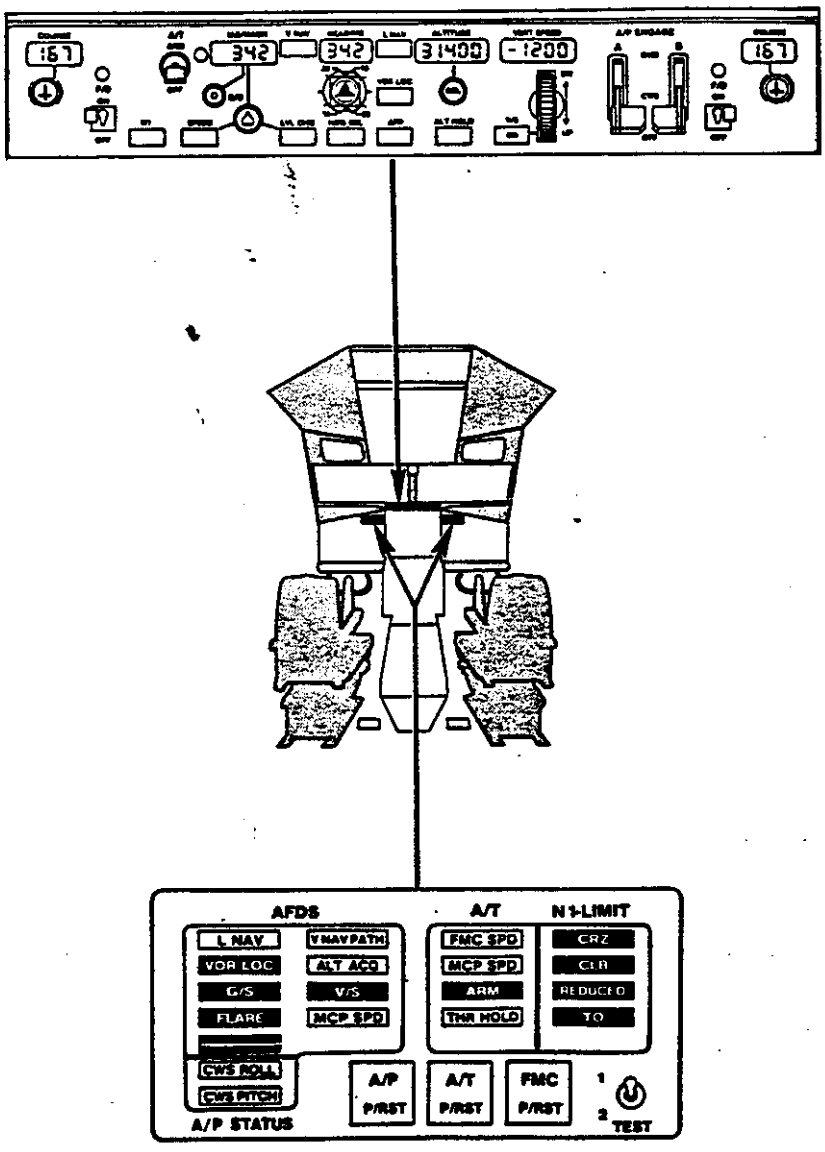
APPENDIX C

B-737-300/400
AUTO FLIGHT SYSTEM
DESCRIPTION

LOCATIONS



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INTRODUCTION

The Auto-Flight System (AFS) consists of the Autopilot Flight Director System (AFDS) and the Auto-Throttle (A/T). The Flight Management Computer (FMC) provides N1 limits and target N1 for the A/T and command airspeeds for the A/T and AFDS.

The AFDS and A/T are operated from the AFDS Mode Control Panel (MCP) and the FMC from the Control Display Unit (CDU).

The AFDS MCP provides coordinated control of the A/P, Flight Director (F/D), A/T, and altitude alert functions.

AFS mode status is displayed on the two Flight Mode Annunciator (FMA) panels, one for each pilot's instrument panel.

Normally, the AFDS and A/T are used to maintain airspeeds and/or thrust settings calculated by the FMC.

AUTOPILOT FLIGHT DIRECTOR SYSTEM (AFDS)

INTRODUCTION

The AFDS is a dual system consisting of two individual flight control computers (FCC's) and a single Mode Control Panel (MCP).

The two FCC's are identified as "A" and "B". For autopilot (A/P) operation, they send control commands to their respective pitch and roll hydraulic servos, which operate the flight controls through two separate hydraulic systems.

For F/D operation, each FCC positions the F/D command bars on the respective ADI.

MCP MODE SELECTOR SWITCHES

The Mode Selector switches are pressed to select desired command modes for the AFDS and A/T. The switch letters, ON, illuminate to indicate mode selection and that the mode can be deselected by pressing the switch again. While a mode is active, deselection can be automatically inhibited and is indicated by the switch light being extinguished.

When engagement of a mode would conflict with current AFS operation, pressing the Mode Selector switch has no effect. All AFDS modes can be disengaged by selecting another command mode or by disengaging the A/P and turning the F/D's OFF.

MCP PARAMETER SELECTIONS

NOTE: The following information is in addition to that contained in the CONTROLS AND INDICATORS portion of this chapter.

Parameter selections common to both FCC's for speed, heading, altitude, and vertical speed are made from the MCP.

Two course selectors and course displays are located on the MCP.

- The *Captain's Course Selector* provides selected course information to the "A" FCC, the No. 1 VHF NAV receiver, and to the Captain's HSI Course Pointer and Course Deviation Bar.
- The *F/O's Course Selector* provides selected course information to the "B" FCC, the No. 2 VHF NAV receiver, and to the First Officer's HSI Course Pointer and Course Deviation Bar.

While in the VOR/LOC or APP mode, the "A" FCC, the "A" A/P, and the Captain's F/D use the selected course set by the Captain and NAV data from the No. 1 VHF NAV receiver. The "B" FCC, "B" A/P, and First Officer's F/D use the selected course and VHF NAV frequency set on the No. 2 VHF NAV receiver.

(cont'd.)

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AUTOPILOT FLIGHT DIRECTOR SYSTEM (AFDS) (cont'd.)

MCP PARAMETER SELECTIONS (cont'd.)

Different courses and frequencies can be selected for the two VHF NAV receivers at any given time. This can cause disagreement between the Captain's and First Officer's F/D command bar displays and affect A/P operation.

AUTOPILOT ENGAGEMENT CRITERIA

Each A/P is engaged with a separate engage paddle. Either paddle can be in one of three states:

- mechanically latched in the OFF position.
- magnetically held in the CWS or CMD position.
- magnetically released from the CWS or CMD position.

The paddles are latched in the OFF position, unless both of the following pilot-controlled conditions are met:

- No force is applied to the control wheel or column.
- The stabilizer trim autopilot cutout switch is at NORMAL.

Once the above unlatch conditions are satisfied, and no system failures exist, either paddle can be raised from OFF to CWS or CMD and is magnetically held there, providing all of the unlatch conditions are retained. Control pressure applied now, overrides pitch or roll into CWS while the paddle remains in CMD.

The A/P automatically disengages when any of the following occur:

- Pressing either A/P disengage switch.
- Pressing either TO/GA switch with a single A/P engaged in CWS or CMD below 2,000 feet RA.
- Pressing either TO/GA switch after touchdown with both A/P's engaged in CMD.
- Moving the A/P engage paddle to OFF.
- Activating either pilot's control wheel trim switch.
- Moving the stabilizer trim autopilot cutout switch to CUTOUT.
- Loss of respective hydraulic system pressure.
- Either left or right IRS system failure or FAULT light illuminated.
- Loss of electrical power or a sensor input which prevents proper operation of the engaged A/P and mode.

During single channel A/P operation, engaging a second A/P in either CWS or CMD disengages the first A/P then operates without interruption. However, both A/P's remain engaged in CMD if the first and second A/P are engaged after the approach (APP) mode has been selected.

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AUTOPILOT ENGAGEMENT CRITERIA (cont'd.)

The F/D command bars may retract from view upon initial A/P engagement in CMD. This occurs when the F/D pitch or roll commands are not approximately centered at the time of engagement. Additionally, the engaged A/P changes modes to control wheel steering for pitch and/or roll.

AUTOPILOT CONTROL WHEEL STEERING

ENGAGE PADDLE IN CWS

Placing an engage paddle in the CWS position, engages the A/P pitch and roll axis in the CWS mode and displays CWS PITCH and CWS ROLL on the FMA's.

With CWS engaged, the A/P maneuvers the airplane in response to control pressures applied by either pilot. The control pressure is similar to that required for manual flight. When control pressure is released, the A/P holds existing attitude.

If aileron pressure is released with 6° or less bank angle, the A/P rolls the wings level and holds existing heading. This heading hold feature, with bank less than 6°, is inhibited when any of the following conditions exist:

— Below 1,500 feet RA with the landing gear down.

— After F/D VOR capture with TAS 250 knots or less.

— After F/D LOC capture in the APP mode.

PITCH CWS WITH ENGAGE PADDLE IN CMD

The pitch axis engages in CWS while the roll axis is in CMD when:

— A command pitch mode has not been selected or was deselected.

— A/P pitch has been manually overridden with control column force. The force required for override is greater than normal CWS control column force. This manual pitch override is inhibited in the APP mode with both A/P's engaged.

CWS PITCH is annunciated on the Flight Mode Annunciators while this mode is engaged. Command pitch modes can then be selected.

When approaching a selected altitude in CWS PITCH, with the engage paddle in CMD, CWS PITCH changes to ALT ACQ and when at the selected altitude, ALT HOLD engages.

If pitch is manually overridden while in ALT HOLD at the selected altitude, ALT HOLD changes to CWS PITCH. If control force is released within 250 feet of the selected altitude, CWS PITCH changes to ALT ACQ and the A/P returns to the selected altitude and ALT HOLD engages. If the elevator force is held until more than 250 feet from the selected altitude, pitch remains in CWS PITCH.

AUTOPILOT CONTROL WHEEL STEERING (cont'd.)

ROLL CWS WITH ENGAGE PADDLE IN CMD

The roll axis engages in CWS while the pitch axis is in CMD when:

— A command roll mode has not been selected or was deselected.

— A/P roll has been manually overridden with control wheel force. The force required for override is greater than the normal CWS control wheel force.

CWS ROLL is annunciated on the Flight Mode Annunciators while this mode is engaged.

CWS ROLL with an A/P Engage Paddle in CMD can be used to capture a selected radio course while the VOR/LOC mode is armed. Upon intercepting the radial or localizer, the F/D and A/P annunciation changes from CWS ROLL to VOR/LOC engaged and the A/P tracks the selected course.

AFDS COMMAND MODES

INTRODUCTION

Command modes can be armed or engaged when an A/P engage paddle is positioned at CMD and/or one or both F/D switches are ON.

The Takeoff Mode is an F/D only mode. The landing flare, during the APP mode, is a dual A/P only maneuver.

ALTITUDE ACQUIRE MODE (ALT ACQ)

The altitude acquire mode is the transition maneuver from a V/S, LVL CHG, or VNAV climb or descent to an automatic level-off at an MCP selected altitude. The altitude acquire mode is also armed while climbing or descending in CWS PITCH with an A/P Engage Paddle at CMD.

Altitude acquire engagement is annunciated ALT ACQ for pitch when leveling off in either V/S or LVL CHG. However, VNAV remains annunciated throughout the altitude acquire mode when leveling in VNAV.

ALT ACQ engagement is inhibited when the ALT HOLD switch is pressed or while the glideslope is captured.

ALTITUDE HOLD MODE (ALT HOLD)

The altitude hold mode gives pitch commands to hold the MCP selected altitude or the pressure altitude at which the ALT HOLD switch was pressed. ALT HOLD engages in either of two conditions:

— ALT HOLD at the MCP selected altitude. This is indicated by annunciation of ALT HOLD and the ALT HOLD switch light extinguished.

— ALT HOLD not at the MCP selected altitude. This is indicated by the annunciation of ALT HOLD and the ALT HOLD switch light illuminated.

ALT HOLD not at the MCP selected altitude occurs with either of the following:

— Pushing the ALT HOLD switch while not at the selected altitude.
— Selected a new MCP altitude while in ALT HOLD at the selected altitude.

ALT HOLD is inhibited after G/S capture.

When in ALT HOLD at the selected altitude, LVL CHG, V/S, and VNAV climb and descent functions are inhibited until a new altitude is selected.

The altitude selected on the MCP is referenced to the Captain's barometric altimeter setting for the "A" A/P and F/D, and to the F/O's barometric setting for the "B" A/P and F/D. After ALT ACQ engages, changes in altimeter barometric settings do not change the selected altitude reference.

VERTICAL SPEED MODE (V/S)

The V/S mode gives pitch commands to hold the selected vertical speed and engages the A/T in the SPEED mode to hold the selected airspeed. This mode has both an armed and an engaged state.

Except during ALT HOLD or after G/S capture in the APP mode, pressing the V/S switch engages the V/S mode. V/S engaged is annunciated, the Vertical Speed Display changes from blank to present vertical speed, and desired vertical speeds can be selected with the Vertical Speed Thumbwheel.

The V/S mode becomes armed if, while in the ALT HOLD mode at the selected altitude, a new MCP altitude is selected which is more than 100 feet different than the previously selected altitude. V/S armed is annunciated and the V/S mode can be engaged by moving the Vertical Speed Thumbwheel.

The V/S mode automatically engages when the ALT ACQ mode is engaged and a new altitude is selected which is more than 100 feet different than the previously selected altitude. The V/S mode annunciates engaged and existing vertical speed appears in the Vertical Speed Display. The commanded V/S can be changed with the Vertical Speed Thumbwheel. Vertical speeds can be selected which command flight toward or away from the selected altitude.

NOTE: (737-300) During V/S mode operation, if airspeed becomes more than 5 knots below the MCP selected airspeed and is not increasing, the AFS automatically engages the LVL CHG mode.

LEVEL CHANGE MODE (LVL CHG)

The LVL CHG mode coordinates pitch and thrust commands to make automatic climbs and descents to preselected altitudes at selected airspeeds. A LVL CHG climb or descent is initiated by selecting a new altitude and engaging the LVL CHG mode. Pressing the LVL CHG switch engages the LVL CHG mode.

During a LVL CHG climb, the annunciations are MCP SPD for pitch and N_1 for the A/T. During a LVL CHG descent, the annunciations are MCP SPD for pitch and RETARD for the A/T while reducing thrust toward idle. When at idle thrust, ARM is annunciated for the A/T.

If a speed mode had been active prior to engaging LVL CHG, the previous speed is retained as the target speed for the LVL CHG mode. If LVL CHG is engaged with no active speed mode, the IAS/Mach Display and Airspeed Cursors synchronize to existing speed and present speed becomes the LVL CHG target speed. After LVL CHG mode engagement, the target speed can be changed with the MCP Speed Selector.

VERTICAL NAVIGATION MODE (VNAV)

With the VNAV mode engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile selected on the FMC CDU's. The profile includes preselected climbs, cruise altitudes, speeds, descents, and can also include altitude constraints at specified waypoints. The profile may end with an ILS approach to the destination airport.

Pressing the VNAV switch selects the VNAV mode provided FMC performance initialization is complete. The mode selector switch illuminates, the MCP IAS/Mach Display becomes blank and the Airspeed Cursors are positioned at the FMC commanded airspeed. The FMA displays are VNAV SPD or VNAV PATH for the AFDS pitch mode and FMC SPD, N_1, RETARD or ARM for the A/T mode.

VNAV climbs and descents are constrained by the selected MCP Altitude. VNAV commanded speeds can be changed with the FMC's CDU's.

During VNAV PATH cruise flight, selecting a lower MCP altitude, arms the FMC to automatically begin the descent upon arrival at the FMC calculated top of descent point.

During VNAV PATH descent, VNAV remains engaged until:

— Glideslope capture, or
— Another pitch mode is selected, or
— Flaps are extended beyond 15, or
— LNAV is disengaged without localizer capture.

Proper MCP altitude selections ensure correct altitude alerting.

LATERAL NAVIGATION MODE (LNAV)

In the LNAV mode, the FMC controls AFDS roll to intercept and track the active FMC route. The desired route is activated and modified through the FMC CDU's. In addition to enroute guidance, the active route can include terminal procedures and instrument approaches.

Engagement criteria must be met to use LNAV. There must be an active route in the FMC, capture criteria must be satisfied, and the LNAV switch pressed.

LNAV capture criteria is divided into two categories. First, any airplane heading satisfies capture criteria when within 3 NM of the active route segment. Second, outside of 3 NM, the airplane must be on an intercept course of 90° or less and intercept the route segment before the active waypoint.

LNAV will automatically disconnect for several reasons. It will disconnect upon reaching the end of the active route or upon entering a route discontinuity. Additionally, it will disconnect upon either intercepting or missing the intercept of an approach path inbound. Finally, either loss of capture criteria or selecing HDG SEL will disconnect LNAV.

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HEADING SELECT MODE (HDG SEL)

The Heading Select mode sends roll commands to turn to and maintain the heading shown in the MCP Heading Display. After mode engagement, roll commands are given to turn in the nearest direction to each selected heading. The bank angle limit is established by the Bank Angle Limit Selector on the MCP.

Pressing the Heading Select switch on the MCP engages the Heading Select mode. HDG SEL is annunciated for the AFDS.

The HDG SEL mode automatically disengaged upon capture of the selected radio course in the VOR/LOC and APP modes.

VOR/LOC MODE (VOR/LOC)

The VOR mode gives roll commands to capture and track the selected VOR course.

The LOC mode gives roll commands to capture and track the selected localizer along the inbound front course bearing. Backcourse tracking is not available.

Pressing the VOR/LOC switch selects the VOR mode if a VOR frequency is tuned or selects the LOC mode if a localizer frequency is tuned. The VOR/LOC switch illuminates and VOR/LOC armed is annunciated. The selected course can be intercepted while engaged in the HDG SEL or CWS ROLL with the A/P Engage Paddle in CMD. The capture point is variable and depends on intercept angle and closure rate. Localizer capture occurs not later than ½-dot deviation. When within the course capture area, the VOR/LOC annunciation changes from armed to captured and roll commands track the VOR or localizer course.

When a localizer frequency is selected, the navigation radios automatically switch from the antenna in the tail to the antenna in the nose, whenever VOR/LOC is annunciated (armed or engaged). If antenna switching does not occur, the localizer and approach modes are inhibited.

The VOR mode can also be disengaged by one of the following:

- Press the LNAV switch.
- Select AUTO tuning for the master navigation receiver or place the master HSI switch in the NAV position.

VOR/LOC MODE (VOR/LOC) (cont'd.)

The LOC mode can be disengaged by any one of the following:

— Select APP, HDG SEL, or LNAV mode.
— Place master HSI switch in the NAV position.
— Manually override the A/P into CWS ROLL with both F/D switches OFF.

APPROACH (APP) MODE DUAL A/P'S

The Approach mode arms the AFDS to capture and track the localizer and glideslope. It can be engaged for dual or single A/P operation. Dual A/P approach operation is described first.

Approach mode allows both A/P's to be engaged at the same time. Dual A/P operation provides fail passive control through landing flare and touchdown or an automatic go-around. During fail passive operation, the flight controls respond to the A/P commanding the lesser control movement.

One NAV receiver must be tuned to an ILS frequency before the Approach mode can be selected. For a Dual A/P approach, the second NAV receiver must be tuned to the ILS frequency and the corresponding A/P engaged in CMD prior to 800 feet RA.

LOCALIZER AND GLIDESLOPE ARMED

After setting the localizer frequency and course, pressing the APP switch selects the APP mode. The APP switch illuminates and VOR/LOC and G/S annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1,500 feet RA occurs.

The localizer can be intercepted in the HDG SEL, CWS ROLL, or LNAV mode.

LOCALIZER CAPTURE

Glideslope capture is inhibited until localizer is captured. The LOC capture point is variable and depends on intercept angle and rate of closure, but does not occur at less than ½-dot. Upon LOC capture, VOR/LOC annunciates captured, SINGLE CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

APPROACH (APP) MODE DUAL A/P'S (cont'd.)

GLIDESLOPE CAPTURE

Glideslope capture is inhibited until localizer is captured. Capture occurs at 2/5-dot. G/S annunciates captured, the previous pitch mode disengages, the APP switch light extinguishes if the localizer has also been captured, airplane pitch tracks the G/S. The N_1 LIMIT annunciates GA below 2,000 feet RA.

After LOC and G/S capture, the APP mode can be exited only by pressing a TO/GA switch or by disengaging the A/P and turning off both F/D switches or retuning a VHF NAV receiver.

AFTER LOC AND G/S CAPTURE

The A/P will not disengage for an invalid ILS signal when above 1,500 feet RA. However, the F/D command bars retract to indicate the invalid signal.

Shortly after capturing both LOC and G/S, the second A/P couples with the flight controls, FLARE armed is annunciated, and the A/P go-around mode arms but is not annunciated.

The pitch and roll axes cannot be manually overridden into CWS. Manual override of the autopilots will result in autopilot disengagement.

800 FEET RADIO ALTITUDE

The second A/P must be engaged in CMD by 800 feet RA to execute a dual channel A/P approach. Otherwise, CMD engagement of the second A/P is inhibited.

400 FEET RADIO ALTITUDE

If FLARE arm is not annunciated by approximately 400 feet RA, both A/P's will automatically disconnect.

The stabilizer is automatically trimmed an additional amount nose up. If the A/P's subsequently disengage, forward control column force may be required to hold the desired pitch attitude.

FLARE

The A/P flare maneuver starts at approximately 42 feet RA and is completed at touchdown. FLARE engaged is annunciated and the F/D command bars retract.

The A/T begins retarding thrust at approximately 27 feet RA so as to reach idle at touchdown. The A/T automatically disengages approximately 2 seconds after touchdown.

The A/P must be manually disengaged after touchdown. Landing rollout is executed manually after disengaging the A/P.

A/P GO-AROUND MODE (GA)

The A/P go-around (GA) mode requires dual A/P operation and becomes armed when FLARE armed is annunciated. The A/P GA mode cannot be engaged before FLARE ARM is annunciated or after the A/P senses touchdown.

NOTE: If the GA mode is selected after touchdown and prior to A/T disengagement, the A/P's will disengage and the A/T's may command GA thrust.

Pressing either TO/GA switch engages the GA mode and TO/GA is annunciated for the AFDS. The MCP IAS/Mach Display becomes blank and the Airspeed Cursors are positioned at the AFDS commanded speed. Command airspeed is flap maneuvering speed.

A/P GO-AROUND PITCH CONTROL

Upon GA engagement, the thrust levers advance toward the reduced go-around N1. The A/P initially commands a 15 nose-up pitch attitude, and the Airspeed Cursors display maneuvering speed for the flap setting when a programmed rate of climb is established, the A/P controls pitch to hold airspeed based on the normal flap maneuvering speed.

A/P GO-AROUND ROLL CONTROL

With the GA mode engaged, the A/P's maintain the airplane ground track existing at GA engagement.

LEAVING THE GA MODE

Below 400 feet RA, the A/P's must be disengaged to change either pitch or roll modes from GA. Above 400 feet RA, other pitch and roll modes can be selected.

If the roll mode is changed first, the selected mode engages in single A/P roll operation and is controlled by the A/P which was first in CMD. Pitch control remains the dual A/P GA mode.

The pitch mode cannot be changed from GA until sufficient nose-down trim has been input to allow single channel A/P operation. This nose-down trim is automatically added to reset the trim input at 400 feet RA on the approach.

If the pitch mode is the first to be changed from GA, the selected pitch mode engages in single A/P operation and is controlled by the A/P which was first in CMD. The second A/P disengages, the roll mode changes to CWS roll, and the thrust limit and A/T engage in compatible modes.

With pitch engaged in GA, ALT ACQ engages when approaching the selected altitude and ALT HOLD engages at the selected altitude if the stabilizer position is satisfactory for single A/P operation.

A/P GO-AROUND MODE (GA) (cont'd.)

LEAVING THE GA MODE (cont'd.)

The transition from GA to ALT ACQ is normally successful if the selected altitude is at least 1,000 feet above the GA engagement altitude. A higher selected altitude may be required if full GA thrust is used.

If stabilizer trim is not satisfactory for single A/P operation, ALT ACQ is inhibited and the A/P disengage lights illuminate steady red and pitch remains in GA. To extinguish the A/P disengage lights, a higher altitude can be selected or the A/P's disengaged.

APPROACH (APP) MODE SINGLE A/P

A single A/P ILS approach can be executed by not raising the second A/P Engage Paddle to CMD after pressing the APP Mode Select switch. Single A/P approach operation is the same as dual, with the following exceptions:

— A/P status of SINGLE CH is annunciated for the entire approach after localizer capture.

— Full automatic flare and touchdown capability is not available. FLARE is not annunciated and stabilizer trim bias is not applied.

— An A/P go-around is not available.

FLIGHT DIRECTOR

INTRODUCTION

F/D commands operate in the same command modes as the A/P except:

— The Takeoff mode is an F/D only mode.

— Dual F/D guidance is available for single-engine operation.

— The F/D has no landing flare capability. F/D command bars retract from view at approximately 42 feet RA on an ILS approach.

The two F/D switches on the MCP turn the F/D's ON and OFF for each pilot. Turning a switch ON displays command bars on the respective pilot's ADI, if command pitch and roll modes are engaged. If command pitch and roll modes are not engaged, the F/D command bars do not appear. The F/D's can be operated with or without the A/P and A/T. F/D command modes can be used with an A/P Engage Paddle in CWS.

Normally, FCC "A" drives the Captain's command bars and FCC "B" drives the First Officer's command bars. With both F/D switches ON, the logic for both pilots' F/D modes are controlled by the master FCC and both FMA panels show the same mode status. If both pilot's VHF NAV frequencies and/or courses have not been set the same, their F/D commands may not agree.

The master FCC is indicated by illumination of the respective Master (MA) F/D Indicator light. The master FCC is determined as follows:

— With neither A/P engaged in CMD, the FCC for the first F/D turned on is the master.

— With one or both A/P's engaged in CMD, the FCC for the first A/P in CMD is the master FCC, regardless of which F/D is turned on first.

F/D modes are controlled directly from the respective FCC under certain conditions. This independent F/D operation occurs when neither A/P is engaged in CMD, both F/D switches are ON, and one of the following mode conditions exist:

— APP mode engaged with LOC and G/S captured.
— GA mode engaged and below 400 feet RA.
— TO mode engaged and below 400 feet RA.

Independent F/D operation is indicated by illumination of both MA lights. When independent operation terminates, the MA light extinguishes on the slaved side.

Both F/D's must be ON to engage the takeoff or go-around mode. If a generator is lost during a F/D TO or GA, the FCC on the unaffected side positions the F/D command bars on both ADI's. If the F/D MA light on the affected side had been illuminated, it extinguishes upon electrical bus transfer.

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FLIGHT DIRECTOR (cont'd.)

GO-AROUND MODE

Several criteria must be met before the F/D can engage in the go-around mode.

— Inflight below 2,000 feet RA and not in the takeoff mode.

— Either F/D switch ON or OFF.

— One or neither AP engaged in CMD.

— TO/GA switch pressed.

After engaging in GA, command bars appear for both pilots, TO/GA is annunciated for the F/D pitch mode, the IAS/Mach Display blanks, and the Airspeed Cursors display maneuvering speed for the existing flap setting.

Below 400 feet RA, both F/D switches must be turned from ON to OFF to exit the F/D GA mode. Above 400 feet RA, other pitch and roll modes can be selected. If the roll mode is changed first, the F/D pitch mode remains in the GA mode. If the pitch mode is changed first, F/D roll mode automatically changes to HDG SEL.

Engaging an A/P in CMD following a F/D go-around automatically engages the A/P and F/D's in LVL CHG and HDG SEL for pitch and roll, respectively.

Two-Engine F/D Go-Around

The F/D's command 15° nose-up pitch and roll to hold the approach ground track at the time of GA engagement. After reaching a programmed rate of climb, pitch commands hold the maneuvering speed for each flap setting.

Single-Engine F/D Go-Around

During a single engine go-around, the F/D pitch command is initially 13° nose-up but as climb rate increases, F/D pitch commands maintain a target airspeed.

Roll commands are the same as for two engine go-around.

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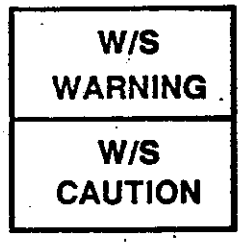
FLIGHT DIRECTOR (cont'd.)

WINDSHEAR (IF INSTALLED)

Some aircraft are equipped with an advanced GPWS, which includes windshear caution and warning logic. Cockpit indications are two lights, labeled W/S CAUTION and W/S WARNING, installed on both the Captain's and F/O's glareshield and an additional GPWS aural warning, "WINDSHEAR, WINDSHEAR, WINDSHEAR".



(Pilots' Glareshields)

W/S CAUTION Alerts

Advises pilots of the presence of an increasing headwind or updraft in the APPROACH MODE ONLY. No aural warning is received.

W/S WARNING Alerts

Advises pilots of the presence of a rapidly DECREASING HEADWIND, a rapidly INCREASING TAILWIND, and/or a DOWNDRAFT in both the takeoff and approach modes. Aural warning "WINDSHEAR, WINDSHEAR, WINDSHEAR" is broadcast.

AUTOTHROTTLE

INTRODUCTION

The A/T system provides automatic thrust control from the start of takeoff through climb, cruise, descent, approach, and go-around or landing. In normal operation, the FMC provides the A/T system with N_1 limit values.

The A/T moves the thrust levers with a separate servo motor on each thrust lever. Manually positioning the thrust levers does not cause A/T disengagement unless 10° of thrust lever separation is exceeded during a dual channel approach after FLARE armed is annunciated. Following manual positioning, the A/T may reposition the thrust levers to comply with computed thrust requirements except while in the THR HOLD and ARM modes.

A/T ENGAGEMENT & DISENGAGEMENT

Moving the A/T Arm switch to ARM, arms the A/T for engagement in the N_1, MCP SPD, or FMC SPD mode. The A/T Arm switch is magnetically held at ARM and releases to OFF when the A/T becomes disengaged.

Any of the following conditions or actions disengages the A/T:

- Moving the A/T Arm switch to OFF.
- Pressing either A/T Disengage switch.
- An A/T system fault is detected.
- Two seconds have elapsed since landing touchdown.
- Thrust levers become separated more than 10° during a dual channel approach after FLARE armed is annunciated.

A/T disengagement is followed by A/T Arm switch releasing to OFF and flashing red A/T Disengage lights.

The A/T Disengage lights can be extinguished by any one of the following actions:

- Returning the A/T Arm switch to ARM.
- Pressing either A/T Disengage light.
- Pressing either A/T Disengage switch.

The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.

A/T TAKEOFF MODE

The takeoff mode is engaged by pressing either TO/GA switch with the airplane on-the-ground, the A/T armed, and the desired takeoff N_1 LIMIT selected from an FMC CDU. The A/T annunciation changes from ARM to N_1 and the thrust levers advance toward takeoff thrust.

The A/T sets takeoff thrust prior to 60 knots IAS and at 64 knots IAS, annunciates THR HOLD to indicate the A/T cannot change thrust lever position, but thrust levers can be repositioned manually.

After lift-off, the A/T remains in THR HOLD until 400 feet RA is reached and approximately 18 seconds have elapsed since lift-off. A/T annunciation then changes from THR HOLD to ARM. Reduction to the climb thrust can now be made by pressing the N_1 switch.

Until 2½ minutes after liftoff, automatic reduction to climb thrust is inhibited when engaging LVL CHG or V/S mode. If VNAV, ALT ACQ or ALT HOLD is engaged during this 2½ minute period, automatic thrust reduction occurs normally.

N_1 MODE

The A/T maintains thrust at the N_1 limit selected from an FMCS CDU. N_1 is annunciated for the A/T and the N_1 switch illuminates. Pressing the N_1 switch changes the A/T mode from N_1 to ARM.

If an engine fails while the A/T is in the N_1 mode, the thrust lever of the failed engine will advance forward a few degrees and return to or below the other thrust lever position.

SPEED MODE

The Speed mode is available throughout the flight once the takeoff phase is completed. Pressing the MCP Speed Select switch selects the Speed mode, if compatible with the engaged AFDS pitch mode. SPEED is annunciated for the A/T and the Speed Mode switch illuminates. The speed or Mach shown in the MCP IAS/Mach Display is the target speed. The A/T will not set power above the N_1 LIMIT displayed on the FMA's.

If an engine fails while the A/T is in a speed mode, both thrust levers advance together to maintain the target speed.

GO-AROUND MODE (cont'd.)

After reaching reduced or full go-around thrust, the A/T GA mode can be terminated by selecting another AFDS pitch mode or when ALT ACQ annunciates engaged.

During a single-engine F/D go-around, the A/T will increase thrust to the full N_1 limit.

A/T MODE ENGAGEMENT AND TRANSFER

A general summary of A/T mode engagement and transfer is as follows:

- A/T SPEED or N_1 modes are automatically engaged when AFDS command pitch modes become engaged.
- A/T SPEED or N_1 modes can be manually selected or deselected by pressing the SPEED or N1 switch if action is compatible with other engaged AFDS modes.
- Engaging LVL CHG or VNAV climb modes automatically engages the A/T N_1 mode.
- Engaging LVL CHG or VNAV descent modes automatically engages the A/T to reduce thrust to idle.

ADI FAST-SLOW INDICATORS

The Fast-Slow Pointer on each ADI is positioned by the A/T computer. The Fast-Slow Pointers are not in-view when any of the following conditions exist:

- A/T is in the N_1 mode.
- A/T annunciates ARM or is disengaged and the A/P is in the GA mode.
- F/D is in the TO/GA mode.
- A/P or F/D is in the VNAV SPD or MCP SPD mode.

ADI Fast-Slow indications are referenced to the speed shown with the Airspeed Cursors on the pilots' Mach/Airspeed indicators.

FMC SPEED MODE

The FMC SPD mode is an A/T mode which is commanded by the FMC during VNAV operation. When engaged, the MCP IAS/Mach Display is blank, the Airspeed Cursors are positioned at the FMC commanded airspeed and the A/T maintains this commanded speed. The A/T is limited to the N_1 value shown on the FMA N1 LIMIT annunciators.

N_1 EQUALIZATION

The A/T attempts to equalize N_1 through the dual servo individual thrust lever control. Equalization control is limited to 8° of thrust lever separation.

ARM MODE

The A/T annunciates ARM when the A/T Arm switch is at ARM and no A/T mode is engaged. The thrust levers can be manually positioned, without interference from the A/T system, while ARM is annunciated.

The A/T automatically transfers to ARM from the SPEED or N_1 mode when the mode is deselected by pressing the respective Mode Selector switch while the switch light is illuminated.

DESCENT RETARD MODE

The A/T engages and annunciates RETARD during LVL CHG and VNAV descents. RETARD changes to ARM when the thrust levers reach the aft stop or when they are manually prevented from reaching the aft stop.

LANDING FLARE RETARD MODE

During landing, the RETARD mode engages, reduces thrust, and annunciates RETARD at approximately 27 feet RA. Flare RETARD mode engagement occurs solely in response to radio altitude and is independent of other AFS active modes. The A/T automatically disengages approximately 2 seconds after landing touchdown.

GO-AROUND MODE

With the A/T Arm switch at ARM, the A/T go-around mode is armed when descending below 2,000 feet RA with or without the AFDS engaged. Once armed, the A/T go-around mode can be engaged until 2 seconds have elapsed after landing touchdown.

Pressing either TO/GA switch engages the A/T go-around mode. GA is annunciated for the A/T and the thrust levers advance to the reduced go-around thrust setting. This reduced setting produces approximately a 1,000 to 2,000 FPM rate of climb. After reaching reduced go-around thrust, pressing either TO/GA switch the second time signals the A/T to advance thrust to the full go-around N_1 limit.

AFS
ELECTRICAL POWER LOSS & RADIO ALTITUDE LOSS

ELECTRICAL POWER LOSS

Power interruption or loss may cause disengagement of the AFDS and/or the A/T. Re-engagement is possible after power is restored.

Dual channel A/P operation is possible only when two generators are powering the buses.

RADIO ALTITUDE LOSS

Two independent radio altimeters provide radio altitude to the respective FCC. The Captain's radio altimeter provides radio altitude to the A/T.

With a radio altimeter inoperative, do not use the associated FCC or the A/T, if affected, for approach and landing.

UNSELECTED MCP ALTITUDE CHANGE (As Installed)

The Flight Control Computers (FCC's) issue a warning horn when the MCP displayed altitude changes without altitude selector movement or when the MCP altitude disagrees with the active altitude stored in the FCC's.

The warning consists of the following three items:

— Intermittent Altitude Alert Tone.
— Flashing Altitude Alert lights.
— MCP displays 50,000 feet.

The warning continues until reset by rotating the MCP altitude selector or when the airplane is on the ground with airspeed less than 60 knots.

During the warning with 50,000 feet displayed on the MCP, the FCC's reference their last stored altitude, not the displayed 50,000 feet.

When the warning is reset by rotating the altitude selector, the direction of rotation and number of detents are applied to the FCC stored altitude. This altitude value then replaces the 50,000 feet displayed on the MCP and becomes the new active altitude.

The MCP altitude warning function cannot be manually tested.

AFS OPERATION IN WINDSHEAR

GENERAL

The autopilot and flight director provide positive corrective action to counteract most windshears.

The autothrottle system also aids in windshear recovery by providing quick response to any increase or decrease in speed. The command levels of power may be beyond what the average pilot might consider necessary but, in fact, are required by the situation.

TAKEOFF OR GO-AROUND

If windshear is encountered during F/D takeoff or go-around, the F/D pitch command bar will provide commands to maintain V_2 + 20 knots until vertical speed decreases to approximately +600 FPM. At this point, the F/D pitch bar commands a 15° nose-up pitch attitude. If vertical speed continues to decrease, F/D continues to command a 15° pitch attitude until a speed of approximately stickshaker is reached. It then commands pitch attitudes which result in intermittent activation of the stickshaker. As the airplane transits the windshear condition, the F/D programming will be reversed. As climb rate increases above approximately +600 FPM, the F/D commands pitch attitudes which result in acceleration back to V_2 + 20 knots. The A/P and F/D both operate in a similar manner during A/P or F/D go-around.

APPROACH AND LANDING

If windshear is encountered during an ILS approach, both the F/D and A/P attempt to hold the airplane on altitude, or on glideslope after glideslope capture, without regard to angle of attack or stickshaker limitations. Airspeed could decrease below stickshaker and into a stall if the pilot does not intervene by pressing the TO/GA switch or disconnecting the A/P and flying manually.

WARNING: ***ALTHOUGH THE F/D, A/P AND A/T MAY BE PERFORMING AS PREVIOUSLY DESCRIBED, SEVERE WINDSHEAR MAY EXCEED THE PERFORMANCE CAPABILITY OF THE SYSTEM AND/OR THE AIRPLANE. IN THIS SITUATION, THE FLIGHT CREW MUST, IF NECESSARY TO AVOID GROUND CONTACT, BE PREPARED TO DISCONNECT THE AUTOTHROTTLE, ADVANCE THRUST LEVERS TO THE FORWARD STOP, DISCONNECT THE AUTOPILOT AND MANUALLY FLY THE AIRPLANE.***

COMMAND SPEED LIMITING & REVERSION MODES

INTRODUCTION

AFS command limiting and reversion operation is independent of the stall warning and Mach airspeed warning systems.

COMMAND SPEED LIMITING

The AFS provides speed pitch and thrust commands to avoid exceeding the following limit speeds:

— V_{MO}/M_{MO}

— Wing Flap Placards

— Landing Gear Placard

— Minimum Speed ←

The commanded speed can be equal to, but will not exceed a limit speed.

Speeds greater than V_{MO}/M_{MO} cannot be selected from the MCP. Speeds can be selected which exceed flap and gear placards or are less than minimum speed.

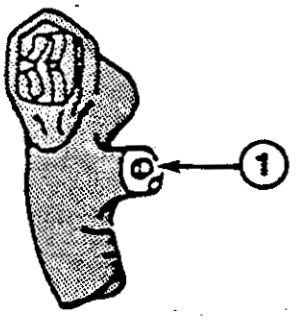
Minimum speed is based on angle of attack and is approximately 1.3 V_S for the current flap configuration. It is sensed by the angle of attack vanes, one on either side of the forward fuselage.

If a speed greater than a placard speed, or less than minimum speed is selected, the AFS allows acceleration or deceleration to slightly short of the limit, then commands the limit speed. The overspeed and underspeed limiting symbol appears in the MCP IAS/Mach Display when the commanded speed cannot be reached. ↵

Either pitch or thrust, whichever is engaged in a speed mode, attempts to hold the limit speed. The commanded limit speed and MCP Speed Condition Symbol remain until another speed is selected which does not exceed the limit. A speed 15 knots greater than the minimum speed must be selected to remove the underspeed limiting symbol. ←

CONTROLS AND INDICATORS

AUTOPILOT & AUTO-THROTTLE DISENGAGEMENT



(Control Wheels)

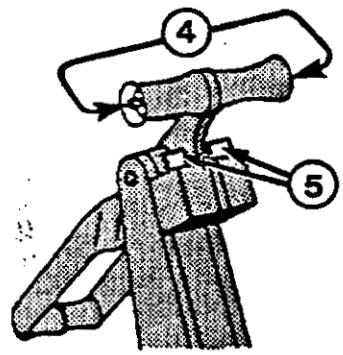
① **AUTOPILOT DISENGAGE SWITCH (2):**

PRESS — Disengages both A/P's. A/P disengage lights flash and A/P disengage warning tone sounds for a minimum of 2 seconds. Second push extinguishes A/P disengage lights and silences disengage warning tone.

Extinguishes A/P disengage lights and silences A/P warning tone after A/P disengagement.

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT & AUTO-THROTTLE DISENGAGEMENT (cont'd.)



(Thrust Levers)

④ **AUTO-THROTTLE DISENGAGE SWITCHES:**

PRESS — Disengages A/T. A/T disengage lights flash and A/T Arm switch trips OFF. Second push extinguishes A/T disengage lights.

Extinguishes A/T disengage lights after A/T disengagement.

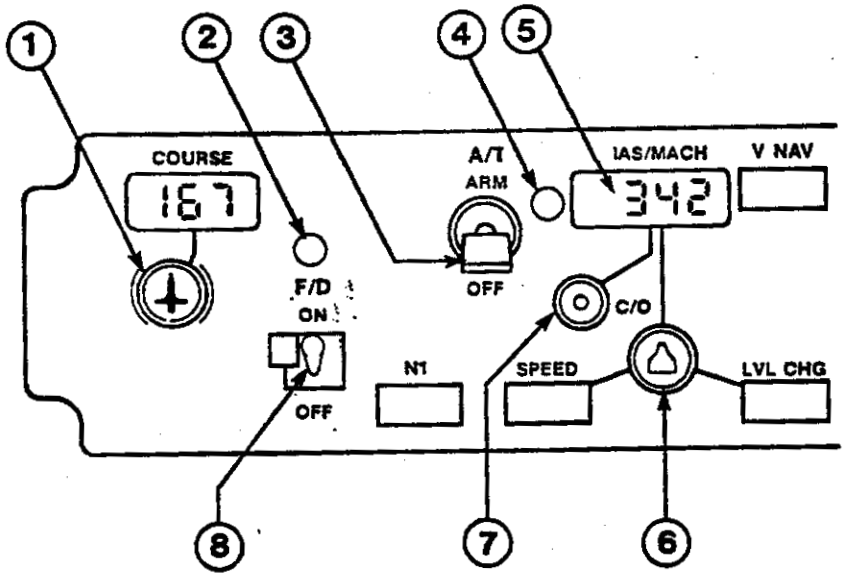
⑤ **TAKEOFF/GO-AROUND (TO/GA) SWITCHES:**

PRESS — Engages AFDS and auto-throttle in takeoff or go-around mode, if previously armed.

(cont'd.)

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE CONTROL PANEL



(Pilots' Glareshield)

(1) COURSE SELECTOR (2):

ROTATE — Sets course in course display for respective VHF NAV receiver, AFDS, and HSI.

(2) MASTER F/D INDICATOR LIGHTS (2):

If an F/D switch is ON, the light indicates which FCC is controlling F/D modes.

ILLUMINATED — Respective FCC is controlling F/D modes.

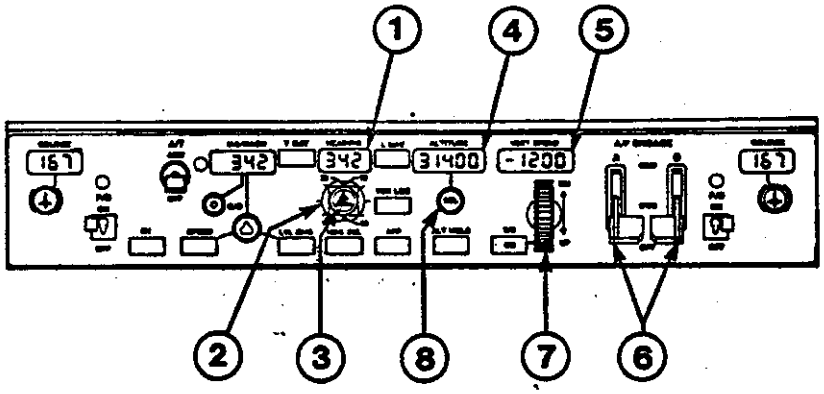
EXTINGUISHED — F/D modes are controlled from opposite FCC.

BOTH LIGHTS ILLUMINATED — Each FCC is controlling modes for respective F/D.

(cont'd.)

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE CONTROL PANEL (cont'd.)



(Pilots' Glareshield)

(1) HEADING DISPLAY:

DISPLAYS: Selected heading.
Same heading as HSI heading markers.

(2) BANK ANGLE SELECTOR:

Sets maximum bank angle for AFDS operation in HDG SEL and VOR modes. Banks angles of 10, 15, 20, 25, and 30 can be selected.

(3) HEADING SELECTOR:

ROTATE — Sets heading in Heading Display. Positions Heading Markers on both HSI's.

(cont'd.)

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE CONTROL PANEL (cont'd.)

(4) ALTITUDE DISPLAY:

- Displays selected altitudes from 0 to 50,000 feet in 100-foot increments.
- Displayed altitude is reference for altitude alerting and automatic level-offs.
- Indicates 10,000 feet when power first applied to the unmodified selector or indicates previous selected altitude when power first applied to the modified selector.

(5) VERTICAL SPEED DISPLAY:

DISPLAYS:

- Selected vertical speeds from -7,900 to +6,000 FPM.
- Blank when V/S mode not active.
- Present V/S when V/S mode is engaged with V/S mode switch.
- 50 FPM units, if less than 1,000 FPM.
- 100 FPM units, if 1,000 FPM or greater.

(6) A/P ENGAGE PADDLES:

Paddles are selectable, one at a time, except both can be placed in CMD while in APP mode. Selecting second paddle disengages first if not in APP mode.

CMD — Enables all command modes for AFDS in addition to CWS. With no pitch or roll commanded mode active, autopilot pitch and roll will be in CWS.

CWS — Autopilot pitch and roll are controlled through control wheel and column pressures. If attitudes acquired exceed autopilot limits, autopilot returns to attitude limits when control force is released. If roll control force is released, with less than 6 of bank, autopilot rolls wings level and holds existing heading. Command modes are available for F/D operation through the mode selector switches.

OFF — Respective autopilot is disengaged.

(7) VERTICAL SPEED THUMBWHEEL:

UP/DN — Sets vertical speed in VERT SPEED display.

(cont'd.)

C-31

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE CONTROL PANEL (cont'd.)

(8) ALTITUDE SELECTOR:

ROTATE — Sets altitude in Altitude Display. Note the effect of altitude selector rotation. The altitude selector will either:

— Change in 100-foot units with the unmodified selector pushed in and 1,000-foot units with the unmodified selector not pushed in.

— Change in 100-foot units only with the modified selector installed.

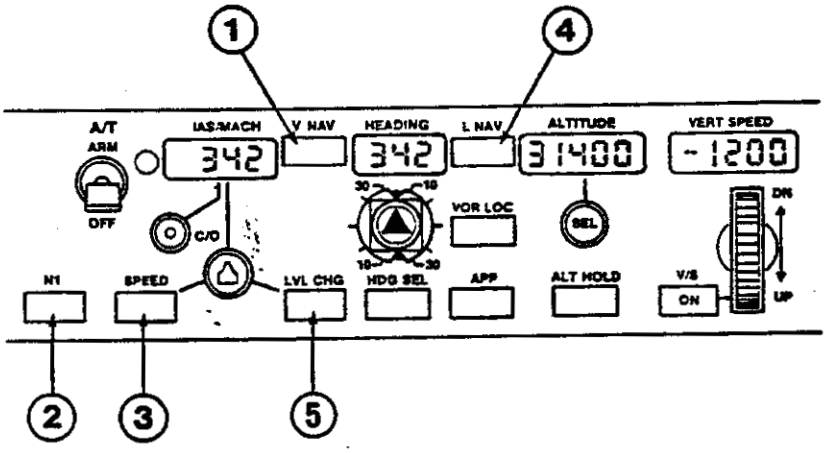
CAUTION: The modified selector can be damaged if forcefully pushed in.

Arms Vertical Speed mode if rotated while in ALT HOLD at selected altitude.

The modified MCP monitors the altitude selector for a between detent position. If the altitude select knob is rotated to a position between detents for several seconds, the displayed altitude will fluctuate up and down 100 feet at approximately once per second. If this indication is observed, the altitude selector should be moved to the detent corresponding to the desired altitude.

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE SELECTORS



(Pilots' Glareshield)

MODE SELECTOR SWITCHES (1 to 4)

All mode selector switches are momentary contact switches.

PRESS — Selects mode. Mode switch illuminates the letters ON to indicate the mode can be deactivated by pressing mode switch a second time. Pressing a lighted mode switch deselects the mode and extinguishes the light. Switch lights do not indicate operating modes. Mode status is shown on the FMA panels.

(1) VERTICAL NAVIGATION (VNAV) MODE:

- AFDS and A/T follow thrust and speed commands from the FMC.
- In VNAV climb, A/T holds FMC thrust limit and AFDS holds FMC target speed.
- During VNAV SPD descent, A/T retards thrust to idle and AFDS holds FMC target speed.
- During VNAV PATH descent, AFDS tracks FMC descent path. A/T starts with idle-ARM, but can be commanded to FMC SPD when required.
- During a VNAV climb or a VNAV descent, automatic level-off occurs at MCP selected altitude or at VNAV altitude, whichever is reached first.

(cont'd.)

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE SELECTORS (cont'd.)

(1) VERTICAL NAVIGATION (VNAV) MODE: (cont'd.)

- (U4 and earlier) During a VNAV speed descent, automatic level off occurs only at the MCP selected altitude.
- In VNAV cruise, AFDS holds altitude and A/T holds FMC target speed.
- VNAV mode is terminated by any one of the following:
  - Selecing V/S, ALT HOLD, LVL CHG, or GA mode.
  - Selecting N1 or SPEED mode.
  - G/S capture.
  - Extending wing flaps beyond 15.

(2) N1 MODE:

- A/T holds N1 limit (TO, GA, CLB, CRZ, or CON) sent from FMC.
- N1 is displayed for A/T mode.

(3) SPEED MODE:

A/T holds speed shown in IAS/MACH Display or a performance or limit speed.

NOTE: N1 and SPEED mode switches select A/T modes only. These modes cannot engage if incompatible with AFDS modes already engaged. Under these conditions, the switches have no effect.

(4) LATERAL NAVIGATION (LNAV) MODE:

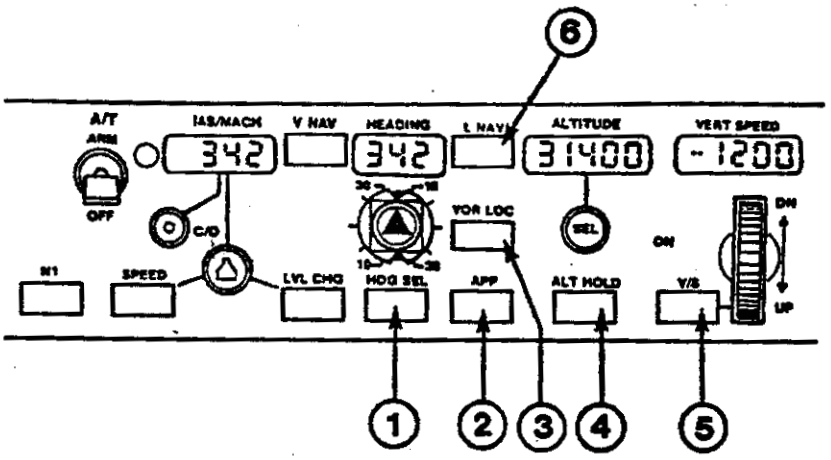
- AFDS follows FMC roll commands to intercept and track the active FMC route.
- LNAV mode terminates when HDG SEL mode is engaged or upon VOR or LOC capture.

(5) LEVEL CHANGE MODE:

- AFDS and A/T execute automatic climbs and descents to MCP selected altitude at selected airspeed.
- AFDS holds selected airspeed. A/T holds limit thrust for climbs and idle thrust for descents.
- Airspeed can be changed with speed selector.
- Inhibited after G/S capture.

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE SELECTORS (cont'd.)



(Pilots' Glareshield)

MODE SELECTOR SWITCHES (1 to 6):

(1) HEADING SELECT MODE:

- AFDS turns to and maintains heading set in the Heading Display.
- Is effective in any radio mode prior to radio course capture.
- Is automatically deactivated at radio course capture.
- Bank is limited by Bank Angle Selector.

(2) APPROACH MODE:

- Selectable after LOC frequency tuned.
- Permits single or dual A/P operation.
- Allows raising second Engage Paddle to CMD for arming and subsequent engagement.
- LOC must be captured before G/S.
- AFDS intercepts and captures LOC as in VOR/LOC mode.
- AFDS captures G/S at 2/5 dot, then commands a descent rate and tracks G/S.

(cont'd.)

CONTROLS AND INDICATORS (cont'd.)

AUTOPILOT FLIGHT DIRECTOR MODE SELECTORS (cont'd.)

(2) **APPROACH MODE: (cont'd.)**

- After LOC and G/S captured and below 1,500 feet RA, second A/P engages, FLARE armed annunciates and APP mode switch extinguishes.
- APP mode remains active until A/P's are disengaged and both F/D's turned OFF or a TO/GA switch is pressed.
- Additionally, if in single A/P operation, CWS can be engaged by manually overriding pitch or roll (High Detent Override).

(3) **VOR/LOC MODE:**

- AFDS intercepts selected VOR or localizer course in either heading select mode or in CMD CWS.
- Course capture point varies depending on course deviation, closure rate and intercept angle.

NOTE: To select VOR LOC or APP mode, the master HSI switch must be in the VOR/ILS position.

(4) **ALTITUDE HOLD MODE:**

- AFDS commands pitch to hold MCP selected altitude.
- AFDS holds altitude at which switch is pressed.
- Mode selector switch extinguishes if altitude being held is within 100 feet of selected altitude. ALT HOLD is annunciated at all times mode is active.
- Inhibited after GS captured.

(5) **VERTICAL SPEED MODE:**

Is not selectable while ALT HOLD mode is active at selected altitude or after glideslope captured in APP mode. V/S is automatically:

- Activated by pressing the V/S mode switch or when a new altitude is selected while ALT ACQ is annunciated.
- Armed if a new altitude is selected while ALT HOLD mode is active at previously selected altitude. Moving V/S thumbwheel then activates V/S mode starting at zero FPM rate.

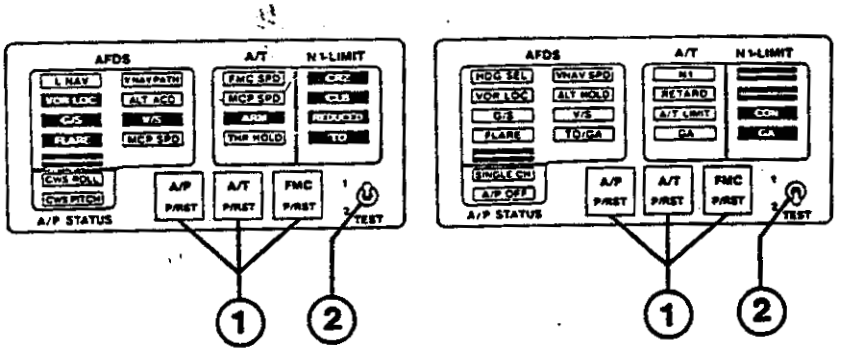
(cont'd.)

MODE ANNUNCIATOR PANELS

INTRODUCTION

A mode annunciator panel is located on each pilot's instrument panel. The two mode annunciator panels are identical and display mode status of the AFDS, A/T, and N1 LIMIT.

The individual annunciators are three-sided prisms which mechanically rotate to the appropriate display and are externally illuminated.



TEST 1 **TEST 2**

(Pilots' Panel)

(1) A/P & A/T DISENGAGE LIGHTS & FMC ALERT LIGHT:

These lights are internally illuminated light caps.

(2) TEST SWITCH:

When the test switch is momentarily held at the 1 and 2 position, the above displays are annunciated. A white horizontal line on a black background indicates a spare annunciator and is displayed only during test.

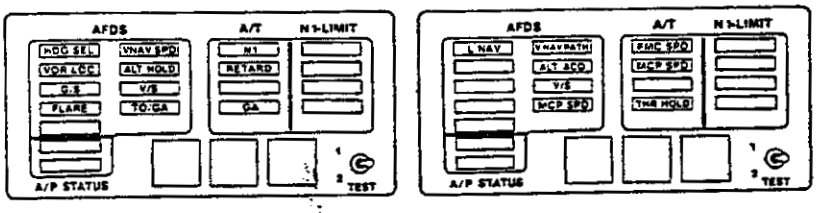
TEST 1 — A/P and A/T Disengage lights and FMC Alert light illuminate steady amber when Test switch momentarily held at position 1.

TEST 2 — A/P and A/T Disengage lights illuminate steady red and FMC Alert light illuminates steady amber when Test switch momentarily held at position 2.

MODE ANNUNCIATOR PANELS (cont'd.)

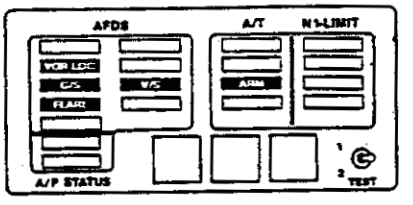
ENGAGED MODE ANNUNCIATIONS

Engaged Mode Annunciations are annunciated with black letters on a green background.



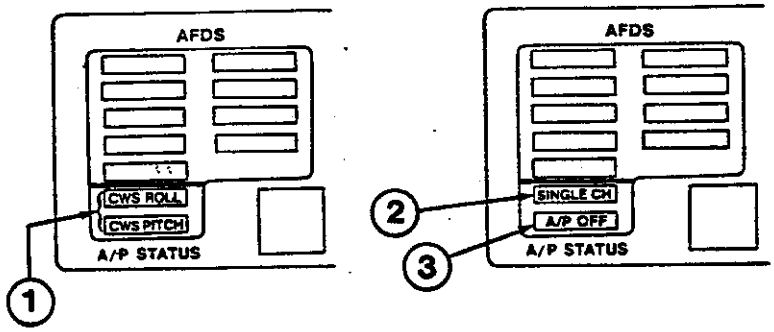
ARMED MODE ANNUNCIATIONS

Armed Mode Annunciations are annunciated with white letters on a black background.



MODE ANNUNCIATOR PANELS (cont'd.)

A/P STATUS ANNUNCIATORS



(1) CWS ROLL/CWS PITCH ANNUNCIATORS:

Black on amber background; indicates axis is in CWS mode.

(2) SINGLE CHANNEL ANNUNCIATOR:

Black on amber background; annunciated in APP mode from LOC capture until second A/P engages at FLARE arm.

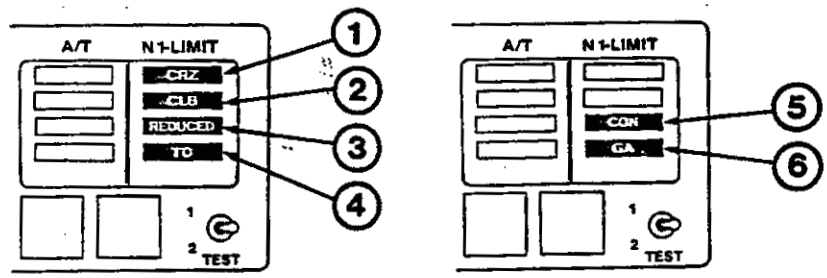
(3) A/P OFF ANNUNCIATOR:

Black on white background; neither autopilot engaged and at least one F/D is ON.

MODE ANNUNCIATOR PANELS (cont'd.)

FMC N1 LIMIT ANNUNCIATORS

All annunciations for N1 LIMIT are white on a black background; and indicates that one of the following FMC N1 limit modes is engaged:



1. **CRZ (CRUISE) ANNUNCIATOR**
2. **CLB (CLIMB) ANNUNCIATOR**
3. **REDUCED ANNUNCIATOR**
   Can appear with TO (Takeoff) Annunciator.
4. **TO (TAKEOFF) ANNUNCIATOR**
5. **CON (CONTINUOUS) ANNUNCIATOR**
6. **GA (GO-AROUND) ANNUNCIATOR**