BOEING 717
AUTO FLIGHT AND FCC

Josh Davidson (Octal450)

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Note: This guide is not an FCOM and does not describe every single behavior of the system.

CONTENTS

INTRODUCTION

The 717's Auto Flight System (AFS) consists of 2 independent Autopilots (APs). Each system has a coupled Auto Thrust System (ATS). The system is capable of automatically flying the aircraft from shortly after liftoff, to touchdown and rollout.

The controls for the system are located on the Flight Control Panel (FCP) on the glareshield. Outputs from the system are shown on both Primary Flight Displays (PFDs) in the form of the Flight Mode Annunciator, Flight Director and target bowtie indicators.

The Flight Control Computers (FCCs) also provide a Yaw Damper and a Mach Trim Compensator.

FLIGHT MODE ANNUNCIATOR

The Flight Mode Annunciator (FMA) shows the engaged and armed modes of the system. It is located at the top of each PFD.
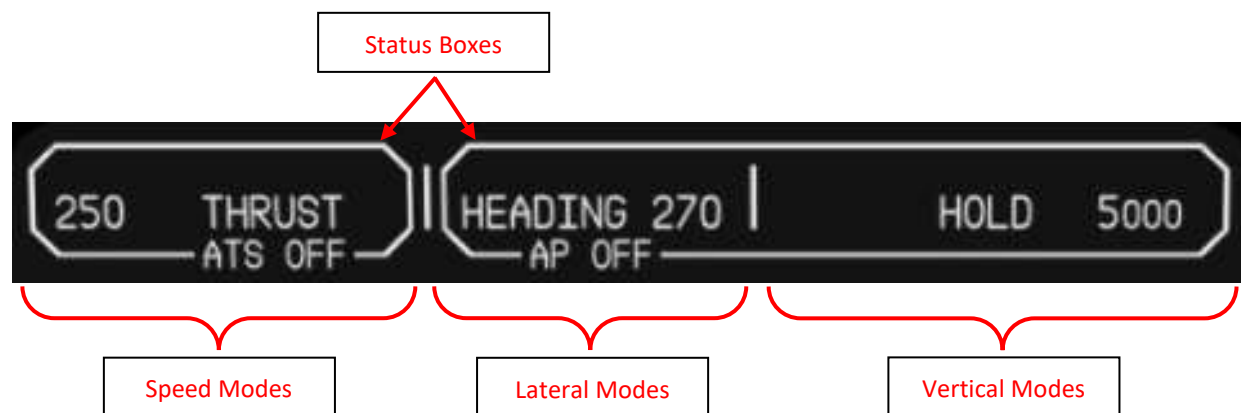
STATUS BOXES

These boxes show the engagement status of the system. When visible and white, the system is off, but available. When the boxes are visible and amber, the system is off and not available.

When turning off a system, the associated box will flash red until silenced (for the AP, aural warning will sound).

When not visible, the systems are engaged. AP1 or AP2 is displayed to indicate the active system. During a DUAL LAND, both APs are engaged, and simply AP is displayed.

https://github.com/Octal450/717

When the speed mode is PITCH, the boxes switch places. This is because the AP is now controlling the speed and lateral modes, while the ATS is controlling the vertical mode.

AUTO FLIGHT MODES

SPEED MODES

The speed mode is coupled to the vertical mode. When the AP is controlling the vertical mode, such as altitude hold or vertical speed, the ATS is controlling the speed. When the AP is controlling the speed, the ATS is controlling the vertical mode. During landing, RETARD mode engages at 30 feet radio altitude.

When FMS SPD is engaged, the mode is displayed in magenta. FMS SPD operation is described in the FMS and MCDU document.

Available modes are:

- THRUST: ATS is adjusting the throttles to control airspeed or Mach number
- PITCH: AP is adjusting the pitch angle to control airspeed or Mach number
- RETARD: ATS is retarding the throttles for touchdown

The ATS command is constrained to the active thrust limit and idle limit.

LATERAL MODES

The lateral modes are controlled by the AP.

When AUTOLAND is active, active mode is displayed in green.

Available modes are:

- HEADING (white): FCP selected heading is being captured and held
- TRACK (white): FCP selected ground track is being captured and held
- NAV (magenta): FMS lateral path is being captured and tracked
- VOR1/VOR2 (white): VOR localizer is being captured and tracked
- LOC/LOC ONLY (white or green): ILS localizer is being captured and tracked
- ALIGN (white or green): Runway alignment is occurring
- ROLLOUT (white or green): Runway centerline is being tracked
- TAKEOFF (white): After liftoff, levelling out and holding current heading

VERTICAL MODES

Vertical path modes are controlled by the AP, and level change modes are controlled by the ATS.

The system will automatically engage HOLD mode and capture the altitude selected on the Flight Control Panel, except when the system is in G/S or Autoland modes.

When AUTOLAND is active, active mode is displayed in green. When the FMS is controlling the vertical mode, the active mode is displayed in magenta.

Available path modes are:

- HOLD (white or magenta): FCP selected altitude is being captured and held
- V/S (white or magenta): FCP selected vertical speed is being tracked
- FPA (white or magenta): FCP selected flight path angle is being tracked
- G/S (white or green): ILS glideslope is being captured and tracked
- FLARE (white or green): The flare maneuver is occurring
- ROLLOUT (white or green): The nose is being lowered to the ground

When in Level Change mode, the AP controls the airspeed by adjusting pitch angle, and the ATS controls the vertical mode by setting power to the active thrust or idle limit. This provides the best climb/descent rates and is automatically engaged based on the aircraft's position in reference to the FCP selected altitude. When the ATS is in any CLAMP mode, the throttle servos are unpowered and the levers can be moved by the pilot.

Available level change modes are: (white or magenta)

- T/O THRUST (Climb): Takeoff Thrust limit is being set
- T/O CLAMP (Climb): Takeoff Thrust limit was set and the servos are now unpowered
- GO AROUND (Climb): Go Around limit is being set
- MCT THRUST (Climb): Max Continuous Thrust limit is being set
- CLB THRUST (Climb): Climb Thrust limit is being set
- IDLE THRUST (Descent): Throttles are being driven to idle and held
- IDLE CLAMP (Descent): Throttles are being driven to idle and then the servos will be unpowered

LAND MODES

When engaged, the land mode capability is displayed to the right of the vertical mode section in place of the target altitude. The indications will appear roughly 10 seconds after passing 1500 feet radio altitude. When a land mode engages, the only way to exit is to press the Go Around button on the throttles. Other mode selection is inhibited.

- AUTOLAND (green): Autoland is available
- APPR ONLY (white): Autoland is not available, disconnect the AP above 100 feet

ARMED MODES

Armed modes appear above the active modes on the FMA. They disappear when the mode activates.

Lateral armed modes are:

- NAV ARMED (Magenta): NAV mode is armed
- LAND ARMED (White): LOC mode is armed
- LOC ARMED (White): LOC ONLY mode is armed
- VOR ARMED (White): VOR1 or VOR2 mode is armed

Vertical armed modes are:

- LAND ARMED (WHITE): G/S mode is armed
- PROF ARMED (Magenta): PROF mode is armed

SPEED PROTECTION

The Auto Flight System provides envelope protection to keep the airspeed is between Vmax and Vmin.

At 5 knots above Vmax or 5 knots below Vmin, speed protection will engage. The ATS off box and HI/LO SPEED PROTECTION flash on the FMA.

If the speed mode is THRUST, ATS speed protection will engage and adjust the throttles to correct the airspeed. The current vertical mode remains active.

At 10 knots above Vmax or 10 knots below Vmin, pitch speed protection will engage. The throttles will be driven to the min/max and the pitch angle will be adjusted via AP or FD commands. Pitch speed protection is inhibited when the vertical mode is HOLD to ensure the aircraft does not deviate from its assigned altitude.

If the throttles are already at their limit or the speed mode is PITCH, the AP goes directly into pitch speed protection.

When the airspeed is no longer outside Vmax or Vmin, speed protection disengages and the aircraft recaptures the speed target and continues on its current trajectory.

FLIGHT CONTROL PANEL

The Flight Control Panel (FCP) is the location of most of the controls for the Auto Flight System (AFS). It is located on the glareshield.
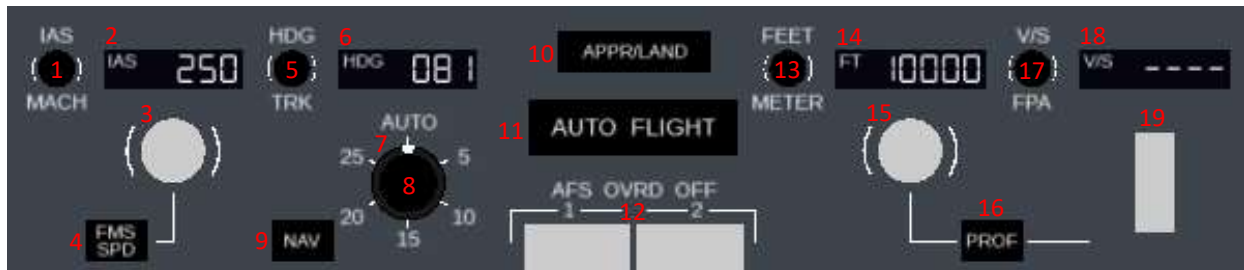
Knobs 3, 8, and 15 are multi-function knobs. A mouse or trackpad with a scroll wheel is required to use them. The 2D panel version includes + and – clickspots for use if no scrolling is available on your device.

- Turn knobs by using the scroll wheel, hold Shift to accelerate adjustment
- Push knobs by left clicking
- Pull knobs by middle-clicking or holding Shift and left-clicking

1) IAS Mach Selector
   Switches the speed pre-select and target between indicated airspeed (knots), and Mach number.

2) Speed Window
   Displays the speed pre-select. Dashed when FMS SPD is active.

3) Speed Knob
   Turn: Adjusts the speed pre-select.
   Push: Sets the speed target to the current speed. Cancels FMS SPD.
   Pull: Sets the speed target to the pre-selected value. Cancels FMS SPD and RETARD mode.

4) FMS SPD Button
   Push to engage FMS SPD mode. Requires at least 400 feet radio altitude.

5) Heading Track Selector
   Switches between heading and ground track modes.

6) Heading Window
   Displays the heading pre-select. Dashed unless HEADING, TRACK, or TAKEOFF lateral modes are active.

7) Bank Limit Selector
   Selects the maximum bank angle in HEADING or TRACK modes. No effect in other modes.

8) Heading Knob

Turn: Adjusts the heading/track pre-select.

Push: Engages HEADING or TRACK and holds the current value. Cancels armed lateral modes.

Pull: Engages HEADING or TRACK and sets the target to the pre-selected value.

9) NAV Button

Arms or engages NAV mode (if available).

10) APPR/LAND Button

Arms or engages LAND modes for ILS approaches if the frequency is in range.

11) AUTOFLIGHT Button

When airborne, engages both the ATS and either AP1 and AP2. The engaged AP is alternated every engagement, and pushing the button while engaged will swap to the other AP.

12) AFS Override Off Switches

Emergency disconnect switches. Immediately disconnects the ATS and both APs. Also disables AFS Speed Protection. Do not use during normal operation.

13) Feet/Meter Selector (Currently INOP)

Switches the altitude pre-select and target between feet and meters.

14) Altitude Window

Displays the altitude pre-select.

15) Altitude Knob

Turn: Adjusts the altitude pre-select.

Push: Engages HOLD mode and holds the current altitude. Cancels armed vertical modes.

Pull: Engages Level Change mode and sets the altitude target to the pre-selected value.

16) PROF Button (Currently INOP)

Arms or engages PROF mode (if available).

17) Vertical Speed/Flight Path Angle Selector

Switches between vertical speed and flight path angle modes.

18) Vertical Speed/Flight Path Angle Window

Displays the vertical speed select in feet-per-minute or flight path angle select in degrees.

19) Vertical Speed/Flight Path Angle Knob

Engages V/S or FPA modes and adjusts the target value.

Yoke

PICTURE
COMING SOON

1

Throttles

PICTURE
COMING SOON

2

3

Sides of Main Panel

PICTURE
COMING SOON

4

5

1) AP Disconnect Button (Both Yokes) (Shift + D)
Disconnects both APs. Aural warning will sound and the AP OFF box on the FMA will flash red. Second press silences the warning.

2) Go Around Buttons (Ctrl + G)
Engages HEADING and GO AROUND mode. The ATS sets throttles to the Go Around thrust limit. If the gear is on the ground and the AP is on, it will disconnect. Button has no effect above 2500 feet radio altitude.

3) ATS Disconnect Button (Both Throttles) (Ctrl + D)
Disconnects the ATS. The ATS OFF box on the FMA will flash red. Second press silences the warning.

4) Flight Director Off Button
Toggles the Flight Director on the associated PFD.

5) Flight Director Selector (Currently INOP)
Switches the associated Flight Director (FD) to the other system. For example, the captain's side switch will set FD1 to be driven by Flight Control Computer 2.

MACH TRIM

A mach trim compensator is provided by the FCC to cancel the mach tuck (nose down) effect at high mach numbers. An override is available to disable the system on the overhead panel.

At high mach numbers, commands from the FCC applies slight nose up stabilizer trim. This increases the pitch up moment to counteract mach tuck. Mach trim is removed as the aircraft slows.

YAW DAMPER

A yaw damper is provided by the FCC to damp Dutch roll and provide turn coordination. The yaw damper is active when above 50 feet radio altitude. The rudder pedals do not move with yaw damper commands.

PROCEDURES

TAKEOFF AND CLIMB

1) Ensure T/O CLAMP is indicated on the FMA, and that climb speed and initial altitude are set on the FCP. Optionally arm NAV mode and once implemented, PROF mode.
2) Spool the engines up to approximately 1.10 EPR and wait for them to stabilize.

3) Push the AUTOFLIGHT button.
4) Push throttles up and check that T/O THRUST appears on the FMA and the ATS drives the throttles to the takeoff limit.
5) At 80 knots, observe and crosscheck T/O CLAMP re-appearing on the FMA and power is set.
6) At rotation speed, smoothly rotate the aircraft up and center the Flight Director bars. Do not chase the bars.
7) At 100 feet radio altitude, the AP can be engaged unless NAV mode is armed or active, where 400 feet radio altitude is the minimum. Center FD bars before engaging the AP.
8) At 400 feet radio altitude, push the FMS SPD button.
9) At thrust reduction altitude (typically 1500 feet above airport elevation), observe CLB THRUST appearing on the FMA. The engines will roll back to the climb limit.
10) At acceleration altitude (typically 3000 feet above airport elevation), observe the speed target advancing to 250 knots. If FMS SPD wasn't engaged or was disengaged, pull the Speed Knob to accelerate to the climb speed set in the FCP.

ENGAGING THE AP OR ATS

1) Ensure the desired modes are active, the flight controls and Flight Director bars are centered, and the stabilizer is trimmed.
2) Push the AUTOFLIGHT button.

DISENGAGING THE AP OR ATS

1) Push the AP disconnect button on the yoke or the ATS disconnect button on the throttles.
2) Silence the disconnect warning and flashing red box by pressing the AP or ATS disconnect button again.

SETTING A NEW SPEED OR HEADING

1) Set desired speed or heading into the FCP.
2) Pull the speed knob or heading knob.

CLIMBING OR DESCENDING TO A NEW ALTITUDE

1) Set desired altitude into the FCP.
2) Pull the altitude knob to engage level change.
3) If engaged, observe the ATS setting power for climb or descent and the AP pitching for speed.

PERFORMING AN ILS APPROACH OR AUTOLAND

1) Set the frequency and course into the ILS radio using the MCDU NAV RAD page.
2) When on an intercept course (30 degrees or less recommended), push the APPR/LAND button.
3) Ensure LAND ARMED is displayed in the lateral mode on the FMA.
4) When LOC engages, ensure LAND ARMED is displayed in the vertical mode on the FMA.
5) When G/S engages, ensure the missed approach altitude is set in FCP.
6) If performing an Autoland, ensure AUTOLAND is annunciated on the FMA roughly 10 seconds after passing 1500 feet radio altitude.
7) Monitor AP performance and be prepared to take over if system disconnects due to loss of ILS signal or malfunction.

TRACKING AN ILS LOCALIZER

1) Set the frequency and course into the ILS radio using the MCDU NAV RAD page.
2) When on an intercept course (30 degrees or less recommended), select *LOC ONLY option in the MCDU NAV RAD page.
3) Ensure LOC ARMED is displayed in the lateral mode on the FMA.

TRACKING A VOR RADIAL

1) Set the frequency and course into either VOR radio using the MCDU NAV RAD page.
2) When on an intercept course (30 degrees or less recommended), select *VOR ARM option in the MCDU NAV RAD page.
3) Ensure VOR ARMED is displayed in the lateral mode on the FMA.