

MCDONNELL DOUGLAS MD-90EFD

AUTO FLIGHT AND DFGS

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

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INTRODUCTION

The MD-90's Digital Flight Guidance System (DFGS) provides dual Autopilots (APs) and an 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 Guidance Control Panel (FGCP) on the glareshield. Outputs from the system are shown on both Flight Mode Annunciators, and the Flight Directors on each Primary Flight Display (PFD) or Attitude Director Indicator (ADI).

The DFGS also provides a Yaw Damper and a Mach Trim Compensator.

There are small differences in the EFD version from the standard MD-90.

FLIGHT MODE ANNUNCIATOR

The Flight Mode Annunciator (FMA) located on the top of each Primary Flight Display (PFD) shows the engaged and armed modes of the system.



- 1) ATS Status Box
White when the ATS is off. Flashes red when the ATS is disengaged until the ATS disconnect button is pressed again. Hidden when the ATS is engaged.
- 2) Thrust Window
Displays the ATS mode when the ATS is engaged.
- 3) Arm Window
Displays the armed modes when the respective FD or either AP is engaged.
- 4) AP Status Box
White when the AP is off. Flashes red when the AP is disengaged until the AP disconnect button is pressed again. Hidden when either AP is engaged.
- 5) AP Indicator
Displays AP OFF when both APs are off. Displays AP1 or AP2 in blue when the respective AP is engaged.
- 6) Roll Window
Displays the roll mode when the respective FD or either AP is engaged.
- 7) Pitch Window
Displays the pitch mode when the respective FD or either AP is engaged.

AUTO FLIGHT MODES

SPEED MODES

The Auto Thrust System (ATS) operates independently of the Autopilot. However, the AP and ATS will ensure that no mode conflicts occur.

If the AP is controlling the speed and the ATS is commanded to control the speed, the AP vertical mode will revert to VERT SPD or ALT HOLD. If the ATS is controlling the speed, and the AP enters IAS or MACH mode, the ATS will revert to CLAMP.

The ATS throttle command is constrained by the active Engine Pressure Ratio (EPR) limit selected on the Thrust Rating Indicator (TRI) and the DFGS computed idle limit.

If the FADEC is in T/O or T/O FLEX mode, the ATS will remain in CLAMP mode unless the aircraft is in TAKE OFF mode on the ground and below 60 knots. In this case, it will engage in EPR LIM mode.

Available modes are:

- SPD 250: FGCP selected airspeed is being held, in this case 250 knots
- SPD ATL: ATS airspeed command exceeds the thrust limit
- MACH 780: FGCP selected mach number is being held, in this case .780
- MACH ATL: ATS mach command exceeds the thrust limit
- LOW LIM: ATS airspeed or mach command exceeds the idle limit
- ALFA SPD: FGCP selected speed too low, safe stall (alpha) margin speed being held
- VMO/MMO/FLAP/SLAT LIM: FGCP selected speed too high, safe speed being held
- EPR XXX: EPR limit being held (T/O, MCT, CL, etc.)
- CLAMP: Throttle servos are unpowered and the levers can be moved by the pilot
- RETARD: Throttles are being retarded for touchdown

LATERAL MODES

Available modes are:

- HDG HOLD: Levelling out and holding current heading
- HDG SEL: FGCP selected heading is being captured and held
- NAV TRK: FMS lateral path is being captured and tracked
- VOR CAP: VOR localizer is being captured
- VOR TRK: VOR localizer is being tracked
- VOR CRS: VOR station crossing is occurring, holding existing heading
- LOC CAP: ILS localizer is being captured
- LOC TRK: ILS localizer is being tracked
- AUTOLAND: ILS localizer is being tracked in LAND mode
- ALIGN: Runway alignment is occurring
- ROLLOUT: Runway centerline is being tracked
- TAKE OFF: After liftoff, levelling out and holding current heading

- GO RND: Levelling out and holding current heading
- WING LVL: Turbulence mode engaged, holding wings level

VERTICAL MODES

Available modes are:

- ALT HOLD: Altitude is being held
- ALT CAP: FGCP selected altitude is being captured
- VERT SPD: FGCP selected vertical speed is being tracked
- G/S CAP: ILS glideslope is being captured
- G/S TRK: ILS glideslope is being tracked
- AUTOLAND: ILS glideslope is being tracked in LAND mode
- FLARE: The flare maneuver is occurring
- ROLLOUT: The nose is being lowered to the ground
- NO FLARE (flashing): The AP is engaged under 100 feet radio altitude but LAND is not engaged
- IAS: FGCP selected airspeed is being tracked by adjusting pitch angle
- MACH: FGCP selected mach number is being tracked by adjusting pitch angle
- TAKE OFF: Takeoff guidance is being tracked to pitch for V2+10 (V2 for engine-out)
- GO RND: Go around guidance is being tracked
- TURB: Turbulence mode engaged, FGCP selected pitch angle is being tracked

ARMED MODES

Armed modes are:

- VOR: VOR mode is armed
- LOC: LOC mode is armed
- NAV: NAV mode is armed
- LND: LAND mode is armed
- ALT: ALT CAP mode is armed
- ILS: LOC and G/S modes are armed
- AUT G/A: DFGS AP go around is armed
- FD G/A: DFGS FD go around is armed
- MAN G/A: DFGS go around is not armed

CONTROLS

FLIGHT GUIDANCE CONTROL PANEL

The Flight Guidance Control Panel (FGCP) is the location of most of the controls for the Digital Flight Guidance System (DFGS). It is located on the glareshield.



Knobs 7, 15, and 24 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) Flight Director Switch

Toggles the Flight Director on the associated PFD or ADI.

2) FMS OVRD Button (Currently INOP)

Allows overriding the VNAV speed command.

3) SPD SEL Button

Sets the ATS to SPD mode. If the vertical mode is IAS, MACH, TAK OFF, or GO RND, it will revert to VERT SPD or ALT HLD. SPD mode will not engage if the TRI is set to TO or TO FLX.

4) MACH SEL Button

Sets the ATS to MACH mode. If the vertical mode is IAS, MACH, TAK OFF, or GO RND, it will revert to VERT SPD or ALT HLD. MACH mode will not engage if the TRI is set to TO or TO FLX.

5) EPR LIM Button

Sets the ATS to EPR mode. The vertical mode does not change.

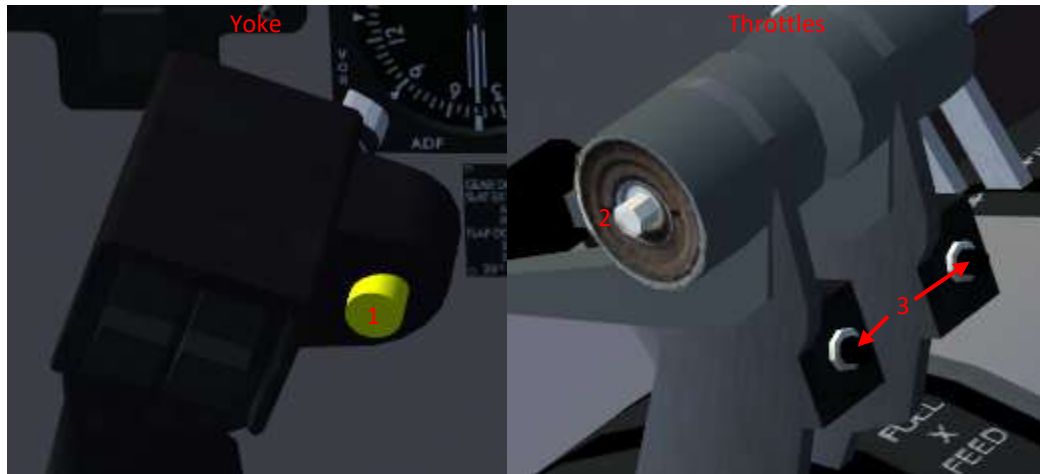
6) Speed Window

Displays the ATS speed select.

- 7) Speed Knob
Turn: Adjusts the ATS speed select.
Push: Switches the ATS speed select between indicated airspeed (knots) and mach number, unless the ATS is in SPD or MACH modes. In SPD or MACH modes, the value is temporarily switched for pre-selection. When the knob is untouched for 3 seconds, it reverts back.
- 8) NAV Button
Arms or engages NAV mode (if available).
- 9) ATS Switch (Auto Throt)
Engages or disengages the ATS. Switch will trip off automatically if the ATS disengages.
- 10) VOR LOC Button
Arms or engages VOR localizer mode.
- 11) ILS Button
Arms or engages ILS localizer and glideslope modes.
- 12) AUTO LAND Button
Arms or engages ILS localizer, glideslope, and LAND modes.
- 13) Heading Window
Displays the heading select.
- 14) Bank Limit Selector
Selects the maximum bank angle in HDG HLD, HDG SEL or VOR modes. No effect in other modes.
- 15) Heading Knob
Turn: Adjusts the heading.
Push: Engages HDG HLD mode. Cancels armed lateral modes.
Pull: Engages HDG SEL mode. Cancels armed lateral modes.
- 16) Pitch Window
When V is annunciated, displays the vertical speed select in feet-per-minute.
When S is annunciated, displays the airspeed select for IAS vertical mode.
When M is annunciated, displays the mach select for MACH vertical mode.
When P is annunciated, displays the pitch angle select in degrees.
- 17) Pitch Knob
Turning in VERT SPD mode adjusts the selected vertical speed.
Turning in IAS mode adjusts the selected airspeed for IAS vertical mode.
Turning in MACH mode adjusts the selected mach for MACH vertical mode.
Turning in TURB mode adjusts the selected pitch angle.
Turning in any other mode engages VERT SPD mode and cancels armed vertical modes.

- 18) VERT SPD Button
Engages VERT SPD mode. Cancels armed vertical modes.
- 19) IAS MACH Button
If below 27,000 feet, engages IAS vertical mode. Cancels armed vertical modes.
If above 27,000 feet, engages MACH vertical mode. Cancels armed vertical modes.
Pushing again toggles between IAS and MACH vertical modes. MACH mode is inhibited below mach 0.5.
- 20) VNAV Button (Currently INOP)
Engages VNAV mode. Cancels armed vertical modes.
- 21) AP Switch
Engages or disengages the AP. Switch will trip off automatically if the AP disengages.
- 22) DFGS Selector Switch
Selects between DFGS/AP 1 and DFGS/AP 2. If the AP is engaged while the switch is moved, it will trip off.
- 23) ALT HOLD Button
Engages ALT HLD mode and holds the current altitude. Cancels armed vertical modes.
- 24) Altitude Window
Displays the altitude pre-select.
- 25) Altitude Knob
Turn: Adjusts the altitude pre-select by 1000 feet.
Push: Allows adjustment of the altitude pre-select by 100 feet. Disarms ALT CAP and resets altitude alert warning.
Pull: Arms ALT CAP for the pre-selected altitude. If the FADEC is in T/O or T/O FLEX and the aircraft is above 400 feet radio altitude, also arms automatic climb thrust reduction.
- 26) TURB Button
Engages the turbulence modes, WNG LVL and TURB. Disengages the ATS and disarms ALT CAP.

OTHER CONTROLS



- 1) AP Disconnect Button (Both Yokes) (Shift + D)
Disconnects both APs. Aural warning will sound and the AP light on the FMA will flash red. Second press silences the warning.
- 2) ATS Disconnect Button (Both Throttles) (Ctrl + D)
Disconnects the ATS. The THROTTLE light on the FMA will flash red. Second press silences the warning.
- 3) Takeoff/Go Around (TOGA) Buttons (Ctrl + G)
If the aircraft is in flight, engages GO RND mode. The Thrust Rating Indicator will switch to GA. The ATS will switch to EPR G/A and the throttles will be set to the Go Around thrust limit. Button has no effect above 1500 feet radio altitude. If the aircraft is on the ground with the flaps extended to at least 5 degrees, engages TAK OFF mode.

AUTOMATIC THRUST RESTORATION

The Automatic Thrust Restoration (ATR) system is provided by the Digital Flight Guidance System (DFGS). The system provides restoration of thrust after takeoff.

ATR is armed if the pitch axis of the DFGS is in the TAKE OFF mode, the Auto Thrust System (ATS) is engaged, the airplane is above 350 feet radio altitude, and the EPRs on both engines are below the go around limit.

If one engine drops by at least 0.1 EPR or 14% N1, or the vertical speed is less than zero for 5 seconds, ATR will activate. The thrust limit will automatically switch to G/A and the ATS will switch to EPR G/A and control to the go around limit.

MACH TRIM

A mach trim compensator is provided by the DFGS 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 DFGS 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 DFGS 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) Extend the flaps and ensure the FADEC is in T/O or T/O FLEX mode, then push either of the TOGA buttons to engage TAKE OFF mode.
- 2) Spool the engines up to approximately 1.10 EPR and wait for them to stabilize.



- 3) Set the ATS switch to AUTO THROT.
- 4) Check that the correct EPR mode appears on the FMA and the ATS drives the throttles to the takeoff limit.
- 5) At 60 knots, observe and crosscheck CLAMP flashing and then becoming steady 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 500 feet radio altitude, the AP can be engaged. Center FD bars before engaging the AP.
- 8) Above 400 feet radio altitude but below thrust reduction altitude (typically 1500 feet above airport elevation), pull the altitude knob to arm climb thrust. At thrust reduction altitude, observe EPR CLB appearing on the FMA. The engines will roll back to the climb limit.
- 9) At acceleration altitude (typically 3000 feet above airport elevation), push the IAS MACH button to engage the IAS vertical mode and use the pitch wheel to dial in the climb speed.

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) Set the AP switch to AP ON or the ATS switch to AUTO THROT.

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 light by pressing the AP or ATS disconnect button again.

CLIMBING TO A NEW ALTITUDE

- 1) Set desired altitude into the FGCP.
- 2) Push the IAS Mach button to engage the IAS or MACH vertical modes. Observe CLAMP flashing on the FMA.
- 3) If the ATS is engaged, push the EPR LIM button to set power for climb. Otherwise, manually advance power to the to the EPR limit.
- 4) If the aircraft is not equipped with auto altitude arm, pull the altitude knob to arm ALT CAP.
- 5) If engaged, observe the AP pitching for speed.

DESCENDING TO A NEW ALTITUDE

- 1) Set desired altitude into the FGCP.
- 2) Push the IAS Mach button to engage the IAS or MACH vertical modes. Observe CLAMP flashing on the FMA.
- 3) Manually idle the throttles to set flight idle power for descent.
- 4) If the aircraft is not equipped with auto altitude arm, pull the altitude knob to arm ALT CAP.
- 5) If engaged, observe the AP pitching for speed.

PERFORMING AN ILS APPROACH OR AUTOLAND

- 1) Set the frequency and course into both NAV radios on the FGCP.
- 2) When on an intercept course (30 degrees or less recommended), push the ILS (or AUTO LAND) button.
- 3) Ensure ILS (or LND) is displayed in the armed mode on the FMA.
- 4) When LOC CAP engages, ensure ILS (or LND) remains displayed in the armed mode on the FMA.
- 5) When G/S CAP engages, ensure the missed approach altitude is set in FCP.
- 6) Ensure both LOC TRK and G/S TRK is displayed when established.
- 7) If performing an Autoland, ensure either LND is displayed in the armed mode on the FMA, or AUTOLAND engages in both the lateral and vertical modes.
- 8) Monitor AP performance and be prepared to take over if system disconnects due to loss of ILS signal or malfunction.

TRACKING A VOR RADIAL OR ILS LOCALIZER

- 1) Set the frequency and course into the active DFGS' NAV radio on the FGCP (selected by the 1-2 selector).
- 2) When on an intercept course (30 degrees or less recommended), push the VOR LOC button.
- 3) Ensure VOR or LOC is displayed in the armed mode on the FMA.
- 4) After VOR CAP or LOC CAP engages, ensure that VOR TRK or LOC TRK is displayed when established.