRESS TO HOLD, DUAL BUTTON PRESS TO CAPTURE

A single button press is typically required to engage a desired hold mode, while pushing two buttons simultaneously is typically required to enter a capture mode. For example, to engage altitude hold, press ALT; to engage heading hold, press HDG, to hold indicated airspeed, press IAS. Likewise, to engage a vertical mode that will result in capturing a new altitude, press both IAS

and ALT or VS and ALT simultaneously, to capture a course, press both HDG and NAV simultaneously, etc.

PRIMARY LOCATION FOR BUG/TARGET SETTING

The primary location for setting the IAS and VS targets is via the dedicated knobs on the autopilot control head.

The primary location for setting the HDG and ALT targets are via the knobs on the Vantage 12 PFD.

VS and IAS targets can optionally be set via the Vantage 12 touchscreen. Both the VS and IAS targets stay synced between the two locations for setting targets.

AURAL ALERTS

Aural alerting, through the aircraft intercom system, is provided for warnings from the autopilot. Coupled describes the condition when the autopilot servos are flying the airplane and non-coupled describes the condition when the servos are not flying the airplane and the pilot is expected to follow the flight director command bars, if present. Specifically, aural alerts as defined in the parenthesis are provided under the following conditions:

- Autopilot Disengaged (approx 16 Disconnect beeps)
- Underspeed during coupled operations (“Speed Protection Active”)
- Overspeed during coupled operations (“Speed Protection Active”)
- Overspeed during non-coupled operations (“Caution, Overspeed”)
- POH bank limit exceeded (“Caution, Excessive Bank”)
- POH 1st notch flap limit exceeded (“Caution, Flap Overspeed”)

ARMED VS ENGAGED MODES INDICATIONS

The DFC-series of autopilots has readily distinguishable armed vs. engaged modes in order to provide the user with higher awareness of the current autopilot state and upcoming state transitions.

An armed mode is defined as a state that will be captured when and if the airplane crosses that target. Armed modes are indicated by a cyan (blue) color on both the autopilot control panel and on the PFD mode annunciator strip.

An engaged mode is defined as a state that the autopilot is holding. Engaged modes are indicated by a green color on both the autopilot control panel and on the PFD mode annunciator strip.

The images below demonstrate the armed and engaged coloring on the autopilot control head. In this example, Heading (HDG) and Pitch modes are engaged and Nav mode is armed.

MODE TRANSITION INDICATION

Automatic transition from armed (cyan) to engaged (green) states is indicated by the cyan armed button on the autopilot control panel and mode annunciation on the PFD changing to green and flashing for up to 10 seconds.

MANUAL ELECTRIC TRIM IMPACT

Any attempt to engage manual electric trim (MET) via the cockpit controls will result in the autopilot disconnecting and then the trim running as commanded by the MET control.

NOTE

Trim Behavior in DFC90-equipped Aircraft
For some aircraft, if the airplane is equipped with a pitch servo, actuating the trim switch will disconnect the AP. For some aircraft that are equipped only with pitch trim, actuating the trim switch will have no effect during autopilot operations (trim will not adjust and the AP will not disengage). For predictability of results, pilots of DFC90-equipped aircraft should therefore determine whether the aircraft is equipped with a pitch servo or pitch trim and the resulting behavior before actuating the trim switch in IMC conditions.

ENVELOPE PROTECTION (EP™)

The DFC90 system provides speed-based Envelope Protection (EP™) (underspeed and overspeed warnings and protection) when in any coupled autopilot mode.

NOTE

No Envelope Protection in Flight Director Mode
Envelope Protection (EP™) is not provided during flight director-only (non-coupled) operations.

NOTE

Aircraft Stall Possible with Envelope Protection
Conditions can exist where an aircraft can be placed in an attitude and/or configuration that would exceed the capability of the Envelope Protection (EP™) system to prevent a stall.

When the servos are engaged (AP mode), the likelihood that a command can be made which results in an autopilot induced stall is significantly reduced over conventional autopilots. If for example, a positive rate of climb was commanded and a low power setting is being held, the autopilot will attempt to achieve the commanded state but as the energy of the airplane decays to approximately 1.2 V_s, the autopilot will adjust bank angle and then pitch angle as required to maintain no lower than 1.2 V_s. Bank angle may be reduced before pitch is adjusted in an effort to avoid even entering Envelope Protection (EP™). As soon as bank angle is adjusted by the autopilot, the pilot is alerted through visual means on the PFD (a yellow “**UNDERSPEED**” text alert and any engaged (green) autopilot mode annunciator will flash) and as soon as pitch is adjusted, the pilot is alerted through the same visual means on the PFD, and aural alerting in the headsets (“SPEED PROTECTION ACTIVE”). In all cases, when underspeed protection is active, the maximum bank angle will be reduced, typically to 5 degrees.

Similarly, Envelope Protection (EP™) will provide high-speed protection and alerting near V_{ne}. In this case, as V_{ne} is approached in AP mode, the autopilot will adjust pitch as required to maintain an airspeed near V_{ne}. Aircraft bank angle is not adjusted by the autopilot during overspeed protection. Depending on conditions (e.g. rapidly changing airspeed, turbulence, etc.), it is possible for V_{ne} to be exceeded. An overspeed condition is annunciated to the pilot via a yellow "**OVERSPEED**" text alert on the PFD, a "SPEED PROTECTION ACTIVE" aural alert in the headsets, and by a flashing of any engaged (green) autopilot mode annunciators.

The DFC90 takes flap position into account in Envelope Protection (EP™) and Envelope Alerting (EA™) calculations and as a result, the definition of V_s, changes depending on flap position.

NOTE

Envelope Protection During Icing Conditions
The DFC90 autopilot is not to be used during icing conditions. The autopilot does not have any kind of AOA or icing input and therefore does not register changing aircraft dynamics during icing conditions. Therefore, Envelope Protection (EP™) is not effective under icing conditions.

ENVELOPE ALERTING (EA™)

The DFC90 autopilot provides speed-based and attitude-based envelope alerting when the autopilot is not engaged (servos not coupled).

Full-time Envelope Alerting (EA™) is triggered when the DFC90 recognizes an underspeed, overspeed, flap overspeed or excessive bank angle condition and will alert the pilot via text alerts on the PFD and aural alerts.

Full-time Envelope Alerting (EA™) is provided during flight director operations (servos not coupled). Envelope Alerting (EA™) is also provided when the autopilot and flight director are off and the autopilot is in the standby position as noted by the **AP READY** mode annunciator on the top strip of the PFD.

NOTE

Suppression of Full-time Envelope Alerting
Full-time Envelope Alerting (EA™) is suppressed during very low power (near idle) conditions when flaps are set to the full-flap position in order to minimize nuisance calls in the landing phase. Full-time Envelope Alerting (EA™) is also suppressed anytime Indicated Airspeed is less than 50 KIAS.

In Flight Director operations, the flight director command bars will continue to direct a pilot to fly to the commanded pitch and roll targets as defined by the bug and nav source entries but if an underspeed condition is recognized, a yellow "**UNDERSPEED**" text alert is displayed on the PFD and a "CAUTION, UNDERSPEED" aural alert is played in the headsets and is repeated approximately every 6 seconds until the condition is no longer valid. The autopilot mode annunciators do not flash during Envelope Alerting* (EA™). The trigger for this Envelope Alerting (EA™) underspeed alert is when the system has determined $1.2V_s$ has been reached. Flap position, bank angle and g-loading are taken into account to define V_s at any point in time (assumes max gross weight).

Similarly, during high-speed flight director operations, the flight director command bars will continue to direct a pilot to fly to the commanded pitch and roll targets as defined by the bug and nav source entries but if an overspeed condition is recognized, a yellow "**OVERSPEED**" text alert is displayed on the PFD and a "CAUTION, OVERSPEED" aural alert is played in the headsets and is repeated approximately every 6 seconds until the condition is no longer valid. There is no flashing of any autopilot mode annunciator during Envelope Alerting (EA™).* The trigger for this Envelope Alerting (EA™) overspeed alert is when the system has determined V_{ne} is about to reached.

If the autopilot is not engaged in any Autopilot or Flight Director modes and is in the standby condition, as indicated by the green "**AP READY**" annunciator on the PFD and no green or cyan lights on the autopilot control head, Full-time Envelope Alerting (EA™) is still active. In this case, there are no flight director command bars present and no autopilot mode annunciators aside from the "**AP READY**" one along the top edge of the PFD.

If an underspeed condition is recognized, a yellow "**UNDERSPEED**" text alert is displayed on the PFD and a "CAUTION, UNDERSPEED" aural alert is played in the headsets and is repeated approximately every 6 seconds until the condition is no longer valid. The trigger for this Envelope Alerting (EA™) underspeed alert is when the system has determined $1.2V_s$ has been reached. Flap position, bank angle and g-loading are taken into account to define V_s at any point in time. One common scenario this capability is designed to alert against is a traffic pattern stall.

Similarly, on the high-speed end of the spectrum with the autopilot in the standby condition (green "**AP READY**" along the top strip of the PFD pages), if an overspeed condition is recognized, a yelllow "**OVERSPEED**" text alert is displayed on the PFD pages and a "CAUTION, OVERSPEED" aural alert is played in the headsets and is repeated approximately every 6 seconds until the condition is no longer valid. The trigger for this Envelope Alerting (EA™) overspeed alert is when the system has determined V_{ne} is about to be reached.

If at any time and in any flight director or standby state, the system detects an excessive bank condition, a yellow "**BANK LIMIT**" text alert is displayed on the PFD pages and a "CAUTION, EXCESSIVE BANK" aural alert is played in the headsets and is

repeated approximately every 6 seconds until the condition is no longer valid. The trigger for this Envelope Alerting (EA™) excessive bank limit is when the system has determined that the lesser of aircraft category or aircraft POH bank angle limits has been exceeded. This number is typically 60 degrees of bank.

If the autopilot system detects a flap overspeed condition per POH flap deployment speed limitations, a “CAUTION, FLAP OVERSPEED” aural alert is played in the headsets and is repeated approximately every 6 seconds until the condition is no longer true. There is no associated text alert.

If “**AP READY**” or “**FD**” are not displayed on the PFD page, Full-time Envelope Alerting (EA™) may not be available.

To disable Full-time Envelope Alerting (EA™), pull the autopilot circuit breaker.

BARO ADJUST

Upon input of a new barometric altimeter setting, the autopilot automatically re-captures the previously set target altitude, without further action required from the pilot. For example, if the autopilot is in Altitude Hold, changing the barometric pressure setting will result in the autopilot automatically correcting the appropriate amount to re-capture the previous altitude hold target.

ENGAGEMENT AND HOLD LIMITS

The DFC90 has maximum engagement limits beyond which the autopilot may not allow a mode to be selected, and maximum hold limits for various parameters. The engagement limits of the autopilot are wider than the hold limits. If the autopilot is engaged between the maximum engagement limits and the maximum hold limits, the autopilot will reduce the value to be within the published maximum hold limits. (* value may vary with airframe)

The maximum engagement and hold limits are as follows:

Autopilot Mode	**Maximum Demonstrated Engagement Limits**	**Maximum Hold Limits**
Roll Hold	±60° bank	±22°bank
Heading	±60° bank	±22° bank (but typically holds 1 standard rate of turn)
Pitch Hold	±30° pitch	±10° pitch
IAS Hold	20 KIAS to V_{ne}	1.2V_s to 185* KIAS
VS Hold	±1600 fpm	±1600 fpm
Straight and Level	±60° bank, ±30° pitch	Will stabilize in +2° pitch and zero bank angle
Localizer, VOR, GPS approach **Capture**	Not Applicable	±22° bank
Localizer, VOR, GPS approach **Track**	Not Applicable	±10° bank

AUTOPILOT ENGAGEMENT

From a standby state (autopilot has power, “AP READY” displayed but no modes are engaged and the airplane is within the engagement limits defined above), pressing any button on the autopilot will engage the DFC autopilot. If a specific lateral and/or vertical mode is not pressed, the system will default to ROLL hold mode in the lateral channel and PITCH hold mode in the vertical channel.

From a standby state:

- Press “AP” → autopilot (servos coupled) engages in **ROLL** and **PITCH** and will hold whatever bank and pitch was present at time of pressing (assuming within command limits)
- Press “FD” → flight director (servos not coupled) engages in **ROLL** and **PITCH** and will command via the green flight director command bars whatever bank and pitch was present at time of pressing (assuming within command limits). It is still up to the pilot to maneuver the plane as required to follow those command bars.
- Press “STRAIGHT & LEVEL” → autopilot (servos coupled) engages and drives the airplane from whatever attitude it is in to zero bank and a small positive pitch that approximates level flight.
- Press any other button(s) on the autopilot → autopilot (servos coupled) engages and will enter the modes as commanded.

AUTOPILOT DISENGAGEMENT

The autopilot can be disengaged using any one of the following methods:

- Press the AP Disconnect switch on the control yoke (in some aircraft, this is a dedicated button and in others, it requires a push in of the trim hat on the yoke);
- Activate the pitch-axis trim switch on the control yoke (this does not apply on pitch trim-only aircraft);

- Press the “AP” button on the autopilot control panel (servos will disconnect but the flight director will remain active);
- Pull the circuit breaker(s) controlling the power to the autopilot.

For those aircraft with the stall warning wired directly to the autopilot, the autopilot will also disconnect if the stall warning alarm is present in the aircraft.

In most cases, the autopilot disconnect will be accompanied by a 16-beep disconnect aural alert. This tone can be muted by pressing the AP Disconnect switch on the control yoke.

FD VS. AP

The status of the reference bugs, autopilot annunciators, autopilot control head, and flight director steering command bars indicate when the PFD is coupled with the autopilot.

A solid magenta heading, altitude, IAS or VS bug indicates that function is currently coupled to an engaged or armed mode of the autopilot or the flight director. A hollow magenta bug indicates that the function is not currently coupled to the autopilot or flight director in an engaged or armed mode. In other words, the autopilot and flight director, are ignoring any hollow magenta bug.

The flight director command bars will indicate the required steering of the aircraft to achieve the commanded tracking of the autopilot. In full autopilot mode, both the “AP” and “FD” buttons will be lit on the autopilot control panel and “AP” will be displayed in the autopilot annunciation field on the display, the command bars will be visible and **magenta** and the aircraft should track those bars very precisely.

In Flight Director only mode, only the “FD” button (and not the “AP” button) will be lit on the autopilot control panel and “FD” will be displayed in the autopilot annunciation field on the display, the command bars will be visible and **green**, and the pilot is expected to use the flight controls as required to track those bars. In Flight Director only mode, the pilot is hand flying the airplane and is expected to guide the aircraft such that the yellow aircraft reference symbol is tucked into the steering command bars.

The flight director command bars in a DFC90 autopilot are designed for easy use and improved performance during uncoupled autopilot operations.

During coupled operations (both “AP” and “FD” buttons lit), pressing the “FD” button will have no effect. Pressing the “AP” button in this state will toggle the “AP” mode on/off. It is a good way to disconnect the servos but continue to have flight director command bars present. The recommended way to disengage both the “AP” and “FD” modes will be via trim or the AP Disconnect switch on the control yoke as described above.

DUAL PFD OPERATIONS

In a Vantage 12 for Cirrus installation, both displays can drive the DFC90. The PFD is normally driving the autopilot. The pilot can manually select to use the MFD’s attitude (and air data, if installed). In the event of a PFD failure, the autopilot will switch to the MFD.

A display-to-display Miscompare will not affect the DFC90.

PFD ANNUNCIATIONS

The top strip of the PFD is dedicated for autopilot mode annunciators. Active modes are depicted in green and armed modes are depicted in cyan. Alerts are depicted in yellow and are listed in order of priority. If multiple alerts are received, then the highest priority message is displayed.

Whenever "**UNDERSPEED**" or "**OVERSPEED**" are displayed while the autopilot is coupled, all engaged (green) autopilot mode annunciators will flash.

The table below is a listing of all annunciations that are possible with the DFC90 system.

DFC90 Annunciations

	AP/FD Mode	Armed Lateral	Active Lateral	Active Vertical	Armed Vertical	Alerts
Normal Annunciations	AP	NAV	ROLL	PITCH	ALT	TRIMMING UP
	FD	NAV APPR	HDG	ALT	GS	TRIMMING DN
	AP READY	GPSS	NAV	IAS		GPSS INVALID
	CWS	GPSS APPR	NAV APPR	VS		NAV INVALID
			GPSS	GS		GS INVALID
			GPSS			NO PFD COMM
			GPSS APPR			SERVO LIMIT
			GPSS APPR			BANK LIMIT
			45° INT			AUDIO FAIL
						MSR FAIL
Envelope Protection	OVERSPEED					
	UNDERSPEED					
Straight & Level	STRAIGHT AND LEVEL					
Autopilot Inop	AUTOPILOT INOP					
	AUTOPILOT INOP AHRS FAIL					
	AUTOPILOT INOP SELF TEST FAIL					
	AUTOPILOT INOP AHRS ALIGNING					
	NO COMMUNICATION WITH AUTOPILOT					
Disconnect	AUTOPILOT DISCONNECTED					

2 Normal Startup Sequence

POWER CONSIDERATIONS

The DFC90 consumes 0.25A when no servos are in operation and up to 0.9A with all servos operating at 100% duty cycle.

There is no power switch for the DFC90. As soon as the power bus is active, the autopilot will power up.

SELF-TEST/ALIGNMENT

The DFC autopilot requires two events to be fully functional. The first is a successful completion of a self-test and the second is a successful alignment of the ADAHRS. To assure readiness of the autopilot for flight, it is also recommended that the pilot conduct the Pre-Flight Test described later in this chapter.

DFC self-test takes less than 5 seconds following power application. The normal self-test indications are a lighting of lights on the autopilot control panel for approximately 1-2 seconds on each color. The lighting color order is White-Cyan-Green-White. Self-test should be considered a success after the button lighting with no associated failure message along the top strip of the PFD.

The top strip of the PFD will display an annunciation that the autopilot is INOP (inoperative) while the ADAHRS is aligning. The message will explicitly state that the ADAHRS is aligning. Any other anomaly during alignment is displayed as a descriptive annunciation along that same top annunciator strip on the PFD.

BRIGHTNESS CONTROLS

The autopilot control head button and knob lighting is controlled via the cockpit dimming controls.

If the autopilot control panel appears inoperative but the PFD is showing autopilot active, check the instrument lighting control on the bolster to ensure it is not set to a dim position.

PRE-FLIGHT TEST

1. Ensure “AP READY” is displayed on PFD annunciator strip
2. Press AP button on autopilot control head
    a. Ensure AP button is lit in green
    b. Ensure “**AP**”, “**ROLL**”, “**PITCH**” annunciations are depicted in green on the PFD annunciator strip
3. Set the Heading Bug to be approximately 90 degrees off current aircraft heading
4. Press HDG button on autopilot control head
    a. Ensure HDG button is lit in green
    b. Ensure the ailerons are being driven in the proper direction by the servos (movement is slow and can be hard to see)
    c. Ensure “**HDG**” annunciation has replaced ROLL annunciation and that it is depicted in green on the PFD annunciator strip (a yellow “**SERVO LIMIT**” may also be displayed – this is normal in some aircraft)
5. Press the AP Disconnect switch on the control yoke
    a. Ensure the aural autopilot disconnect tone is heard in the headset
    b. Ensure “**AUTOPILOT DISCONNECTED**” annunciation is depicted in yellow on the PFD annunciator strip
    c. Ensure “**AP READY**” annunciation is then depicted in green on the PFD annunciator strip
6. Trim the aircraft to the appropriate pre-takeoff position in accordance with normal aircraft checklist procedures.

NOTE

Preflight Test Does Not Test Every Aspect of AP
The Pre-Flight test of the DFC90 autopilot outlined above will check the functionality of such items as the ability of the autopilot to engage and disconnect, the ability of the autopilot to engage the roll axis control surfaces, and the communications between the autopilot and the PFD. However, the Pre-Flight test does not check the function of every item essential to the use of the autopilot. It remains the pilot's duty to monitor the autopilot for proper function upon activation and during use.

BEFORE TAKEOFF TECHNIQUES

A normal technique is to set up the desired autopilot targets while on the ground (e.g. IAS or VS, ALT and HDG bugs).

Neither the Flight Director or Autopilot should be engaged until in-flight and at a safe altitude, a minimum of 200' AGL.

3 Climb-out/Enroute

This section covers normal modes of the autopilot during climb-out and enroute operations as well as procedures, mode control and display.

NORMAL OPERATING MODES

Envelope Protection (EP™) is active in all of the autopilot modes defined below.

PITCH HOLD

In Pitch Hold mode, the autopilot will maintain a constant pitch from the moment of mode entry. If the mode was entered at a pitch that exceeds the maximum hold limit, the pitch will be reduced to the maximum hold limit value.

Pitch mode is the default vertical mode if no other vertical mode was selected at time of autopilot activation.

There is no specific Pitch Hold button on the autopilot control head. The commanded pitch may be modified by using CWS in Pitch Hold mode.

The autopilot modes annunciator indication is green “**PITCH**” on the PFD.

ROLL HOLD

In Roll Hold mode, the autopilot will maintain a constant bank angle from the moment of mode entry. If the mode was entered at a bank angle that exceeds the maximum hold limit, the bank angle will be reduced to be the maximum hold limit value.

Roll mode is the default lateral mode if no other lateral mode was selected at time of autopilot entry.

There is no specific Roll Hold button on the autopilot control head. The commanded bank may be modified using CWS once in Roll Hold mode.

The autopilot modes annunciator indication is green “**ROLL**”.

HEADING (HDG)

Heading mode is entered by pressing the “HDG” button on the autopilot control panel. The system will light up the control panel button in green and track the set heading bug value and the bug will become solid magenta. Select a new heading by moving the heading bug at any time while the autopilot is in heading mode and the autopilot will track the new bug value.

The aircraft will turn in the same direction that the heading bug knob was turned. If the knob was turned 300 degrees to the right, the airplane will turn to the right for 300 degrees.

Typical bank angles used in heading mode is 1 standard rate of turn, up to a maximum of 22 degrees of bank.

The autopilot modes annunciator indication is green “**HDG**”.

NAVIGATION (NAV)

Nav mode is entered by pressing the “NAV” button on the autopilot control panel. The system will light up the control panel button in green and track the lateral profile provided by the navigation source that is selected in the Primary Nav field. This can be either GPS or VLOC.

The system will seek a 45-degree intercept angle to the selected nav course unless either the aircraft is sufficiently close to the commanded course (at which time it is in capture mode) or the pilot has set up a pilot-selectable intercept angle of something other than 45 degrees.

Typical bank angles used during Nav mode intercepts are 22 degrees and this may be reduced if in close proximity to the intended course or during VOR station passage.

The system will briefly transition to a coast mode during VOR station passage within the “cone-of-confusion” and any entered course changes while inside that area will result in a smooth turn to a wind-corrected heading until the station signal is re-acquired and signal tracking can resume.

For the condition when Nav mode is executing a 45 degree intercept, this is depicted by a cyan “**NAV**” autopilot mode annunciator indicating Nav mode is armed, followed by a green “**45° INT**” indicating the system is currently conducting a 45

degree intercept of the commanded Nav course. When the transition to captured course happens, the green "**45° INT**" extinguishes and in its place a green "**NAV**" is displayed.

NOTE

Approaches with Curved Paths Must Use GPSS
Certain GPS procedures involving curved paths can not be flown in NAV mode (e.g. holds, DME arcs, etc). GPSS mode must be used for those procedures.

GPS ROLL STEERING (GPSS)

GPSS mode is entered by pressing the "GPSS" button on the autopilot control head. The system will light up the control panel button in green and track the lateral profile provided by the navigation source to the active GPS waypoint.

In GPSS mode, the selected IFD is driving the intercept angle and subsequent course tracking. GPSS mode intercept and tracking generally provide better performance than Nav mode.

If the Primary Nav field on the PFD is not set to a GPS source (GPS1 or GPS2), then the "**GPSS**" autopilot mode annunciator is lit in yellow indicating you have a VHF source driving the CDI depiction and GPS source driving the autopilot.

If GPSS mode has been selected on the autopilot control head, and there is no active GPS waypoint, then "**GPSS INVALID**" is also depicted along the autopilot modes annunciator line of the PFD. The aircraft will continue in wings level flight in this situation.

ALTITUDE HOLD (ALT)

Altitude Hold mode is entered by pressing the “ALT” button on the autopilot control panel. The system will light up the control panel button in green, sync the altitude bug on the altimeter to current altitude and turn it solid, and hold the altitude at the time of mode entry.

If the barometric setting is subsequently adjusted, the airplane will automatically climb or descend as required to reacquire the selected altitude.

If the altitude bug is moved more than 50’ away from the holding altitude, it will turn hollow. The autopilot does not command an aircraft altitude change at this point and it provides a means for a new future altitude target to be preset.

The only place to set the Altitude bug is via the PFD.

The autopilot modes annunciator indication is green “**ALT**”.

Altitude hold mode will sync to the nearest 10 feet on the Vantage 12 display.

INDICATED AIRSPEED (IAS) HOLD

Indicated Airspeed Hold mode is entered by pressing the “IAS” button on the autopilot control panel. The system will light up the control panel button in green, and adjust the aircraft pitch as required to achieve the selected indicated airspeed target and turn the IAS bug solid. If already in IAS mode, any subsequent adjustments to the IAS bug sets a new IAS target for the system and aircraft pitch is automatically adjusted to achieve that new IAS target.

In aircraft equipped with pitch trim only (no separate pitch servo), this mode is still functional but may feel less precise than those aircraft that also have a pitch servo. In these cases, the aircraft IAS may vary by as much as 5 knots around the target IAS as the trim system works to hold the target IAS.

The minimum settable IAS bug is V_{so} and the maximum settable IAS bug is V_{ne}.

The primary location to set the IAS bug is via the dedicated IAS knob on the autopilot control panel. The knob has a push-to-sync capability that will sync the target IAS to the current aircraft IAS.

A secondary method is via the PFD. See the Vantage 12 pilot guide for more information.

The autopilot modes annunciator indication is green “**IAS**”. There is no armed (cyan) IAS mode.

VERTICAL SPEED (VS) HOLD

Vertical Speed Hold mode is entered by pressing the “VS” button on the autopilot control panel. The system will light up the control panel button in green, turn the VS bug solid and adjust the aircraft climb/descent rate as required to match the bug setting.

The range of settable VS targets is ±1600 fpm.

The primary location to set the VS bug is via the dedicated VS knob on the autopilot control head. The knob has a push-to-sync capability that will sync the target VS to the closest 50 fpm to the current aircraft VS. A secondary method is via the PFD. For more information, see the Vantage 12 pilot guide.

The autopilot modes annunciator indication is green “**VS**”. There is no armed (cyan) VS mode.

The touchscreen on Vantage 12 can be used to set the Vertical Speed target. The bug can be dragged, or the keypad can be used to enter a value.

ALTITUDE CAPTURE

Altitude captures can be performed using either IAS or VS.

To perform an indicated airspeed-based altitude capture, set both the IAS bug and the ALT bug to the desired values and press both the “IAS” and “ALT” buttons on the autopilot control panel simultaneously. The system will light up the IAS button in green and turn the IAS bug solid and light up the ALT button in cyan and turn the ALT bug solid. Assuming a logical combination of speed and altitude were selected, the aircraft will immediately start a pitch change to seek the target indicated airspeed. A pilot throttle input may be required to sustain the target airspeed.

NOTE

Logical Combination of Commanded Targets
A logical combination of commanded autopilot targets means a combination of the altitude bug and either the vertical speed bug or indicated airspeed bug that can be achieved. For example, an altitude bug that is above current aircraft altitude and a positive vertical speed bug is a logical combination. In contrast, an altitude bug that is above current aircraft altitude and a negative vertical speed bug is NOT a logical combination.

To perform a vertical speed-based altitude capture, set both the VS bug and the ALT bug to the desired values and press both the “VS” and “ALT” buttons on the autopilot control panel simultaneously. The system will light up the VS button in green and turn the VS bug solid and light up the ALT button in cyan and turn the ALT bug solid. Assuming a logical combination of vertical speed and altitude were selected, the aircraft will immediately start a pitch change to seek the target vertical speed. If a logical combination wasn’t already preset, the VS bug will jump to +/- 500 fpm and then the aircraft will climb or descend as required. If, during a vertical speed-based altitude capture, either the target vertical speed or altitude are changed to become an illogical combination, the aircraft will fly the target vertical speed. A pilot throttle input may be required to sustain the target vertical speed.

In the case of an indicated airspeed-based altitude capture, if a logical combination of speed and altitude were not selected, the aircraft will maintain its current state (will not initiate the climb or descent). For example, if a target altitude was selected above current aircraft altitude but an IAS target that was faster than current aircraft IAS was also selected, the airplane will NOT descend to pick up airspeed and then start the climb. Instead, it will hold position. The same is true if a descent were attempted at a speed slower than current aircraft speed.

The desired means of mode entry is via a simultaneous push of both the speed and altitude buttons on the autopilot control panel. However, an alternative technique is to press and hold one of the buttons, and while that button is still depressed, press the other

paired button. For example, for an IAS-based altitude capture, the IAS button can be pressed and held, and while that button is depressed, press the ALT button. When both are released, the speed mode will be active and the altitude mode armed just as intended.

There is also a ‘black out’ period where the autopilot will ignore the commanded target altitude if it is being edited as the original target altitude is approached. For example, if the system is currently performing an altitude capture on departure leg to an ATC assigned altitude, and as the aircraft is approaching that original assigned altitude, ATC issues a new assigned altitude that the pilot is in the process of entering into the system, the autopilot will ignore the original target and keep climbing to the new target. As soon as the edit mode is exited, as indicated by the altitude bug value or button no longer being reverse highlighted, the autopilot will honor whatever target altitude is active in the system.

The autopilot modes annunciator indication for altitude captures are a green “**IAS**” or “**VS**” and a cyan “**ALT**”. As the target altitude is approached, the “IAS” or “VS” annunciators and buttons on the autopilot control panel extinguish and the “**ALT**” annunciator and button turns green and flashes for up to 10 seconds indicating the system is capturing the target altitude. At the end of the flashing period, both the modes annunciator and the control panel button are displayed in steady green.

STRAIGHT AND LEVEL

NOTE

Straight and Level Definition
Pressing the “STRAIGHT AND LEVEL” button on the autopilot will result in a zero bank, +2° pitch angle attitude. It is not an altitude hold mode or a zero vertical speed mode, nor does it hold a heading.

NOTE

Straight and Level Usable Envelope
The Straight and Level button and functionality were demonstrated to the POH limits of the aircraft (±60° bank, ±30° pitch), This mode is not to be relied upon to stabilize an aircraft under all conditions. Activating this mode will result in the aircraft reaching a wings level, +2° pitch angle attitude. Depending on the power setting and aircraft configuration, this could produce a climb, steady altitude, or a descent

Straight and Level mode is entered by pressing the “STRAIGHT & LEVEL” button on the autopilot control panel. The system will light up the control panel button in green (blinking) and immediately change the bank and pitch as required to seek wings level, +2° pitch angle conditions. Once straight and level is achieved, the Straight & Level button on the control panel will be steady green until another mode is selected. Upset recovery will be a smooth, but depending on the entry attitude, aggressive maneuver designed to achieve those steady state conditions in an expedited manner. At sufficiently high power settings and aircraft configurations (e.g. no flaps), a +2° pitch angle will result in a shallow climb. At low power settings and/or aircraft configurations, a +2° pitch angle may result in a descent.

Straight and Level mode can be entered from any autopilot state, including from the off position.

NOTE

Limitation of Overspeed Protection in Straight and Level

Overspeed protection is not ensured during initiation of Straight and Level mode. Depending on the dynamics of the airplane and the available torque in the servos, the recovery to straight and level conditions may exceed V_{ne}. For example, if the aircraft were in an extreme nose-low and/or high-speed condition at time of Straight and Level activation, it is possible for V_{ne} to be exceeded during the recovery to straight and level conditions.

The autopilot modes annunciator indication is a green "**STRAIGHT AND LEVEL**". If the aircraft was not in a wings level, zero flight path condition at time of mode entry, then both the button and the mode annunciator will flash green while the aircraft is being maneuvered to achieve those conditions. At that time, both the control panel button and the mode annunciator stop flashing and turn steady green.

PILOT SELECTABLE INTERCEPTS

The autopilot can be commanded to perform a pilot selectable intercept angle in the lateral modes of GPSS and NAV. This can prove useful both enroute as well as in the terminal area and approaches.

To perform a pilot selectable intercept of a calculated nav course, set the heading bug to the desired value and press both the "HDG" and "NAV" (or "GPSS") buttons on the autopilot control panel at the same time. The system will light up the HDG button in green and turn the heading bug solid and light up the NAV (or GPSS) button in cyan.

The heading knob can be adjusted at any time (before or after entering pilot selectable intercept mode) and the system will adjust the intercept angle accordingly.

The desired means of mode entry is via a simultaneous push of both the heading (HDG) and lateral nav (GPSS or NAV) buttons on the autopilot control panel. However, an alternative technique is to press and hold one of the buttons, and while that button is still depressed, press the other paired button. For example, for a 30-degree intercept of a Nav course, the HDG button can be pressed and held, and while that button is depressed, press the NAV button. When both are released, the heading mode will be active and NAV mode will be armed just as intended.

To disarm the intercept, press the “HDG” button. To re-arm the intercept, press “HDG” and either “NAV” or “GPSS” again.

The autopilot modes annunciator indication for pilot selectable intercepts are a green “**HDG**” and a cyan “**NAV**” or “**GPSS**”. As the lateral nav course is approached, the “HDG” annunciators and buttons on the autopilot control panel extinguish and the “**NAV**” or “**GPSS**” annunciators and button turns green and flashes for up to 10 seconds indicating the system is capturing the lateral nav course. At the end of the flashing period, both the modes annunciator and the control panel button are displayed in steady green.

CONTROL WHEEL STEERING

Control Wheel Steering (CWS) mode is entered by pressing and holding the CWS button on the yoke.

CWS will cause the servos to be temporarily disengaged while the CWS button is held down, providing an opportunity for the pilot to manually maneuver the aircraft as desired without disconnecting the autopilot. Typical uses for this mode include an easy way to adjust the pitch and bank targets while in PITCH and/or BANK hold modes, maneuvering to avoid traffic, weather, or airspace conflicts, flying a more aggressive intercept scenario than the autopilot would have provided, and an alternative method of syncing the active vertical mode bugs (ALT, IAS, or VS) to present aircraft state.

The flight director command bars will be removed from display for the duration that the CWS mode is active.

During CWS, the horizontal targets (HDG or CRS) remain unchanged and if either HDG or NAV modes were active

immediately prior to engaging CWS, the autopilot will automatically re-establish its tracking of those modes and targets when the CWS button is released. If one of the commandable vertical modes (ALT, IAS, or VS) were active immediately prior to engaging CWS, the bug associated with the active mode (e.g. altitude bug for ALT mode, IAS bug for IAS mode, and VS bug for VS mode) will stay synchronized with the actual aircraft state and when the CWS button is released, the new bug value becomes the new target.

If PITCH and/or BANK modes were active at the time of CWS engagement, the pitch and bank values at the time of CWS button release will become the new pitch and bank values the autopilot will hold.

The autopilot modes annunciator indication is white “**CWS**”. The autopilot modes annunciators that were lit immediately prior to entering CWS remain lit in the same manner and the “**CWS**” annunciation takes the place of the “AP”, “FD”, or “AP READY” annunciation location while it is active.

4 Approach Procedures

GENERAL BEHAVIOR

The integrated DFC90 and Vantage display system is designed to take full advantage of the auto transition capability of the Avidyne IFD GPS/NAV/COM for flying a GPS flight plan ending in an ILS approach.

Provided the GPS Nav-Com “ILS CDI Selection” is set to Auto, and VLOC was not manually selected by the pilot on the PFD’s Primary Nav field, at an appropriate time on the approach, the CDI course is automatically set to the inbound localizer course and the Primary Nav source is automatically toggled from GPS to VLOC resulting in a hands-free transition with the proper course dialed in the PFD Course setting.

Note that “GS” mode as annunciated refers to a generic glideslope, encompassing both ILS glideslope and GPS WAAS approach vertical guidance.

Note that for all approaches except VORs, APPR mode will automatically arm when NAV is armed. VORs require the pilot to press the APPR button.

APPROACH MODES

WAAS APPROACHES

When “GPS1” or “GPS2” has been selected as the source in the “Primary Nav” field, and one of the GPS approach types with vertical guidance (LPV, L/VNAV, LNAV+V) is the selected approach, the ADI will provide horizontal and vertical guidance by means of the HDI and VDI.

To enable vertical guidance using a WAAS approaches, the autopilot must be in NAV APPR mode and the “Primary Nav” selection on the PFD must be set to GPS1 or 2.. Glide slope will not arm if the autopilot mode is GPSS.

If the autopilot is in GPSS mode and the “Primary Nav” field is set to GPS1/2, the autopilot will automatically switch from GPSS to NAV mode if/when a valid glide slope signal is received.

If the autopilot is in GPSS mode and the “Primary Nav” field is set to VLOC1/2, the glide slope will not arm and the autopilot will not automatically switch from GPSS to NAV mode.

There are several types of WAAS approaches:

LNAV (Lateral Navigation): Provides lateral (horizontal) guidance only, with standard GPS precision of 0.3 NM full-scale deflection. This is essentially the same as a non-WAAS GPS approach. It is flown as any other non-precision approach – descend to MDA, fly at MDA altitude to the MAP, and execute the missed approach procedure if appropriate.

For this approach type, a manual coupling to the autopilot is available. Prior to FAF the “NAV” (or “APPR”) button on AP must be pressed. There is no glide slope in a LNAV approach, so a manual means to accomplish the vertical component of this approach needs to be enabled (VS and ALT). Then fly coupled to MDA.

LNAV+V (Lateral Navigation with Vertical Information) This mode provides the same lateral navigation as LNAV, but presents an ILS GS-like presentation on the VDI. The GPS draws a 3-D picture of the approach based on crossing the FAF at the depicted altitude. Then it follows a glidepath from the published approach, which is typically a 3 degree angle to the touchdown zone. This type of approach remains a non-precision approach and does not consider any step-down limitations.

For this approach type, a manual coupling to the autopilot is available. Prior to FAF the “NAV” (or “APPR”) button on AP must be pressed. If it is not manually changed to NAV, then an automatic switch will occur when/if a GPS glide slope signal is received. In either the manual or automatic case, the AP switches to NAV APPR. Then fly coupled to MDA. If a level off at the MDA is desired, the ALT button must be pressed on the autopilot.

LNAV/VNAV (Lateral Navigation with Vertical Navigation) In this mode, the GPS provides lateral navigation, providing more accurate guidance than regular LNAV but easier to follow indications than a localizer. The vertical navigation is driven by GPS signals. LNAV/VNAV

approaches are operationally different from LNAV+V in that the glide path is protected from obstructions, but attention still must be applied to step down fixes. Also, the minimum altitude presented is a decision altitude/height (DA/DH) – DA being what is on the altimeter, and DH being the height of the DA above the touchdown zone elevation. This is not an MDA, thus, fly it just as though it were a precision approach. Follow the glide slope needle just as though it were an ILS GS and continue all the way to DA before initiating a missed approach, if appropriate.
This type of approach is automatically coupled to the autopilot meaning that somewhere in the vicinity of the FAF, the system will automatically toggle the autopilot mode from GPSS to NAV APPR and GS will arm.

LP (Lateral Performance) The lateral guidance is significantly more precise than LNAV, and equivalent to that of a localizer, except easier to fly. There is no glide slope in an LP approach so a manual means to accomplish the vertical component of this approach needs to be enabled (VS and ALT). Then fly coupled to MDA.

Lateral tolerance starts out at 0.3 NM full-scale (slightly less than a localizer at the FAF), transitioning to 350 feet either side at the runway threshold (slightly greater than a localizer). The steering remains linear all the way, so you don't get the difficult to follow swings of a real localizer close in.

For this approach type, a manual coupling to the autopilot is available. Prior to FAF the "NAV" (or "APPR") button on AP must be pressed. There is no glide slope in an LP approach so a manual means to accomplish the vertical component of this approach needs to be enabled (VS and ALT). Then fly coupled to MDA.

LP+V (Localizer Performance with Advisory Vertical Guidance) The lateral guidance is significantly more precise and stable than that of a localizer, making it easier to fly precisely.

Lateral tolerance starts at 0.3 NM full-scale (slightly less than a localizer at the FAF), transitioning to 350 feet either side at the runway threshold (slightly greater than a

localizer). The steering remains linear all the way, so you don't get the difficult to follow swings of a localizer close in. The GPS draws a 3-D picture of the approach based on crossing the FAF at the depicted altitude, which is typically a 3-degree angle to the touchdown zone. This type of approach remains a precision approach.

This type of approach is also automatically coupled to your autopilot. This means, in the vicinity of the FAF, the system will automatically toggle the autopilot mode from GPSS to NAV APPR. The pilot is ultimately responsible for managing the vertical component.

LPV (Localizer Precision with Vertical Guidance) The lateral guidance is significantly more precise and stable than LNAV, and equivalent to that of a localizer, making it easier to fly. Vertical guidance is provided to minimums as low as 200' AGL above the touchdown zone. Lateral tolerance starts out at 0.3 NM full-scale (slightly less than a localizer at the FAF), transitioning to 350 feet either side at the runway threshold (slightly greater than a localizer). The steering remains linear all the way, so you don't get the difficult to follow swings of a real localizer close in. The vertical guidance is precise and has a DA/DH (shown as "DA(H)" on approach charts) rather than an MDA.

This type of approach is also automatically coupled to your autopilot. This means, in the vicinity of the FAF, the system will automatically toggle the autopilot mode from GPSS to NAV APPR and GS will arm.

NON-WAAS GPS APPROACH (RNAV OR OVERLAY OR LNAV)

- □ Ensure the Primary Nav field is set to a GPS source, and a GPS approach is loaded in the GPS Nav-Com
- □ Press the "NAV" or "APPR" or "GPSS" buttons on the autopilot control panel
- □ Note that the "NAV" and "APPR" buttons on the autopilot control panel are lit in green or the "GPSS" and "APPR" buttons are lit in green if the autopilot is flying the bank commands

- □ Note that “**NAV APPR**” or “**GPSS APPR**” is displayed in the PFD mode annunciator section
- □ Execute a missed approach, if appropriate

VOR APPROACH

- □ Ensure the Primary Nav field is set to a VHF source and tuned to a VOR
- □ Ensure the approach course is set in the Selected Course window
- □ Press “APPR” on the autopilot control panel, or “NAV” and then “APPR” (VOR approaches are the only types of approaches in which the “APPR” button must be pressed.)
- □ Note that both the “NAV” and “APPR” button on the autopilot control panel are lit in green
- □ Note that “**NAV APPR**” is displayed in the PFD mode annunciator section
- □ Execute a missed approach, if appropriate

LOCALIZER APPROACH

To fly the complete published approach, select the approach and IAF desired, load and then activate the approach at the appropriate time in the IFD. Ensure the correct navigator is selected in the PFD Primary Nav field, and ensure the DFC90 is in NAV mode.

When flying a Vectors-To-Final approach, use the Heading knob and the “HDG” button on the autopilot control panel when ATC is issuing vectors.

NAV APPR can be armed prior to capturing the localizer beam but it is highly recommended to wait until ATC clears you for the approach before trying to arm NAV and APPR. To arm NAV APPR while still in Heading mode, press the “HDG” and “NAV” (or “HDG” and “APPR”) buttons at the same time. Once armed, the system will automatically capture the localizer signal and transition out of Heading mode on its own.

- □ Ensure the Primary Nav field is set to a VHF source and tuned to a localizer
- □ Ensure the front course is set in the Selected Course window
- □ When cleared for the approach or established on final, press the “NAV” or “APPR” buttons on the autopilot control panel (either will work)
- □ Note that the “NAV” and “APPR” buttons on the autopilot control panel are lit in green
- □ Note that “**NAV APPR**” is displayed in the PFD mode annunciator section
- □ If desired, a combination of VS and ALT or just VS modes can be used to control the vertical axis
- □ Execute a missed approach, if appropriate

ILS APPROACH INCLUDING GLIDE SLOPE INTERCEPT

When flying a Vectors-To-Final approach, use the Heading knob and the “HDG” button on the autopilot control panel when ATC is issuing vectors.

NAV APPR can be armed prior to capturing the localizer beam but it is highly recommended to wait until ATC clears you for the approach before arming NAV and APPR. To arm NAV APPR while still in Heading/Vectors mode, press the “HDG” and “NAV” (or “HDG” and “APPR”) buttons at the same time. Once armed, the system will automatically capture the localizer signal and transition out of Heading mode on its own. In summary:

- □ Ensure the Primary Nav field is set to a VHF source and tuned to a properly identified ILS
- □ Press “NAV” or “APPR” on the autopilot control panel (Approach mode will automatically arm if tuned to an ILS frequency when NAV is pressed)
- □ The autopilot will enter NAV and Approach lateral modes or arms them if off course

- ☐ The autopilot will automatically arm the GS vertical mode, retaining the existing vertical mode until capture (see paragraphs below)
- ☐ At this point, “NAV” and “APPR” buttons along with the previous vertical buttons will be lit green on the autopilot control panel and the “GS” button will be lit in cyan
- ☐ PFD mode annunciator will display **NAV** and **APPR** along with the previous vertical mode in green and **GS** in cyan
- ☐ When the autopilot captures glideslope, the vertical mode button on the autopilot control panel and mode annunciator on the PFD will transition to a flashing green “**GS**” which will flash for approximately 10 seconds before going steady green
- ☐ Execute a missed approach, if appropriate

Glide slope (GS) will automatically arm if the following 4 conditions are met:

1. PFD Primary Nav field is set to VLOC1 or VLOC2;
2. The selected GPS Nav-Com (VLOC1 or VLOC2) has a valid localizer/glide slope frequency loaded in the active;
3. NAV mode on the DFC90 must be armed (cyan) or engaged (green). (APPR mode will also be automatically armed or engaged under these conditions);
4. The course value on the PFD is set to any value that would create a “front course” condition.

Note that there can only be one armed vertical mode at a time. So, if VS was engaged (green) and ALT was armed (cyan), GS won’t arm until ALT transitions to engaged (green), provided the four conditions listed above are met.

Glide slope will automatically transition to engaged/captured when two additional conditions are met:

5. Glide slope signal is received by the selected VLOC and is considered valid;

6. Glide slope signal is within approximately 1 dot of center beam. Note that this can be from below or above – both are equally valid with the DFC90.

Glide slope is intended to be captured from below. If so desired, or required via NOTAM, GS mode can be toggled on/off through presses of the “GS” button on the autopilot control panel. There is no other required time to press the “GS” button.

In the event the pilot is attempting to capture the glide slope from above, glide slope will be captured as the aircraft passes through the glide slope signal, if GS mode was previously armed. If GS hadn’t been armed, glide slope will be captured by manually pressing the “GS” button on the autopilot control panel when within 1 dot of glide slope centerline.

PROCEDURE TURN ILS OR LOCALIZERS

The procedure for an ILS or Localizer with a procedure turn is the same as the straight-in procedures except that Heading mode should be used on the procedure turn. This is accomplished by pressing the “HDG” button on the autopilot control panel and then using the heading knob on the PFD. Command the heading bug to the outbound procedure turn heading. Hold that heading until the point at which it is time to turn inbound. Use the heading knob to select the inbound procedure turn heading, being careful to turn the heading knob in the same direction you wish the aircraft to turn. When established on the front inbound procedure turn heading, arm the NAV APPR modes by simultaneously pressing the “HDG” button and the “NAV” or “APPR” button.

If the procedure turn is activated in the GPS Nav-Com, then the autopilot can be flown in GPSS mode by pressing the “GPSS” button on the autopilot control panel. In this case, the aircraft will automatically fly the outbound procedure turn heading, automatically make the turn inbound to the inbound procedure turn heading and then fly that inbound procedure turn heading. The pilot is still responsible for manually pressing the “APPR” (or “NAV”) button on the autopilot control panel when established on the front inbound localizer course. In this case, Primary Nav must be ensured/set to VLOC.

BACK COURSE APPROACHES

Always ensure the front course is set in the Selected Course window. The system will recognize it is on a back course when the VHF receiver is locked onto a valid signal and there is a sufficient difference between aircraft heading and the selected course. There is no “REV” or similar button in a DFC90 autopilot. A “BC” annunciation will be added to the HDI, the HDI and CDI indicators will display correct sensing, and the autopilot will turn in the proper direction.

- □ Ensure the Primary Nav field is set to a VHF source and tuned to a LOC/ILS
- □ Ensure the front course is set in the Selected Course window
- □ Press either the “NAV” or “APPR” button on the autopilot control panel (either will work fine)

- Note that the “NAV” and “APPR” button are lit in green on the autopilot control panel
- Note that “**NAV APPR**” is displayed in green in the autopilot modes annunciator section of the display

MISSED APPROACH

Prior to going missed approach, disconnect the autopilot, apply go-around power, ensure the aircraft is trimmed for the power setting, establish a climb attitude and use the autopilot to smoothly execute the assigned climb-out or published missed approach procedures. A recommended technique is as follows:

- Set the altitude bug to the desired altitude
- Press the “HDG” or “NAV” button on the autopilot control head, depending on missed approach instructions
- Press the “ALT” and “VS” buttons on the autopilot control head simultaneously to command an altitude capture
- Press the “OBS” button on the GPS Nav-Com to continue the coupled missed approach

VISUAL APPROACHES

If the DFC90 is coupled for a visual approach with close-in turns, the autopilot may not provide the desired precision.

Avidyne recommends against coupling the autopilot for traffic pattern visual approaches, however the flight director can be used effectively.

5 Abnormal Procedures

GENERAL FAILURE MODE INFORMATION

The only failure modes that result in the loss of a DFC-series autopilot are when the system AHRS is unavailable (Red-Xs over the attitude display) or when the PFD has no power.

Each autopilot contains an internal data recorder for use during service operations. The contents of the data logs remain the property of Avidyne. If an anomalous behavior is observed with the autopilot, pressing the “GS” button on the autopilot control panel multiple times will produce a series of events in the data log that will aid the Avidyne Service Center in finding and analyzing the data logs during troubleshooting operations.

In all cases, basic airmanship should be exercised and fundamentals utilized such as maintain aircraft control, analyze the situation, and take proper action.

Some failure modes identified in this section do not affect the functioning of the AHRS and therefore allow continued use of the autopilot.

LOSS OF PFD DISPLAY (AHRS STILL OPERATIONAL)

Failure Indication:

A loss of PFD display condition is identified by a display being unreadable, but PFD bezel button lights are still lit.

Functionality Lost:

None.

Recommended Pilot Action:

USE THE MFD’S PFD REVERSIONARY MODE FOR NO LOSS OF CAPABILITY.

LOSS OF PFD BEZEL BUTTONS AND KNOBS

Failure Indication:

A failure of the PFD bezel buttons/knobs is indicated by the display still being present and functional, but the bezel buttons/knobs are inoperative.

Functionality Lost:

The ability to enter altitude and heading autopilot commands and target bugs will be degraded.

The ability to change which GPS/NAV/COM navigator is driving the PFD nav solution will also be degraded.

Recommended Pilot Action:

Use the touchscreen to make changes to the autopilot target bugs and Primary Nav source.

LOSS OF PFD DISPLAY AND BEZEL BUTTONS

Failure Indication:

A failure of the PFD display and bezel buttons is indicated by the display being blank or a solid color such as green, and the bezel buttons are inoperative.

Functionality Lost:

The ability to enter some autopilot commands/target bugs will be degraded or lost. The rest of the PFD remains functional in this case (e.g. internal ADAHRS, automatic communication with other avionics, etc).

The ability to change which GPS/NAV/COM navigator is driving the PFD nav solution will also be degraded.

Recommended Pilot Action:

Use the MFD's reversionary mode.

Use the autopilot in the remaining usable modes (e.g. Alt Hold, NAV, GPSS, VS, IAS, Envelope Protection (EP™)). Consider attempting a PFD reboot via the circuit breaker(s). If the reboot is unsuccessful, consider leaving the circuit breaker disengaged to ensure the DFC90 uses the MFD as its primary input.

LOSS OF PFD AND MFD DISPLAYS

Failure Indication:

A loss of PFD and MFD displays is identified by both displays being blank or a solid color such as green, and the bezel buttons are inoperative.

Functionality Lost:

The ability to enter some autopilot commands/target bugs will be degraded or lost. The rest of the PFD remains functional in this case (e.g. internal ADAHRS, automatic communication with other avionics, etc).

The ability to change which GPS/NAV/COM navigator is driving the PFD nav solution will also be degraded.

Recommended Pilot Action:

Use the autopilot in the remaining usable modes (e.g. Alt Hold, NAV, GPSS, VS, IAS, Envelope Protection (EP™)). Consider attempting a PFD reboot via the circuit breaker(s).

LOSS OF AHRS

Failure Indication:

A failure of an AHRS is identified by Red-Xs over the attitude and HSI compass card.

Under normal circumstances with the MFD's ARS source selection in auto mode, the only indication of failure will be an amber indication of "**ARS X**", where X is either 1 or 2, in the upper left corner of the PFD screen. This indicates the display is using off-side ARS data.

If the MFD's ARS source selection is manually set to the display with the failed AHRS, then the autopilot will disconnect and a yellow "**AUTOPILOT INOP AHRS FAIL**" message is displayed in the center of the autopilot mode annunciator area on the PFD.

Functionality Lost:

As soon as the MFD's source selection is set to the fully functional display or Auto, there is no loss of any autopilot functionality.

Recommended Pilot Action:

Ensure the MFD's source selection is set to "Auto".

If the source selection is already set to "Auto", nominate each sensor individually.

LOSS OF AIR DATA (SINGLE ADC INSTALLATION)

Failure Indication:

A failure of the on-board air data system is indicated by the airspeed, altimeter, and vertical speed tapes being replaced by Red-Xs.

Functionality Lost:

The following autopilot modes will be lost:

- Altitude Hold
- Altitude Capture
- IAS Hold
- VS Hold
- Envelope Protection (EP™)

Recommended Pilot Action:

Press the “STRAIGHT & LEVEL” button on the autopilot control panel, OR, manually disconnect the autopilot, maneuver the airplane to the desired attitude, and then re-engage the autopilot via the “AP” button which puts the system into Roll and Pitch Hold. All lateral modes are still fully functional including Heading mode as are Roll and Pitch, Straight and Level, and ILS including glide slope. In addition, you can use the VS knob on the control panel to control pitch.

LOSS OF AIR DATA (DUAL ADC INSTALLATION)

Failure Indication:

A failure of the on-board air data system is indicated by the airspeed, altimeter, and vertical speed tapes being replaced by Red-Xs.

Under normal circumstances with the MFD's ADC source selection in auto mode, the only indication of failure will be an amber indication of "**ADC X**", where X is either 1 or 2, in the upper left corner of the PFD screen. This indicates the display is using off-side ADC data.

If the MFD's ADC source selection is manually set to the failed ADC, then the autopilot will not have any source of air data.

Functionality Lost:

As soon as the MFD's source selection is set to the fully functional ADC or Auto, there is no loss of any autopilot functionality.

Recommended Pilot Action:

Ensure the MFD's source selection is set to "Auto".

If the source selection is already set to "Auto", nominate each sensor individually.

LOSS OF ENGINE

Loss of engine does not affect the DFC90 operation but the DFC90 autopilot can be useful during loss of engine situations. One technique is to set the IAS bug to best glide speed and engage IAS mode in the event of engine-out conditions. The autopilot will adjust aircraft pitch as required to slow down, or speed up to achieve V_g, freeing up time to perform other cockpit duties during this emergency situation.

One minor variation of this technique is to set the IAS bug to V_g after climb-out so that it is already preset to V_g.

In all cases, Full-time Envelope Alerting (EA™) and Envelope Protection (EP™) (if an autopilot mode is engaged) will be available.

OTHER ERROR MODES

Autopilot failures that prevent any operation are annunciated across the center of the PFD mode annunciator strip in amber (yellow) as shown in the examples immediately below.

PFD Autopilot Annunciator

GENERAL OR UNKNOWN FAILURES

Failure Indication:

If the DFC-PFD system recognizes that the autopilot is invalid but cannot decipher the reason, a yellow "**AUTOPILOT INOP**" message is displayed along middle of the PFD annunciator strip.

Functionality Lost:

All autopilot functionality will be lost for the duration of this message display, meaning the autopilot would disconnect or prevent engagement. It is possible that the autopilot will conduct an auto-reset which would kick off any engaged autopilot mode but following a successful reset, all functionality would be restored and a manual re-command of autopilot modes will be available.

Recommended Pilot Action:

Immediately transition to hand-flying via the PFD display.

If the autopilot does not conduct a successful automatic restart, consider attempting an autopilot restart by cycling the autopilot circuit breaker.

BUILT-IN TEST (BIT) FAILURE

Failure Indication:

If the DFC-PFD system recognizes that the autopilot is invalid due to failing an internal self-test, a yellow "**AUTOPILOT INOP SELF TEST FAIL**" message is displayed along middle of the PFD annunciator strip.

Functionality Lost:

All autopilot functionality will be lost for the duration of this message display. It is most likely experienced during initial power on of the autopilot during ground operations and therefore, would not allow autopilot engagement.

Recommended Pilot Action:

If on the ground and the fault does not clear itself within 15 seconds, consider cycling power to the autopilot either via the circuit breaker or the avionics master.

If unsuccessful, recognize that all autopilot functionality will be lost so plan your flight accordingly.

AHRS ALIGNING

Failure Indication:

If the PFD AHRS has not finishing aligning, a yellow "**AUTOPILOT INOP AHRS ALIGNING**" message is displayed along the middle of the PFD annunciator strip. This message should be expected to be seen during all normal ground operations in the course of all standard alignments.

Functionality Lost:

Since the DFC autopilot requires a fully aligned AHRS for its attitude source, the autopilot will remain non-functional until the AHRS is aligned and the message is removed.

Recommended Pilot Action:

If on the ground, wait until the AHRS has finished aligning before taking off.

If in the air, follow the PFD Pilot Guide instructions for completing an in-air restart before attempting to use the autopilot. If the in-air restart was not successful, plan the remainder of the flight without use of the autopilot.

NO COMMUNICATION WITH AUTOPILOT

Failure Indication:

If the PFD stops receiving data from the autopilot, a yellow "**NO COMMUNICATION WITH AUTOPILOT**" message is displayed in the center of the PFD annunciator strip.

Functionality Lost:

All autopilot functionality will be lost for the duration of this message display. It is possible that the autopilot will conduct an auto-reset which would kick off any engaged autopilot mode but following a successful reset, all functionality would be restored and a manual re-command of autopilot modes will be available.

Recommended Pilot Action:

Immediately transition to hand-flying via the PFD display.

If the autopilot does not conduct a successful automatic restart, consider attempting an autopilot restart by cycling the autopilot circuit breaker.

TRIMMING UP/DOWN

Failure Indication:

If the DFC-PFD system recognizes that trim has been running for an excessive duration, a yellow “Trimming Up” or “Trimming Down” CAS message is displayed on the PFD.

Functionality Lost:

No functionality has been lost. In all cases, the trim system can be manually overridden with pilot-controlled control stick/yoke inputs.

Recommended Pilot Action:

Monitor the alert and if it is removed within a few seconds, no further action need be taken – the autopilot is operating normally.

If the alert is present for more than a few seconds, consider disconnecting the autopilot, manually trim the aircraft accordingly and if autopilot operations are still desired, re-engage the autopilot in the desired mode.

GPSS INVALID

Failure Indication:

If the DFC-PFD system recognizes that the autopilot mode is GPSS but the roll steering information from the GPS/NAV/COM is invalid, a yellow "**GPSS INVALID**" message is displayed on the PFD.

Functionality Lost:

Either a flight plan has not been entered in the governing GPS/NAV/COM and GPSS mode was selected on the autopilot control head in which case, there is no loss of functionality, or the system is unable to fly the flight plan in GPSS roll steering due to some anomalous GPS/NAV/COM situation, or the ground speed is less than 40 knots.

Recommended Pilot Action:

Enter a flight plan into the navigator or select an autopilot mode that is not GPSS.

NAV INVALID

Failure Indication:

If the DFC-PFD system recognizes that the VHF lateral nav signal from the GPS/NAV/COM is invalid, a yellow "**NAV INVALID**" message is displayed on the PFD. In addition, the Horizontal Deviation Indicator (HDI) along the bottom edge of the ADI will be Red-X'd.

The autopilot will command a wind corrected course hold and, if sufficient power is available, the flight path angle at the time the system displayed a yellow "**NAV INVALID**".

Functionality Lost:

The ability to track a VHF lateral course (VOR or Localizer) from the selected GPS/NAV/COM navigator has been lost.

Recommended Pilot Action:

Consider switching the navigator that is driving the PFD CDI and autopilot.

If unable to select a usable alternative navigation source, take the proper action when a navigation source has been lost. If on a published approach that requires VHF-based lateral guidance, the approach must be terminated.

Consider switching to GPSS or Heading modes of the autopilot for lateral mode operations.

GLIDE SLOPE INVALID

Failure Indication:

If the DFC-PFD system recognizes that the VHF vertical nav signal (glide slope) from the GPS/NAV/COM is invalid, a yellow "**GS INVALID**" message is displayed on the PFD. In addition, the Vertical Deviation Indicator (VDI) along the right edge of the ADI will be Red-X'd.

Functionality Lost:

The ability to track a VHF vertical course (Glide Slope) from the selected GPS/NAV/COM navigator has been lost.

Recommended Pilot Action:

Consider switching the navigator that is driving the PFD VDI and autopilot.

If unable to select a usable alternative navigation source, take the proper action when the glide slope signal has been lost. If on a published ILS approach, transition to non-precision approach procedures and minimums or go missed approach.

NO PFD COMM

Failure Indication:

If the autopilot stops receiving data from the PFD, a cyan “AP Comm Fault” CAS message is displayed on the PFD.

Functionality Lost:

All autopilot functionality will be lost.

Recommended Pilot Action:

Immediately transition to hand-flying the aircraft.

Consider attempting a PFD reboot via the circuit breaker(s).

MSR FAIL

Failure Indication:

If the autopilot computer determines that it can no longer read from, or write to the internal maintenance and safety recorder, a cyan “AP MSR Failure” CAS message is displayed on the PFD. In addition, all aurals associated with the autopilot (e.g. full-time Envelope Alerting (EA™), Envelope Protection (EP™) alerts), will be absent.

Functionality Lost:

The autopilot will still be fully functional in all pilot-usable modes but the on-board data logging has likely stopped and all autopilot aural alerts will be unavailable.

Recommended Pilot Action:

Apply extra vigilance to the autopilot annunciator status messages along the top of the PFD due to the absence of the associated aural alerts.

After the flight, notify an Avidyne Service Center or Avidyne Customer Support to coordinate for a repair action.

AUDIO FAIL

Failure Indication:

If the autopilot computer determines that it has corrupted or missing audio files, a yellow “AP Audio Unavail” CAS message is displayed on the PFD. In addition, all aurals associated with the autopilot (e.g. full-time Envelope Alerting (EA™), Envelope Protection (EP™) alerts), will be absent.

Functionality Lost:

The autopilot will still be fully functional in all pilot-usable modes but all autopilot aural alerts will be unavailable.

Recommended Pilot Action:

Apply extra vigilance to the autopilot annunciator status messages on the PFD due to the absence of the associated aural alerts.

After the flight, notify an Avidyne Service Center or Avidyne Customer Support to coordinate for a repair action.

SERVO LIMIT

Pilot Indication:

If the autopilot computer determines that the roll-axis servo limit has been reached, a yellow "**SERVO LIMIT**" message is displayed on the PFD. Since the autopilot may stop following lateral commands, this could appear to the pilot as an uncommanded roll or a failure to follow the commanded lateral target.

Functionality Lost:

The autopilot will still be fully functional but the roll axis may not follow the autopilot commands since the servo has reached its maximum limit.

Recommended Pilot Action:

Avoid making flight control inputs while in coupled autopilot mode operations aside from CWS and minor rudder input to maintain coordinated flight. Moderate rudder or any roll input may result in an inability of the DFC90 autopilot to track the commanded targets.

As soon as pilot input on the flight controls is removed, or, a different lateral command is issued (e.g. turn the heading bug in opposite direction if in HDG mode), the condition should go away.

BANK LIMIT

Pilot Indication:

If the autopilot computer determines that the aircraft has exceeded the POH bank limit, a yellow "**BANK LIMIT**" message is displayed on the PFD. In addition, a "Caution, Excessive Bank" aural alert is played in the headsets.

Functionality Lost:

None.

Recommended Pilot Action:

Reduce the manual bank angle command.

6 Limitations and Performance

LIMITATIONS

See the individual aircraft Pilot Operating Handbook (POH) Supplement for altitude, airspeed and other limitations with respect to DFC90 autopilot operations.

SOFTWARE COMPATIBILITY

The following table identifies authorized combinations of PFD and autopilot code and any associated operational notes.

PFD Version	AP Version*	Wired for Flap Position?	Operational Notes
12.0.0.2 or later	3	Yes	Full functionality per DFC90 Pilot Guide 600-00252-000 Rev 07

*The Autopilot Version number can be obtained from the aircraft logs or, on the Avidyne PFD, via Maintenance Mode. However, the part numbers vary with airframe type and the DFC90 Installation Manual must be referred to for reference if not known by the pilot.

GENERAL PERFORMANCE – CIRRUS AIRCRAFT

The input forces required for roll-axis control surface actuation are demonstrably light and it is not difficult to force the servo (roll trim spring cartridge) to drive to its limit. By design, reaching the physical limit causes a micro-switch to be tripped which effectively decouples the autopilot commands from the flight control surfaces.

Pilot-induced inputs on the system including yoke input, rudder input, p-factor, fuel imbalance, airspeed and general aircraft trim alignment can all contribute to this condition.

In the event the DFC system believes the roll-axis servo limit has been reached, a yellow "**SERVO LIMIT**" text message is displayed on the PFD.

WARNING

Reaching Servo Limits Can Cause Uncommanded Rolls If the roll servo limit is reached, the autopilot may stop following lateral commands. This could appear to the pilot as an uncommanded roll or a failure to follow the commanded lateral target.

As a result, it is highly recommended that a pilot avoid making flight control inputs while in coupled autopilot mode operations aside from minor rudder input to maintain coordinated flight. Moderate rudder or any roll input may result in an inability of the DFC90 autopilot to track the commanded targets.

Note that the maximum aileron deflection by the roll trim motor is ½ the total possible aileron throw.

PERFORMANCE IN PITCH TRIM-ONLY AIRCRAFT

As noted earlier, all modes and behaviors described in this manual work both in aircraft with pitch servos and those without (pitch trim-only) with the exception of the reaction to manual electric trim inputs. However, aircraft equipped with pitch trim only (no pitch servo) should expect a less precise and, depending on the environmental and aircraft dynamic conditions, a slower reaction time in the vertical axis when experiencing vertical turbulence or other inputs like flap deployment/retraction, IAS mode tracking and unusual attitude recoveries using the Straight and Level button.

7 Legal/Regulatory

AVIDYNE PRODUCT TERMS OF USE

Your use of the Avidyne product is conditioned on all the terms and conditions provided with the product sale, including, but not limited to the following:

(1). The warranties provided by Avidyne Corporation for its aviation products are exclusive of and in substitution for any other remedy available under the law. I understand my remedy arising out of or related to use of Avidyne aviation products for the life of the product is limited to the repair or replacement of the product to be determined in Avidyne's sole discretion. I hereby agree to waive, release, disclaim and renounce any other warranties, obligations and liabilities, whether express or implied, including the warranties of merchantability and fitness for a particular purpose, as against Avidyne Corporation and its officers, directors, successors, assigns, insurance companies, agents, employees and affiliates (the released parties),

(2). I hereby release Avidyne Corporation and the other released parties from any and all liability, loss, injury, damage, costs, claims and/or causes of action, including but not limited to all claims for bodily injuries and property damage arising out of or related to the use of said aviation products and the use of the aircraft in which the product is installed, whether in strict liability or in tort, regardless of how such injury, damage or loss may arise and regardless of whether the injury, damage or loss is occasioned in whole or in part by the negligence, neglect or fault of any one or more of the released parties. Notwithstanding the above, this provision (2) shall not apply if the National Transportation Safety Board determines that a defect in Avidyne's aviation product was the probable cause of the accident or incident. All other provisions of this agreement will remain in full force and effect.

(3). Avidyne Corporation and the released parties will have no obligation or liability whatsoever, whether arising in contract (including warranty), tort (whether or not arising from the negligence of Avidyne), strict liability, or otherwise, for any incidental, consequential, general or special damages.

(4). If the National Transportation Safety Board determines that the pilot (the person operating the aircraft equipped with Avidyne aviation products, hereinafter “pilot”) was the probable cause of an accident or incident, and provided the accident or incident occurred while I had an ownership interest in the accident or incident aircraft equipped with the Avidyne aviation products, I will indemnify and hold harmless Avidyne Corporation and the released parties from and against all claims referred to in the preceding paragraphs, and pay the costs of defending such claims (including attorney’s fees), regardless of whether the alleged injury, damage or loss is occasioned in whole or in part by the negligence, neglect or fault of any one or more of the released parties.

(5). The law of the state of Delaware shall govern the construction and enforcement of this agreement, as well as all aspects of the parties’ relationships and any disputes that may arise between them. Any and all disputes or claims that I or my heirs and assigns may Assert against Avidyne Corporation shall be submitted to binding arbitration before the American Arbitration Association within the state of Delaware.

(6). The invalidity or unenforceability of any provision of this contract shall not affect the validity or enforceability of any other provision hereof. If any of the covenants or agreements in this contract are determined to be unenforceable, then the parties agree that all other terms are to remain in full force and effect.

(7). This agreement identified as Avidyne waiver, release and indemnification rev03-a supersedes and replaces prior versions of the agreement.

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Service Hotline A hotline has been established to service questions or issues regarding Avidyne products. The U.S. Toll Free number is 1-888-723-7592.

Email Customer/product support issues can be emailed as well at pilotsupport@avidyne.com

When calling or emailing for product-related help, please have the following information available, if able:

- Customer Name/Account Information.
- Aircraft tail number, product serial number(s), and software versions.
- A good description of the problem or question.
- A copy of your data logs.