SECTION 6: AUTOMATIC FLIGHT CONTROL

NOTE: The Aircraft Flight Manual (AFM) always supersedes the information in this guide. This section only applies to the GFC 700 Automatic Flight Control System (AFCS).

6.1 AFCS CONTROLS

The following dedicated AFCS keys are located on the bezels of the PFD and MFD:



Figure 6-1 Dedicated AFCS Controls

The following AFCS controls are located in the cockpit separately from the MFD:

• AP DISC Switch (Autopilot Disconnect)

Disengages the autopilot and interrupts pitch trim operation. The red **AP DISC** Switch is located forward of the **MET** Switch on the pilot's control wheel left grip. This switch may be used to acknowledge an autopilot disconnect and mute the associated aural tone.

• CWS Button (Control Wheel Steering)

Momentarily disengages the autopilot and synchronizes the flight director's Command Bars with the current aircraft pitch (if not in Glideslope Mode) and roll (if in Roll Hold Mode). The **CWS** Button is located on the top of the pilot's control wheel right grip. Upon release of the **CWS** Button, the flight director may establish new reference points, depending on the current pitch and roll modes.

• GA Switch (Go-Around)

Disengages the autopilot, selects flight director Go-Around Mode, and activates the missed approach. The **GA** Switch is located on the instrument panel above the throttle.

• MET Switch (Manual Electric Trim)

The **MET** Switch is located on the pilot's control wheel left grip. This composite switch is split into left and right sides. The left switch is the ARM contact and the right switch controls the DN (forward) and UP (rearward) contacts. The **MET** ARM switch can be used to disengage the autopilot and to acknowledge an autopilot disconnect alert and mute the associated aural tone. Manual trim commands are generated only when both sides of the switch are operated simultaneously. If either side of the switch is active separately for more than three seconds, MET function is disabled and 'PTRM' is displayed as the AFCS Status Annunciation on the PFD. The function remains disabled until both sides of the switch are inactivated.

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6.2 FLIGHT DIRECTOR OPERATION

With the flight director activated, the aircraft can be hand-flown to follow the path shown by the Command Bars. Maximum commanded pitch (+20°/-15°) and bank (22°) angles, vertical acceleration, and roll rate are limited to values established during AFCS certification. The flight director also provides commands to the autopilot.

Activating the Flight Director

Pressing the **FD** or **AP** Key (when the flight director is not active) activates the flight director in default pitch/roll modes. Pushing the **GA** Switch or any flight director mode key activates the flight director in the respective mode(s).

The flight director may be turned off by pressing the **FD** Key.

Command Bars

Upon activation of the flight director, Command Bars are displayed on the PFD as a single cue. If the attitude information sent to the flight director becomes invalid or unavailable, the Command Bars are removed from the display. The Command Bars do not override the aircraft symbol.



Figure 6-3 PFD AFCS Display

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AFCS Status Box

Flight director roll modes are shown on the left and pitch on the right. Armed modes are annunciated in white and active in green. Autopilot status is displayed in the center of the AFCS Status Box.

6.3 FLIGHT DIRECTOR MODES

Flight director modes are normally selected independently for the pitch and roll axes. Unless otherwise specified, all mode keys are alternate action (i.e., press on, press off). In the absence of specific mode selection, the flight director reverts to the default pitch and/or roll mode(s).

Armed modes are annunciated in white and active in green in the AFCS Status Box. Under normal operation, when the control for the active flight director mode is pressed, the flight director reverts to the default mode(s) for the axis(es). Automatic transition from armed to active mode is indicated by the white armed mode annunciation moving to the green active mode field and flashing for ten seconds.

A flashing yellow mode annunciation and annunciator light indicate loss of sensor (AHRS, ADC, IAU) or navigation data (VOR, LOC, GPS, VNAV, WAAS) required to compute commands. When such a loss occurs, the system automatically begins to roll the wings level or maintain the pitch angle, depending on the affected axis. The flashing annunciation stops when the affected mode key is pressed or another mode for the axis is selected. If after ten seconds no action is taken, the flashing annunciation stops and the flight director enters the default mode for the affected axis.

VOR AP ALT 7000FT

Figure 6-4 Loss of VOR Signal

If the information required to compute a flight director mode becomes invalid or unavailable, the flight director automatically reverts to the default mode for that axis. The flight director is automatically disabled if the attitude information required to compute the default flight director modes becomes invalid or unavailable.

Pitch Modes

- **Pitch Hold** (default mode)— Holds the current aircraft pitch attitude; may be used to climb/descend to the Selected Altitude
- **Selected Altitude Capture** Captures the Selected Altitude
- Altitude Hold Holds the current Altitude Reference
- **Vertical Speed** Maintains the current aircraft vertical speed; may be used to climb/descend to the Selected Altitude
- Flight Level Change Maintains the current aircraft airspeed while the aircraft is climbing/ descending to the Selected Altitude
- Vertical Path Tracking Follows an active vertical profile for enroute and terminal phases of flight
- VNAV Target Altitude Capture Captures the VNAV Target Altitude
- **Glidepath** Intercepts and tracks the WAAS glidepath on approach (only available in installations with GIA 63W Integrated Avionics Units and when WAAS is available)
- **Glideslope** Intercepts and tracks the ILS glideslope on approach
- **Go Around** Automatically disengages the autopilot and commands a constant pitch angle and wings level while in the air

Table 6-1 lists the pitch modes with their corresponding controls and annunciations. The mode reference (shown with default measurement units) is displayed next to the active mode annunciation for Altitude Hold, Vertical Speed, and Flight Level Change modes. The **NOSE UP/ NOSE DN** Keys can be used to change the pitch mode reference while operating under Pitch Hold, Vertical Speed, or Flight Level Change Mode.

Pitch Mode	Control	Aı	nnunciation	Reference Range	Reference Change Increment
Pitch Hold	(default)		PIT	-20° to +15°	0.5°
Selected Altitude Capture	*		ALTS		
Altitude Hold	ALT Key	ALT	nnnnn ft		
Vertical Speed	VS Key	VS	nnnn FPM	-3000 to +1500 fpm	100 fpm
Flight Level Change, IAS Hold	FLC Key	FLC	nnn kt	70 to 165 kt	1 kt
Vertical Path Tracking	VNV Key		VPTH		
VNAV Target Altitude Capture	**		ALTV		
Glidepath			GP		
Glideslope	AFRINEY		GS		
Go Around (in air)	GA Switch		GA		

* ALTS is armed automatically when PIT, VS, FLC, or GA is active, and under VPTH when the Selected Altitude is to be captured instead of the VNAV Target Altitude.

** ALTV is armed automatically under VPTH when the VNAV Target Altitude is to be captured instead of the Selected Altitude.

Table 6-1 Flight Director Pitch Modes

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Pitch Hold Mode (PIT)

When the flight director is activated (the **FD** Key is pressed), Pitch Hold Mode is selected by default. Pitch Hold Mode is indicated as the active pitch mode by the green annunciation 'PIT'. This mode may be used for climb or descent to the Selected Altitude (shown above the Altimeter), since Selected Altitude Capture Mode is automatically armed when the mode is activated.

In Pitch Hold Mode, the flight director maintains a constant pitch attitude, the pitch reference. The pitch reference is set to the aircraft attitude at the moment of mode selection. If the aircraft pitch attitude exceeds the flight director pitch command limitations, the flight director commands a pitch angle equal to the nose-up/ down limit.

Changing the Pitch Reference

When operating in Pitch Hold Mode, the pitch reference can be adjusted by:

- Using the **NOSE UP/NOSE DN** Keys
- Pressing the **CWS** Button, hand-flying the aircraft to establish a new pitch reference, then releasing the **CWS** Button





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Selected Altitude Capture Mode (ALTS)

Selected Altitude Capture Mode arms automatically when the flight director is in Pitch Hold, Vertical Speed, Flight Level Change, or Go Around Mode. This mode is also armed automatically under Vertical Path Tracking Mode when the Selected Altitude is to be captured instead of the VNAV Target Altitude. The white 'ALTS' annunciation indicates Selected Altitude Capture Mode is armed (see Figure 6-5 for example).

The **ALT** Knob is used to set the Selected Altitude, shown above the Altimeter.

As the aircraft nears the Selected Altitude, the flight director automatically transitions to Selected Altitude Capture Mode with Altitude Hold Mode armed (Figure 6-7). This automatic transition is indicated by the green 'ALTS' annunciation flashing for up to ten seconds and the appearance of the white 'ALT' annunciation. The Selected Altitude is shown as the Altitude Reference beside the 'ALTS' annunciation.

At 50 ft from the Selected Altitude, the flight director automatically transitions from Selected Altitude Capture to Altitude Hold Mode and holds the Selected Altitude (shown as the Altitude Reference). As Altitude Hold Mode becomes active, the white 'ALT' annunciation moves to the active pitch mode field and flashes green for ten seconds to indicate the automatic transition.





Changing the Selected Altitude



NOTE: Pressing the **CWS** Button while in Selected Altitude Capture Mode does not cancel the mode.

Use of the **ALT** Knob to change the Selected Altitude while Selected Altitude Capture Mode is active causes the flight director to revert to Pitch Hold Mode with Selected Altitude Capture Mode armed for the new Selected Altitude.

Altitude Hold Mode (ALT)

Altitude Hold Mode can be activated by pressing the **ALT** Key; the flight director maintains the current aircraft altitude (to the nearest ten feet) as the Altitude Reference. The flight director's Altitude Reference is shown in the AFCS Status Box and is independent of the Selected Altitude, displayed above the Altimeter. Altitude Hold Mode active is indicated by a green 'ALT' annunciation in the AFCS Status Box.

Altitude Hold Mode is automatically armed when the flight director is in Selected Altitude Capture Mode. Selected Altitude Capture Mode automatically transitions to Altitude Hold Mode when the altitude error is less than 50 ft. In this case, the Selected Altitude becomes the flight director's Altitude Reference.

Changing the Altitude Reference

NOTE: Turning the **ALT** Knob while in Altitude Hold Mode changes the Selected Altitude, but not the flight director's Altitude Reference and does not cancel the mode.

With the **CWS** Button depressed, the aircraft can be hand-flown to a new Altitude Reference. When the **CWS** Button is released at the desired altitude, the new altitude is established as the Altitude Reference.

If the Selected Altitude is reached during CWS maneuvering, the Altitude Reference is not changed. To adjust the Altitude Reference in this case, the **CWS** Button must be pressed again after the Selected Altitude is reached.





Vertical Speed Mode (VS)

In Vertical Speed Mode, the flight director acquires and maintains a Vertical Speed Reference. Current aircraft vertical speed (to the nearest 100 fpm) becomes the Vertical Speed Reference at the moment of Vertical Speed Mode activation. Vertical Speed Mode does not consider the relative position of the Selected Altitude in relation to the current aircraft altitude at the time of mode activation, so it is possible to use Vertical Speed Mode while not climbing/descending to the Selected Altitude. Vertical Speed Mode is activated by pressing the **VS** Key; the 'VS' annunciation appears in the AFCS Status Box to indicate the active pitch mode, along with the Vertical Speed Reference to the right. The Vertical Speed Reference is also displayed above the Vertical Speed Indicator. A Vertical Speed Reference Bug corresponding to the Vertical Speed Reference is shown on the indicator.

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Figure 6-8 Vertical Speed Mode

Changing the Vertical Speed Reference

The Vertical Speed Reference (shown both in the AFCS Status Box and above/below the Vertical Speed Indicator) may be changed by:

- Using the NOSE UP/NOSE DN Keys
- By pressing the **CWS** Button, hand-flying the aircraft to attain a new Vertical Speed Reference, then releasing the **CWS** Button

Flight Level Change Mode (FLC)

NOTE: The Selected Altitude should be set before selecting Flight Level Change Mode.

Flight Level Change Mode is selected by pressing the **FLC** Key. When Flight Level Change Mode is active, the flight director continuously monitors Selected Altitude, airspeed, and altitude. This mode acquires and maintains the Airspeed Reference while climbing or descending to the Selected Altitude (shown above the Altimeter). The Airspeed Reference is set to the current airspeed upon mode activation. Flight Level Change Mode is indicated by an 'FLC' annunciation beside the Airspeed Reference in the AFCS Status Box. The Airspeed Reference is also displayed directly above the Airspeed Reference along with a bug corresponding to the Airspeed Reference along the tape.

Engine power must be adjusted to allow the autopilot to fly the aircraft at a pitch attitude corresponding to the

Airspeed Reference and the desired flight profile (climb or descent). The flight director maintains the current altitude until either engine power or the Airspeed Reference are adjusted and does not allow the aircraft to climb or descend away from the Selected Altitude.

Changing the Airspeed Reference

The Airspeed Reference (shown in both the AFCS Status Box and above the Airspeed Indicator) may be adjusted:

- Using the **NOSE UP/NOSE DN** Keys
- By pressing the **CWS** Button, hand-flying the aircraft to a new airspeed, then releasing the **CWS** Button to establish the new Airspeed Reference



Figure 6-9 Flight Level Change Mode

Vertical Navigation Modes (VPTH, ALTV)

NOTE: Pressing the **CWS** Button while Vertical Path Tracking Mode is active does not cancel the mode. The autopilot guides the aircraft back to the descent path upon release of the **CWS** Button.

NOTE: VNAV flight director pitch modes are available only in conjunction with GPS roll modes.



NOTE: The Selected Altitude takes precedence over any other vertical constraints.

Vertical Navigation (VNAV) flight control is available for enroute/terminal cruise and descent operations when VNAV has been enabled and a VNAV flight plan (with at least one vertical waypoint) or direct-to with a vertical constraint has been activated. Refer to the Navigation section for more information on VNAV flight plans. The flight director may be armed for VNAV at any time, but no target altitudes are captured during a climb.

The Command Bars provide vertical profile guidance based on specified altitudes (entered manually or loaded from the database) at waypoints in the active flight plan or vertical direct-to. The appropriate VNAV flight control modes are sequenced by the flight director to follow the path defined by the vertical profile. Upon reaching the last waypoint in the VNAV flight plan, the flight director transitions to Altitude Hold Mode and cancels any armed VNAV modes.

Vertical Path Tracking Mode (VPTH)

NOTE: If another pitch mode key is pressed while Vertical Path Tracking Mode is selected, Vertical Path Tracking Mode reverts to armed. When a vertical profile (VNAV flight plan) is active and the **VNV** Key is pressed, Vertical Path Tracking Mode is armed in preparation for descent path capture. 'VPTH' (or '/V' when Glidepath or Glideslope Mode is concurrently armed) is annunciated in white in addition to previously armed modes. If applicable, the appropriate altitude capture mode is armed for capture of the next VNAV Target Altitude (ALTV) or the Selected Altitude (ALTS), whichever is greater.

GPS	ALT	3000ft	VPTH	
GPS	FLC	120kt	ALTS	GP/V

Figure 6-10 Vertical Path Tracking Armed Annunciations

Prior to descent path interception, the Selected Altitude must be set below the current aircraft altitude by at least 75 ft. For the flight director to transition from Altitude Hold to Vertical Path Tracking Mode, acknowledgment is required within five minutes of descent path capture by:

- Pressing the **VNV** Key
- Adjusting the Selected Altitude

If acknowledgment is not received within one minute of descent path interception, the white 'VPTH' annunciation and the **VNV** Key annunciator light start to flash. Flashing continues until acknowledged or the descent path is intercepted. If the descent is not confirmed by the time of interception, Vertical Path Tracking Mode remains armed and the descent is not captured.

In conjunction with the "TOD [top of descent] within 1 minute" annunciation in the Navigation Data Box, VNAV indications (VNAV Target Altitude, vertical deviation, and vertical speed required) appears on the PFD in magenta (Figure 6-11).





When a descent leg is captured (Figure 6-12), Vertical Path Tracking becomes active and tracks the descent profile. An altitude capture mode ('ALTS' or 'ALTV') is armed as appropriate. • Cannot be computed for a leg type (such as a hold or procedure turn)



Figure 6-12 Vertical Path Tracking Mode

Automatic Pitch Hold Reversion

Several situations can occur while Vertical Path Tracking Mode is active which cause the flight director to revert to Pitch Hold Mode. Vertical Path Tracking and the appropriate altitude capture modes are armed for possible descent profile recapture if the vertical deviation:

- Exceeds 200 ft during an overspeed condition
- Experiences a discontinuity exceeding 200 ft due to a flight plan change
- Becomes invalid due to excessive cross-track error, track angle error

The following circumstances cause mode reversion without arming Vertical Path Tracking Mode:

- Navigation source manually changed from GPS
- **CNCL VNV** Softkey selected on the Active Flight Plan Page (MFD)
- All remaining vertical waypoints deleted from the flight plan
- Displays entering Reversionary Mode

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Non-Path Descents

Pitch Hold, Vertical Speed, and Flight Level Change modes can also be used to fly non-path descents while VNAV flight control is selected. If the **VS** or **FLC** Key is pressed while Vertical Path Tracking Mode is selected, Vertical Path Tracking Mode reverts to armed along with the appropriate altitude capture mode to allow profile re-capture.

GPS FLC 120kt ALTS VPTH

Figure 6-13 Flight Level Change VNV Non-Path Descent

To prevent immediate profile re-capture, the following must be satisfied:

- At least ten seconds have passed since the non-path transition was initiated
- Vertical deviation from the profile has exceeded 250 ft, but is now less than 200 ft

Pressing the **VNV** Key twice re-arms Vertical Path Tracking for immediate profile re-capture.

VNAV Target Altitude Capture Mode (ALTV)

NOTE: Armed VNAV Target Altitude and Selected Altitude capture modes are mutually exclusive. However, Selected Altitude Capture Mode is armed implicitly (not annunciated) whenever VNAV Target Altitude Capture Mode is armed. This ensures the Selected Altitude is not violated during a change from VNAV Target Altitude Capture to Selected Altitude Capture Mode close to Selected Altitude interception.

VNAV Target Altitude Capture is analogous to Selected Altitude Capture Mode and is armed automatically after the **VNV** Key is pressed and the next VNAV Target Altitude is to be intercepted before the Selected Altitude. The annunciation 'ALTV' indicates that the VNAV Target Altitude is to be captured. VNAV Target Altitudes are shown in the active flight plan or vertical direct-to, and can be entered manually or loaded from a database (see the Navigation section for details). At the same time as "TOD within 1 minute" is annunciated in the Navigation Data Box, the VNAV Target Altitude is displayed above the Vertical Speed Indicator (see Figure 6-12). VNAV Target Altitudes can be modified until VNAV Target Altitude Capture Mode becomes active.

As the aircraft nears the VNAV Target Altitude, the flight director automatically transitions to VNAV Target Altitude Capture Mode with Altitude Hold Mode armed. This automatic transition is indicated by the green 'ALTV' annunciation flashing for up to ten seconds and the appearance of the white 'ALT" annunciation. The VNAV Target Altitude is shown as the Altitude Reference beside the 'ALTV' annunciation.

At 50 ft from the VNAV Target Altitude, the flight director automatically transitions from VNAV Target Altitude Capture to Altitude Hold Mode and tracks the level leg. As Altitude Hold Mode becomes active, the white 'ALT' annunciation moves to the active pitch mode field and flashes green for ten seconds to indicate the automatic transition. The flight director automatically arms Vertical Path Tracking, allowing upcoming descent legs to be captured and subsequently tracked.

> Altitude Reference (In This Case, Equal To VNAV Altitude Target)



Figure 6-14 VNAV Altitude Capture

Changing the VNAV Target Altitude

NOTE: Pressing the **CWS** Button while in VNAV Target Altitude Capture Mode does not cancel the mode.

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Changing the current VNAV Target Altitude while VNAV Target Altitude Capture Mode is active causes the flight director to revert to Pitch Hold Mode. Vertical Path Tracking and the appropriate altitude capture mode are armed in preparation to capture the new VNAV Target Altitude or the Selected Altitude, depending on which altitude is to be intercepted first.

VNAV target altitudes can be changed while editing the active flight plan (see the Navigation section for details).

Glidepath Mode (GP)

NOTE: Pressing the **CWS** Button while Glidepath Mode is active does not cancel the mode. The autopilot guides the aircraft back to the glidepath upon release of the **CWS** Button.



NOTE: Glidepath Mode is available only in installations with GIA 63W Integrated Avionics Units and WAAS currently available.

Glidepath mode is used to track the WAAS-based glidepath. Arming Glidepath Mode (annunciated in white as 'GP') requires:

- Approach supporting WAAS vertical guidance is loaded into the flight plan
- Expected availability of vertical guidance
- GPS Approach Mode is armed, after acquiring clearance for approach, prior to intercepting the WAAS glidepath (GPS is the selected navigation source and the **APR** Key is pressed; see GPS Approach Mode)



Figure 6-15 Glidepath Mode

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GPS AP VPTH ALTS GP

Figure 6-16 Glidepath Mode Armed

If vertical guidance becomes or is expected to become unavailable and the approach downgrades, Glidepath Mode is disarmed. When vertical guidance becomes available again, Glidepath Mode is automatically re-armed under GPS Approach Mode.

Glideslope Mode (GS)

NOTE: Pressing the **CWS** Button while Glideslope Mode is active does not cancel the mode. The autopilot guides the aircraft back to the glideslope upon release of the **CWS** Button. Glideslope Mode is available for LOC/ILS approaches to capture and track the glideslope. Glideslope Mode is armed when:

- A valid localizer frequency is tuned
- LOC Approach Mode is armed (the **APR** Key is pressed and either LOC is the selected navigation source or a LOC/ILS approach is loaded into the flight plan; see LOC Approach Mode)

LOC HDG AP ALT 10000FT GS

Figure 6-18 Glideslope Mode Armed

Once the localizer has been set as the navigation source, the localizer and glideslope can be captured. Upon reaching the glideslope, the flight director transitions to Glideslope Mode and begins to intercept and track the glideslope.



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Go Around (GA) Mode

Pushing the **GA** Switch engages the flight director in a wings level, 7° pitch-up attitude, allowing the execution of a missed approach or a go around. This mode is a coupled pitch and roll mode and is annunciated as 'GA' in both the pitch and roll active mode fields. Go Around Mode disengages the autopilot and arms Altitude Hold Mode automatically. Subsequent autopilot engagement is allowed. Attempts to modify the aircraft attitude (i.e., with the **CWS** Button or **NOSE UP/NOSE DN** keys) result in reversion to Pitch and Roll Hold modes.



Command Bars Indicate Climb

Figure 6-19 Go Around Mode

Roll Modes

- **Roll Hold** (default mode) Holds the current aircraft roll attitude or rolls the wings level, depending on the commanded bank angle
- **Heading Select** Captures and tracks the Selected Heading
- **Navigation** (GPS, VOR, LOC) Captures and tracks the selected navigation source
- **Backcourse** Captures and tracks a localizer signal for backcourse approaches
- **Approach** (GPS, VAPP, LOC) Captures and tracks the selected navigation source with greater sensitivity for approach
- **Go Around** Commands a constant pitch angle and wings level while in the air

The following table relates each roll mode to its respective control and annunciation. Refer to the pitch modes section for information regarding Go Around and Takeoff Modes.

The **CWS** Button does not change lateral references for Heading Select, Navigation, Backcourse, or Approach modes. The autopilot guides the aircraft back to the Selected Heading/Course upon release of the **CWS** Button.

Roll Hold Mode (ROL)



NOTE: If Roll Hold Mode is activated as a result of a mode reversion, the flight director rolls the wings level.

When the flight director is activated (the **FD** or **AP** Key is pressed), Roll Hold Mode is selected by default. This mode is annunciated as 'ROL' in the AFCS Status Box. The current aircraft bank angle is held, subject to the bank angle conditions listed in Table 6-3.

Roll Mode	Control	Annunciation
Roll Hold	(default)	ROL
Heading Select	HDG Key	HDG
Navigation, GPS Arm/Capture/Track		GPS
Navigation, VOR Enroute Arm/Capture/Track	NAV Kov	VOR
Navigation, LOC Arm/Capture/Track (No Glideslope)	ation, LOC Arm/Capture/Track lideslope)	
Backcourse Arm/Capture/Track	BC Key	BC
Approach, GPS Arm/Capture/Track		GPS
Approach, VOR Arm/Capture/Track	ADR Kov	VAPP
Approach, ILS Arm/Capture/Track (Glideslope Mode automatically armed)	:k LOC	
Go Around (in air)	GA Switch	GA

Table 6-2 Roll Modes

ROL | PIT ALT

Figure 6-20 Roll Hold Mode Annunciation

Bank Angle	Flight Director Response	
< 6°	Rolls wings level	
6° to 22°	Maintains current aircraft roll attitude	
> 22°	Limits bank to 22°	

Table 6-3 Roll Hold Mode Responses

Changing the Roll Reference

The roll reference can be changed by pressing the **CWS** Button, establishing the desired bank angle, then releasing the **CWS** Button.

Heading Select Mode (HDG)

Heading Select Mode is activated by pressing **HDG** Key. Heading Select Mode acquires and maintains the Selected Heading. The Selected Heading is shown by a light blue bug on the HSI and in the box to the upper left of the HSI.

Changing the Selected Heading



NOTE: Pressing the **HDG** Knob synchronizes the Selected Heading to the current heading.

The Selected Heading is adjusted using the **HDG** Knob on either display. Pressing the **CWS** Button and handflying the aircraft does not change the Selected Heading. The autopilot guides the aircraft back to the Selected Heading upon release of the **CWS** Button.





Figure 6-21 Heading Select Mode

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AL1

Turns are commanded in the same direction as Selected Heading Bug movement, even if the bug is turned more than 180° from the present heading (e.g., a 270° turn to the right). However, Selected Heading changes of more than 330° at a time result in turn reversals.

Navigation Mode (GPS, VOR, LOC)

NOTE: The selected navigation receiver must have a valid VOR or LOC signal or active GPS course for the flight director to enter Navigation Mode.

Pressing the **NAV** Key selects Navigation Mode. Navigation Mode acquires and tracks the selected navigation source on the HSI (GPS, VOR, LOC). The flight director follows GPS roll steering commands when GPS is the selected navigation source. When the HSI is coupled to VOR or LOC, the flight director creates roll steering commands from the Selected Course and deviation. Navigation Mode can also be used to fly non-precision GPS and LOC approaches where glideslope capture is not required.

If the Course Deviation Indicator (CDI) shows greater than one dot when the **NAV** Key is pressed, the selected mode is armed. The armed annunciation appears in white to the left of the active roll mode. For cases where the projected course is offset a large distance from the present course for turn anticipation, GPS Navigation Mode can be activated with crosstrack error up to 10 nm when the **NAV** Key is pressed.

PIT



GPS ROL

Figure 6-22 Navigation Mode



When the CDI has automatically switched from GPS to LOC during a LOC/ILS approach, GPS Navigation Mode remains active, providing GPS steering guidance until the localizer signal is captured. LOC Navigation Mode is armed in anticipation of localizer signal capture if the **APR** Key is not pressed prior to the automatic source switch.

If Navigation Mode is active and either of the following occur, the flight director reverts to Roll Hold Mode (wings rolled level):

- Different VOR is tuned while in VOR Navigation Mode (VOR Navigation Mode reverts to armed)
- Navigation source is manually switched
- Localizer signal is not captured by the final approach fix (FAF)

Changing the Selected Course

The Selected Course on the PFD is controlled using the **CRS** Knob. Pressing the **CWS** Button and hand-flying the aircraft does not change the Selected Course while in Navigation Mode. The autopilot guides the aircraft back to the Selected Course (or GPS flight plan) when the **CWS** Button is released.

Approach Mode (GPS, VAPP, LOC)

NOTE: The selected navigation receiver must have a valid VOR or LOC signal or active GPS course for the flight director to enter Approach Mode.

Approach Mode is activated when the **APR** Key is pressed. Approach Mode acquires and tracks the selected navigation receiver on the HSI (GPS, VOR, or LOC), depending on the loaded approach. This mode uses the selected navigation receiver deviation and desired course inputs to fly the approach. Approach Mode provides greater sensitivity for signal tracking than Navigation Mode.

Pressing the **APR** Key when the CDI is greater than one dot arms the selected approach mode (annunciated in white to the left of the active roll mode). If the selected navigation receiver is GPS, pressing the **APR** Key arms GPS Approach Mode, provided that a GPS approach has been loaded into the flight plan. If the loaded approach provides WAAS-based vertical guidance, Glidepath Mode is also armed (Figure 6-16). If GPS Approach Mode is selected while in GPS Navigation Mode, capture can occur with crosstrack error of up to 2 nm.

GPS ROL PIT

Figure 6-24 Navigation/Approach Mode Armed

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LOC Approach Mode allows the autopilot to fly a LOC/ ILS approach with a glideslope. LOC Approach Mode is armed (along with Glideslope Mode; see Figure 6-17) when the **APR** Key is pressed and either of the following have been done:

- Navigation source is set to LOC
- A LOC/ILS approach is loaded into the flight plan and the corresponding localizer frequency tuned (even if the selected navigation source is GPS)

Localizer capture is suppressed until the navigation source is changed to LOC.

If Approach Mode is active and either of the following occur, the flight director reverts to Roll Hold Mode (wings rolled level):

- Vectors-to-Final is activated
- Navigation source is manually switched
- Localizer signal is not captured by the final approach fix (FAF)

Changing the Selected Course

The Selected Course on the PFD is controlled using the **CRS** Knob. Pressing the **CWS** Button and hand-flying the aircraft does not change the Selected Course while in Approach Mode. The autopilot guides the aircraft back to the Selected Course (or GPS flight plan) when the **CWS** Button is released.

Backcourse Mode (BC)



NOTE: When making a backcourse approach, set the Selected Course to the localizer front course.

Backcourse Mode captures and tracks a localizer signal. The mode may be selected by pressing the **BC** Key. Backcourse Mode is armed if the CDI is greater than one dot when the mode is selected. The flight director creates steering commands from the Selected Course and deviation when in Backcourse Mode.

Changing the Selected Course

The Selected Course on the PFD is controlled using the **CRS** Knob. Pressing the **CWS** Button and hand-flying the aircraft does not change course while in Backcourse Mode. The autopilot guides the aircraft back to the Selected Course when the **CWS** Button is released.





LOC2 is Selected Navigation Source



Command Bars Hold Pitch Attitude

Figure 6-25 Backcourse Mode

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6.4 AUTOPILOT OPERATION



NOTE: Refer to the AFM for specific instructions regarding emergency procedures.

Cessna Nav III's autopilot operates flight control surface servos to provide automatic flight control. The autopilot controls the aircraft pitch and roll attitudes following commands received from the flight director. Pitch autotrim provides trim commands to the pitch trim adapter to relieve any sustained effort required by the pitch servo.

Flight Control

Pitch and roll commands are provided to the servos, based on the active flight director modes. Servo motor control limits the maximum servo speed and torque. The servo gearboxes are equipped with slip-clutches set to certain values. This allows the servos to be overridden in case of an emergency.

Pitch Axis and Pitch Trim

The autopilot pitch axis uses pitch rate to stabilize the aircraft pitch attitude during upsets and flight director maneuvers. Flight director pitch commands are rate- and attitude-limited, combined with pitch damper control, and sent to the pitch servo motor. The pitch servo measures the output effort (torque) and provides this signal to the pitch trim servo. The pitch trim servo commands the motor to reduce the average pitch servo effort.

When the autopilot is not engaged, the pitch trim servo may be used to provide manual electric trim. This allows the aircraft to be trimmed using a control stick switch rather than the trim wheel. Manual trim commands are generated with the **MET** Switch. Trim speeds are scheduled with airspeed to provide more consistent response.

Roll Axis

The autopilot roll axis uses roll rate to stabilize aircraft roll attitude during upsets and flight director maneuvers. The flight director roll commands are rate- and attitudelimited, combined with roll damper control, and sent to the roll servo motor.

Engaging the Autopilot

NOTE: Autopilot engagement/disengagement is not equivalent to servo engagement/disengagement. Use the **CWS** Button to disengage the pitch and roll servos while the autopilot remains active.

When the **AP** Key is pressed, the autopilot and flight director (if not already engaged) are activated. Engagement is indicated by a green 'AP' annunciation in the center of the AFCS Status Box. The flight director engages in Pitch and Roll Hold modes when initially activated.

Autopilot Engaged





Control Wheel Steering

During autopilot operation, the aircraft may be handflown without disengaging the autopilot. Pressing and holding the **CWS** Button disengages the pitch and roll servos from the flight control surfaces and allows the aircraft to be hand-flown. At the same time, the flight director is synchronized to the aircraft attitude during the maneuver. The 'AP' annunciation is temporarily replaced by 'CWS' in white for the duration of CWS maneuvers.

In most scenarios, releasing the **CWS** Button reengages the autopilot with a new reference. Refer to the flight director modes section for CWS behavior in each mode.

Control Wheel Steering

Figure 6-27 CWS Annunciation

Disengaging the Autopilot

Automatic disengagement occurs due to:

- System failure
- Inability to compute default flight director modes (FD also disengages automatically)
- Invalid sensor data

Automatic autopilot disengagement is indicated by a flashing red 'AP' annunciation and by the autopilot disconnect aural alert, which continue until acknowledged by pushing the **AP DISC** or **MET** Switch.

Autopilot Automatically Disengaged

 ROL
 AP
 PIT
 ALTS

 Figure 6-28
 Automatic Autopilot Disengagement

The autopilot is manually disengaged by pushing the **AP DISC** Switch, **GA** Switch, **MET ARM** Switch, or the **AP** Key on the MFD. Manual disengagement is indicated by a five-second flashing yellow 'AP' annunciation and a three-second autopilot disconnect aural alert. After manual disengagement, the autopilot disconnect aural alert may be cancelled by pushing the **MET ARM** or **AP DISC** Switch (**AP DISC** Switch also cancels the flashing 'AP' annunciation).

Autopilot Manually Disengaged



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6.5 EXAMPLE PROCEDURES

NOTE: The following example flight plan and diagrams (not to be used for navigation) in this section are for instructional purposes only and should be considered not current. Numbered portions of accompanying diagrams correspond to numbered procedure steps.

This scenario-based set of procedures (based on the example flight plan found in the Flight Management Section) shows various GFC 700 AFCS modes used during a flight. In this scenario, the aircraft departs Charles B. Wheeler Downtown Airport (KMKC), enroute to Colorado Springs Airport (KCOS). After departure, the aircraft climbs to 12,000 ft and airway V4 is intercepted, following ATC vectors.

Airway V4 is flown to Salina VOR (SLN) using VOR navigation, then airway V244 is flown using GPS Navigation. The ILS approach for runway 35L and LPV (WAAS) approach for runway 35R are shown and a missed approach is executed.

Departure

RU

Climbing to the Selected Altitude and flying an assigned heading:

- Before takeoff, set the Selected Altitude to 12,000 feet using the ALT Knob.
- **2)** After takeoff, hand-fly the aircraft to an altitude above the autopilot minimum engage height.
- 3) In this example, Vertical Speed Mode is used to capture the Selected Altitude (Pitch Hold, Vertical Speed, or Flight Level Change Mode may be used).
 - a) Press the **VS** Key to activate Vertical Speed Mode.

VS 1 500FPM ALTS

The Vertical Speed Reference may be adjusted after Vertical Speed Mode is selected using the **NOSE UP/NOSE DN** keys or pushing the **CWS** Button while hand-flying the aircraft to establish a new Vertical Speed Reference.

b) Press the **AP** Key to engage the autopilot in a climb using Vertical Speed Mode.



Figure 6-30 Flight Plan Overview

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4) Use the HDG Knob to set the Selected Heading, complying with ATC vectors to intercept Airway V4.

Press the HDG Key to activate Heading Select Mode

At 50 feet from the Selected Altitude, the green 'ALT' annunciation flashes for up to 10 seconds; the autopilot transitions to Altitude Hold Mode and levels the aircraft.



Figure 6-31 Departure

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Intercepting a VOR Radial

During climb-out, the autopilot continues to fly the aircraft in Heading Select Mode. Airway V4 to Salina VOR (SLN) should now be intercepted. Since the enroute flight plan waypoints correspond to VORs, flight director Navigation Mode using either VOR or GPS as the navigation source may be used. In this scenario, VOR Navigation Mode is used for navigation to the first VOR waypoint in the flight plan.

Intercepting a VOR radial:

- 1) Arm VOR Navigation Mode:
 - a) Tune the VOR frequency.
 - b) Press the **CDI** Softkey to set the navigation source to VOR.
 - c) Use the **CRS** Knob to set the Selected Course to 255°. Note that at this point, the flight director is still in Heading Select Mode and the autopilot continues to fly 290°.

d) Press the NAV Key. This arms VOR Navigation Mode and the white 'VOR' annunciation appears to the left of the active lateral mode.

VOR HDG AP ALT 12000FT

2) As the aircraft nears the Selected Course, the flight director transitions from Heading Select to VOR Navigation Mode and the 'VOR' annunciation flashes green. The autopilot begins turning to intercept the Selected Course.

VOR AP ALT 12000FT

3) The autopilot continues the turn until the aircraft is established on the Selected Course.



Figure 6-32 Intercepting a VOR Radial

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Flying a Flight Plan/GPS Course



NOTE: Changing the navigation source cancels Navigation Mode and causes the flight director to revert back to Roll Hold Mode (wings rolled level).

As the aircraft closes on Salina VOR, GPS is used to navigate the next leg, airway V244. The aircraft is currently tracking inbound on Airway V4.

Flying a GPS flight plan:

- 1) Transition from VOR to GPS Navigation Mode:
 - a) Press the **CDI** Softkey until GPS is the selected navigation source.
 - b) Press the **NAV** Key to activate GPS Navigation Mode. The autopilot guides the aircraft along the active flight plan leg.

GPS AP ALT 12000FT

2) Following the flight plan, the autopilot continues to steer the aircraft under GPS guidance. Note that in GPS Navigation Mode, course changes defined by the flight plan are automatically made without pilot action required.



Figure 6-33 Transition to GPS Flight Plan

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Descent

While flying the arrival procedure, the aircraft is cleared for descent in preparation for the approach to KCOS. Three methods are presented for the descent from 12,000 ft:

- Flight Level Change descent Flight Level Change Mode can be used to descend to the Selected Altitude at a constant airspeed. This descent method does not account for flight plan waypoint altitude constraints.
- Vertical Path Tracking descent Vertical Path Tracking Mode is used to follow the vertical descent path defined in the GPS flight plan. Altitude constraints correspond to waypoints in the flight plan. Before VNV flight control can provide vertical profile guidance, a VNV flight plan must be entered and enabled.
- Non-path descent in a VNV scenario While the flight director is following VNV guidance for descent, Pitch Hold, Vertical Speed, or Flight Level Change Mode can be used to descend to the VNV Target Altitude prior to reaching the planned TOD. Flight Level Change Mode is used in the example.



- 1) Select Flight Level Change Mode:
 - a) Using the **ALT** Knob, set the Selected Altitude to 10,000 feet.

b) Press the FLC Key to activate Flight Level Change Mode. The annunciation 'FLC' appears next to the Airspeed Reference, which defaults to the current aircraft airspeed. Selected Altitude Capture Mode is armed automatically.

GPS AP FLC 130kt ALTS

- Use the **NOSE UP/NOSE DN** keys or push the **CWS** 2) Button while hand-flying the aircraft to adjust the commanded airspeed while maintaining the same power, or reduce power to allow descent in Flight Level Change Mode while the autopilot maintains the current airspeed.
- As the aircraft nears the Selected Altitude, the flight 3) director transitions to Selected Altitude Capture Mode, indicated by the green 'ALTS' annunciation flashing for up to 10 seconds.

GPS 1 AP A TS 10000FT ALT

GPS AP

The green 'ALT' annunciation flashes for up to 10 seconds upon reaching 50 feet from the Selected Altitude; the autopilot transitions to Altitude Hold Mode and levels the aircraft.

АТ 10006т



Vertical Path Tracking descent to VNV Target Altitude:

- **1)** Select VNV flight control:
 - a) Press the **VNV** Key to arm Vertical Path Tracking Mode. The white annunciation 'VPTH' appears.

GPS | AP | ALT 12000FT VPTH

b) Using the ALT Knob, set the Selected Altitude at least 75 feet below the flight plan's VNV Target Altitude of 10,000 feet.

If the Selected Altitude is not adequately adjusted below the VNV Target Altitude, the flight director commands descent to the Selected Altitude rather than the VNV Target Altitude once Vertical Path Tracking Mode becomes active (ALTS is armed rather than ALTV).

c) If Vertical Path Tracking Mode is armed more than 5 minutes prior to descent path capture, acknowledgment is required for the flight director to transition from Altitude Hold to Vertical Path Tracking Mode. To proceed with descent path capture if the white 'VPTH' annunciation begins flashing, do one of the following:

- Turn the ALT Knob to adjust the Selected Altitude
- Press the **VNV** Key

If the descent is not confirmed by the time of interception, Vertical Path Tracking Mode remains armed and the descent is not captured.

2) When the top of descent (TOD) is reached, the flight director transitions to Vertical Path Tracking Mode and begins the descent to the VNV Target Altitude. Intention to capture the VNV Target Altitude is indicated by the white 'ALTV' annunciation.

GPS AP VPTH ALTV

3) As the aircraft nears the VNV Target Altitude, the flight director transitions to VNV Target Altitude Capture Mode, indicated by the green 'ALTV' annunciation flashing for up to 10 seconds.

GPS AP ALT 10000 FT ALT

The green 'ALT' annunciation flashes for up to 10 seconds upon reaching 50 feet from the VNV Target Altitude; the autopilot transitions to Altitude Hold Mode and levels the aircraft at the vertical waypoint.





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Non-path descent using Flight Level Change Mode:

- 1) Command a non-path descent using Flight Level Change Mode:
 - a) Using the ALT Knob, set the Selected Altitude below the current aircraft altitude to an altitude (in this case, 9,400 feet) at which to level off between VNV flight plan altitudes.
 - b) Press the FLC Key before the planned TOD during an altitude hold while VPTH is armed. The Airspeed Reference defaults to the current aircraft airspeed. Vertical Path Tracking and Selected Altitude Capture Mode are armed automatically.

GPS AP FLC 130kt ALTS VPTH

- 2) Reduce power to allow descent in Flight Level Change Mode. The autopilot maintains the Airspeed Reference.
- 3) As the aircraft nears the Selected Altitude, the flight director transitions to Selected Altitude Capture Mode, indicated by the green 'ALTS' annunciation flashing for up to 10 seconds.

9400 FT ALT VPTH GPS ΔP TS

The green 'ALT' annunciation flashes for up to 10 seconds upon reaching 50 feet from the Selected Altitude; the autopilot transitions to Altitude Hold Mode and levels the aircraft.

GPS AP ALT 9400ft VPTH

4) When the next TOD is reached, Vertical Path Tracking becomes active (may require acknowledgment to allow descent path capture).

ALTV GPS ΔP

5) As the aircraft nears the VNV Target Altitude, the flight director transitions to VNV Target Altitude Capture Mode, indicated by the green 'ALTV' annunciation flashing for up to 10 seconds.

AP ALLY 9000FT ALL GPS

The green 'ALT' annunciation flashes for up to 10 seconds upon reaching 50 feet from the VNV Target Altitude; the autopilot transitions to Altitude Hold Mode and levels the aircraft at the vertical waypoint.

GPS ΔF

9000FT



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Approach

Flying an ILS approach:

- **1)** Transition from GPS Navigation Mode to Heading Select Mode.
 - a) Select the Runway 35L ILS approach for KCOS and select 'VECTORS' for the transition. Load and activate the approach into the flight plan.
 - b) Use the **HDG** Knob to set the Selected Heading after getting vectors from ATC.
 - c) Press the **HDG** Key. The autopilot turns the aircraft to the desired heading.
 - d) Use Heading Select Mode to comply with ATC vectors as requested.

GPS AP ALTY 9000FT ALT

- 2) Arm LOC Approach and Glideslope modes.
 - a) Ensure the appropriate localizer frequency is tuned.
 - b) Press the **APR** Key when cleared for approach to arm Approach and Glideslope modes. 'LOC' and 'GS' appear in white as armed mode annunciations.

GPS AP ALTY 9000FT ALT

- c) The navigation source automatically switches to LOC. After this switch occurs, the localizer signal can be captured, and the flight directors determine when to begin the turn to intercept the final approach course. The flight director now provides guidance to the missed approach point.
- **3)** There are two options available at this point, as the autopilot flies the ILS approach:
 - Push the **AP DISC** Switch at the decision height and land the aircraft.
 - Use the **GA** Switch to execute a missed approach.

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Flying a RNAV GPS approach with vertical guidance:

- 1) Arm flight director modes for a RNAV GPS approach with vertical guidance:
 - a) Make sure the navigation source is set to GPS (use **CDI** Softkey to change navigation source).
 - b) Select the Runway 35R LPV approach for KCOS. Load and activate the approach into the flight plan.
- 2) Press the **APR** Key once clearance for approach has been received. GPS Approach Mode is activated and Glidepath Mode is armed.

ALTS GP

3) Once the glidepath is captured, Glidepath Mode becomes active. The flight director now provides guidance to the missed approach point.

GPS AP GP

GPS AP VPTH

- 4) There are two options available at this point, as the autopilot flies the approach:
 - Push the **AP DISC** Switch at the Decision height and land the aircraft.
 - Use the **GA** Switch to execute a missed approach.



Figure 6-38 LPV Approach to KCOS

Go Around/Missed Approach

NOTE: As a result of calculations performed by the system while flying the holding pattern, the display may re-size automatically and the aircraft may not precisely track the holding pattern.

Flying a missed approach:

1) Push the GA Switch at the Decision height and apply go around power to execute a missed approach. The flight director Command Bars establish a nose-up climb to follow. If flying an ILS or LOC approach the CDI also switches to GPS as the navigation source.

Note that when the **GA** Switch is pushed, the missed approach is activated and the autopilot disconnects, indicated by the 'AP' annunciation flashing yellow for 5 seconds and the autopilot disconnect aural alert.



- 2) Start the climb to the prescribed altitude in the published Missed Approach Procedure (in this case, 10,000 ft).
 - a) After climbing to altitude exceeding the autopilot minimum engage height, press the AP Key to reengage the autopilot.
 - b) Press the **NAV** Key to have the autopilot fly to the hold.

ALT

GPS AP I PTT

3) Use the ALT Knob to set a Selected Altitude to hold.

To hold the current airspeed during the climb, press the **FLC** Key.

GPS AP 100 KT ALTS FLC

As the aircraft nears the Selected Altitude, the flight director transitions to Selected Altitude Capture Mode, indicated by the green 'ALTS' annunciation flashing for up to 10 seconds.

GPS AP ALTS 10000FT ALT

The green 'ALT' annunciation flashes for up to 10 seconds upon reaching 50 feet from the Selected Altitude; the autopilot transitions to Altitude Hold Mode and levels the aircraft.

GPS AP ALT 10000ft

The autopilot flies the holding pattern after the 4) missed approach is activated. Annunciations are displayed in the Navigation Status Box, above the AFCS Status Box.



Figure 6-39 Go Around/Missed Approach

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6.6 AFCS ANNUNCIATIONS AND ALERTS

AFCS Status Alerts

The following annunciations (listed in order of increasing priority) can appear on the PFD above the Airspeed and Attitude indicators. Only one annunciation may occur at a time, and messages are prioritized by criticality.



Figure 6-40 AFCS Status Annunciation

Alert Condition	Annunciation	Description	
Aileron Mistrim Right	AIL→	Roll servo providing sustained force in the indicated direction	
Aileron Mistrim Left	HIA→		
Elevator Mistrim Down	JELE	Ditch cargo providing sustained force in the indicated direction	
Elevator Mistrim Up	†ELE	Prich servo providing sustained force in the indicated direction	
Pitch Trim Failure	DTDM	If AP engaged, take control of the aircraft and disengage AP	
(or stuck MET Switch)	PIRM	If AP disengaged, move MET switches separately to unstick	
Roll Failure	ROLL	Roll axis control failure; AP inoperative	
Pitch Failure	PTCH	Pitch axis control failure; AP inoperative	
System Failure	AFCS	AP and MET are unavailable; FD may still be available	
Preflight Test	PFT	Performing preflight system test; aural alert sounds at completion Do not press the AP DISC Switch during servo power-up and preflight system tests as this may cause the preflight system test to fail or never to start (if servos fail their power-up tests). Power must be cycled to the servos to remedy the situation.	
	PFT	Preflight system test failed; aural alert sounds at failure	

Table 6-4 AFCS Status Field Alerts

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Overspeed Protection

Overspeed protection is provided in situations where the flight director cannot acquire and maintain the vertical Mode Reference for the selected vertical mode without exceeding the certified maximum autopilot airspeed.

When an autopilot overspeed condition occurs, the Airspeed Reference appears in a box above the Airspeed Indicator, flashing a yellow 'MAXSPD' annunciation. Engine power should be reduced and/or the pitch reference adjusted to slow the aircraft. The annunciation disappears when the overspeed condition is resolved.



Figure 6-41 Overspeed Annunciation