B737 NG

Flight Controls

Introduction

The primary flight control system uses conventional control wheel, column and pedals linked mechanically to hydraulic power control units which command the primary flight control surfaces; ailerons, elevators and rudder. The flight controls are powered by redundant hydraulic sources; system A and system B. Either hydraulic system can operate all primary flight controls. The ailerons and elevators may be operated manually if required. The rudder may be operated by the standby hydraulic system if system A and system B pressure is not available.

The secondary flight controls, high lift devices consisting of trailing edge (TE) flaps and leading edge (LE) flaps and slats (LE devices), are powered by hydraulic system B. In the event hydraulic system B fails, the TE flaps can be operated electrically. Under certain conditions the power transfer unit (PTU) automatically powers the LE devices. (Refer to Chapter 13, Hydraulics, Power Transfer Unit). They can also be extended using standby hydraulic pressure.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- SPEED BRAKE lever
- FLAP lever
- STAB TRIM cutout switches
- STAB TRIM override switch
- stabilizer trim switches
- stabilizer trim wheel
- AILERON trim switches
- RUDDER trim control
- YAW DAMPER switch
- ALTERNATE FLAPS master switch
- alternate flaps position switch
- FLT CONTROL switches
- flight SPOILER switches

The columns and wheels are connected through transfer mechanisms which allow the pilots to bypass a jammed control or surface.

There is a rigid connection between both pairs of rudder pedals.

The SPEED BRAKE lever allows manual or automatic symmetric actuation of the spoilers.

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer.

Roll control is provided by:

- two ailerons
- eight flight spoilers.

Yaw control is provided by a single rudder. During takeoff, the rudder becomes aerodynamically effective between 40 and 60 knots.

TE flaps and LE flaps and slats provide high lift for takeoff, approach and landing.

[Option: Blended Winglets]
Blended winglets provide enhanced performance, extended range and increased fuel efficiency.

In the air symmetric flight spoilers are used as speed brakes. On the ground symmetric flight and ground spoilers destroy lift and increase braking efficiency

Roll Control

The roll control surfaces consist of hydraulically powered ailerons and flight spoilers, which are controlled by rotating either control wheel.

Ailerons

The ailerons provide roll control around the airplane's longitudinal axis.
The ailerons are positioned by the pilots' control wheels. The A and B FLT CONTROL switches control hydraulic shutoff valves. These valves can be used to isolate each aileron, as well as the elevators and rudder, from related hydraulic system pressure.The Captain's control wheel is connected by cables to the aileron power control units (PCUs) through the aileron feel and centering unit.
The First Officer's control wheel is connected by cables to the spoiler PCUs through the spoiler mixer. The two control wheels are connected by a cable drive system which allows actuation of both ailerons and spoilers by either control wheel.
With total hydraulic power failure the ailerons can be mechanically positioned by rotating the pilots' control wheels. Control forces are higher due to friction and aerodynamic loads..

Aileron Transfer Mechanism

If the ailerons or spoilers are jammed, force applied to the Captain’s and the First Officer’s control wheels will identify which system, ailerons or spoilers, is usable and which control wheel, Captain’s or First Officer’s, can provide roll control. If the aileron control system is jammed, force applied to the First Officer’s control wheel provides roll control from the spoilers. The ailerons and the Captain’s control wheel are inoperative. If the spoiler system is jammed, force applied to the Captain’s control wheel provides roll control from the ailerons. The spoilers and the First Officer’s control wheel are inoperative.

Aileron Trim

Dual AILERON trim switches, located on the aft electronic panel, must be pushed simultaneously to command trim changes. The trim electrically repositions the aileron feel and centering unit, which causes the control wheel to rotate and redefines the aileron neutral position. The amount of aileron trim is indicated on a scale on the top of each control column.

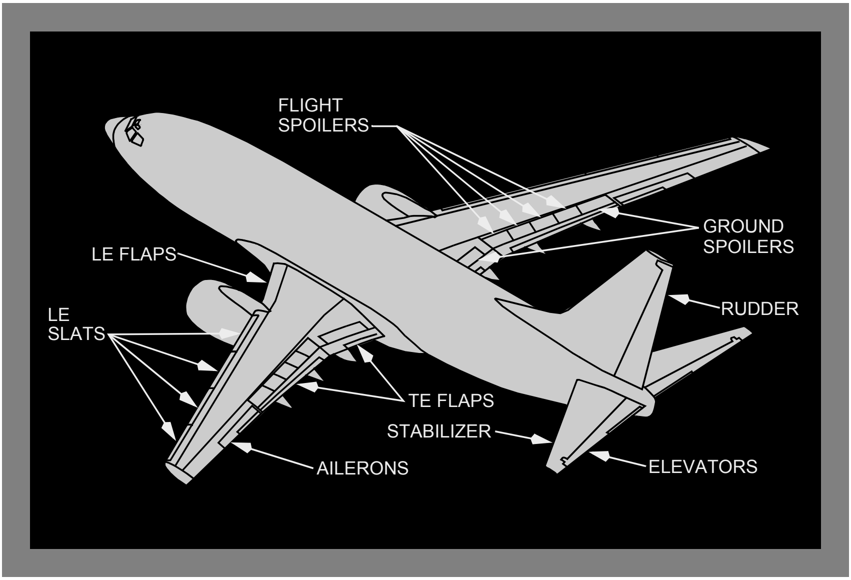
If aileron trim is used with the autopilot engaged, the trim is not reflected in the control wheel position. The autopilot overpowers the trim and holds the control wheel where it is required for heading/track control. Any aileron trim applied when the autopilot is engaged can result in an out of trim condition and an abrupt rolling movement when the autopilot is disconnected.

Flight Spoilers

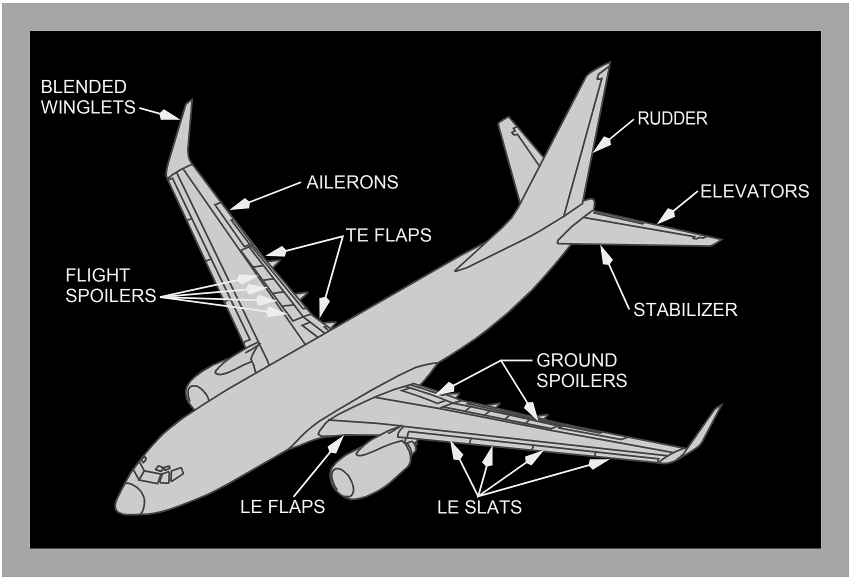
Four flight spoilers are located on the upper surface of each wing. Each hydraulic system, A and B, is dedicated to a different set of spoiler pairs to provide isolation and maintain symmetric operation in the event of hydraulic system failure. Hydraulic pressure shutoff valves are controlled by the two flight SPOILER switches.

Flight spoiler panels are used as speed brakes to increase drag and reduce lift, both in flight and on the ground. The flight spoilers also supplement roll control in response to control wheel commands. A spoiler mixer, connected to the aileron cable-drive, controls the hydraulic power control units on each spoiler panel to provide spoiler movement proportional to aileron movement.

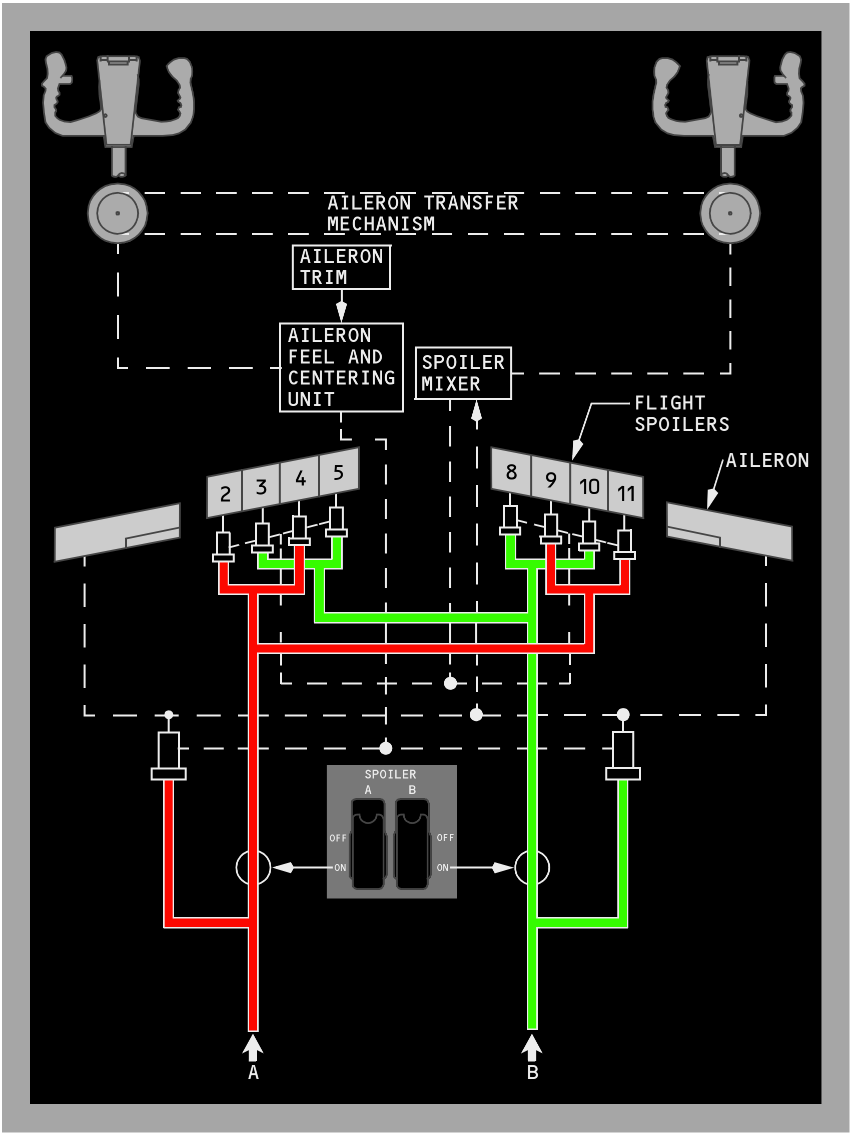
The flight spoilers rise on the wing with up aileron and remain faired on the wing with down aileron. When the control wheel is displaced more than approximately 10°, spoiler deflection is initiated.



[Option: Blended Winglets]



Roll Control Schematic



Pitch Control

The pitch control surfaces consist of hydraulically powered elevators and an electrically powered stabilizer. The elevators are controlled by forward or aft movement of the control column. The stabilizer is controlled by autopilot trim or manual trim.

Elevators

The elevators provide pitch control around the airplane's lateral axis. The elevators are positioned by the pilots' control columns. The A and B FLT CONTROL switches control hydraulic shutoff valves for the elevators.

Cables connect the pilots' control columns to elevator power control units (PCUs) which are powered by hydraulic system A and B. The elevators are interconnected by a torque tube. With loss of hydraulic system A and B the elevators can be mechanically positioned by forward or aft movement of the pilots' control columns. Control forces are higher due to friction and aerodynamic loads.

Elevator Control Column Override Mechanism

In the event of a control column jam, an override mechanism allows the control columns to be physically separated. Applying force against the jam will breakout either the Captain's or First Officer's control column. Whichever column moves freely after the breakout can provide adequate elevator control.

Although total available elevator travel is significantly reduced, there is sufficient elevator travel available for landing flare. Column forces are higher and exceed those experienced during manual reversion. If the jam exists during the landing phase, higher forces are required to generate sufficient elevator control to flare for landing. Stabilizer trim is available to counteract the sustained control column force.

Elevator Feel System

The elevator feel computer provides simulated aerodynamic forces using airspeed (from the elevator pitot system) and stabilizer position. Feel is transmitted to the control columns by the elevator feel and centering unit. To operate the feel system the elevator feel computer uses either hydraulic system A or B pressure, whichever is higher. When either hydraulic system or elevator feel pitot system fails, excessive differential hydraulic pressure is sensed in the elevator feel computer and the FEEL DIFF PRESS light illuminates.

Mach Trim System

A Mach trim system provides speed stability at the higher Mach numbers. Mach trim is automatically accomplished above Mach .615 by adjusting the elevators with respect to the stabilizer as speed increases. The flight control computers use Mach information from the ADIRU to compute a Mach trim actuator position. The Mach trim actuator repositions the elevator feel and centering unit which adjusts the control column neutral position.

Stabilizer

The horizontal stabilizer is positioned by a single electric trim motor controlled through either the stab trim switches on the control wheel or autopilot trim. The stabilizer may also be positioned by manually rotating the stabilizer trim wheel.

Stabilizer Trim

Stabilizer trim switches on each control wheel actuate the electric trim motor through the main electric stabilizer trim circuit when the airplane is flown manually. With the autopilot engaged, stabilizer trim is accomplished through the autopilot stabilizer trim circuit. The main electric and autopilot stabilizer trim have two speed modes: high speed with flaps extended and low speed with flaps retracted. If the autopilot is engaged, actuating either pair of stabilizer trim switches automatically disengages the autopilot. The stabilizer trim wheels rotate whenever electric stabilizer trim is actuated.

The STAB TRIM MAIN ELECT cutout switch and the STAB TRIM AUTOPILOT cutout switch, located on the control stand, are provided to allow the autopilot or main electric trim inputs to be disconnected from the stabilizer trim motor.

Control column actuated stabilizer trim cutout switches stop operation of the main electric and autopilot trim when the control column movement opposes trim direction. When the STAB TRIM override switch is positioned to OVERRIDE, electric trim can be used regardless of control column position.

Manual stabilizer control is accomplished through cables which allow the pilot to position the stabilizer by rotating the stabilizer trim wheels. The stabilizer is held in position by two independent brake systems. Manual rotation of the trim wheels can be used to override autopilot or main electric trim. The effort required to manually rotate the stabilizer trim wheels may be higher under certain flight conditions. Grasping the stabilizer trim wheel will stop stabilizer motion.

Stabilizer Trim Operation with Forward or Aft CG

In the event the stabilizer is trimmed to the end of the electrical trim limits, additional trim is available through the use of the manual trim wheels. If manual trim is used to position the stabilizer beyond the electrical trim limits, the stabilizer trim switches may be used to return the stabilizer to electrical trim limits.

Stabilizer Position Indication and Green Band

Stabilizer position is displayed in units on two STAB TRIM indicators located inboard of each stabilizer trim wheel. The STAB TRIM indicators also display the TAKEOFF green band indication.

The trim authority for each mode of trim is limited to:

- Main Electric Trim
  - flaps extended 0.05 to 14.5 units

[B737-600]

  - flaps retracted 4.10 to 14.5 units

[B737-700]

  - flaps retracted 4.30 to 14.5 units

[B737-800]

  - flaps retracted 3.95 to 14.5 units

[B737-900]

  - flaps retracted 3.90 to 14.5 units
- Autopilot Trim 0.05 to 14.5 units
- Manual Trim -0.20 to 16.9 units.

The green band range of the STAB TRIM indicator shows the takeoff trim range. An intermittent horn sounds if takeoff is attempted with the stabilizer trim outside the takeoff trim range.

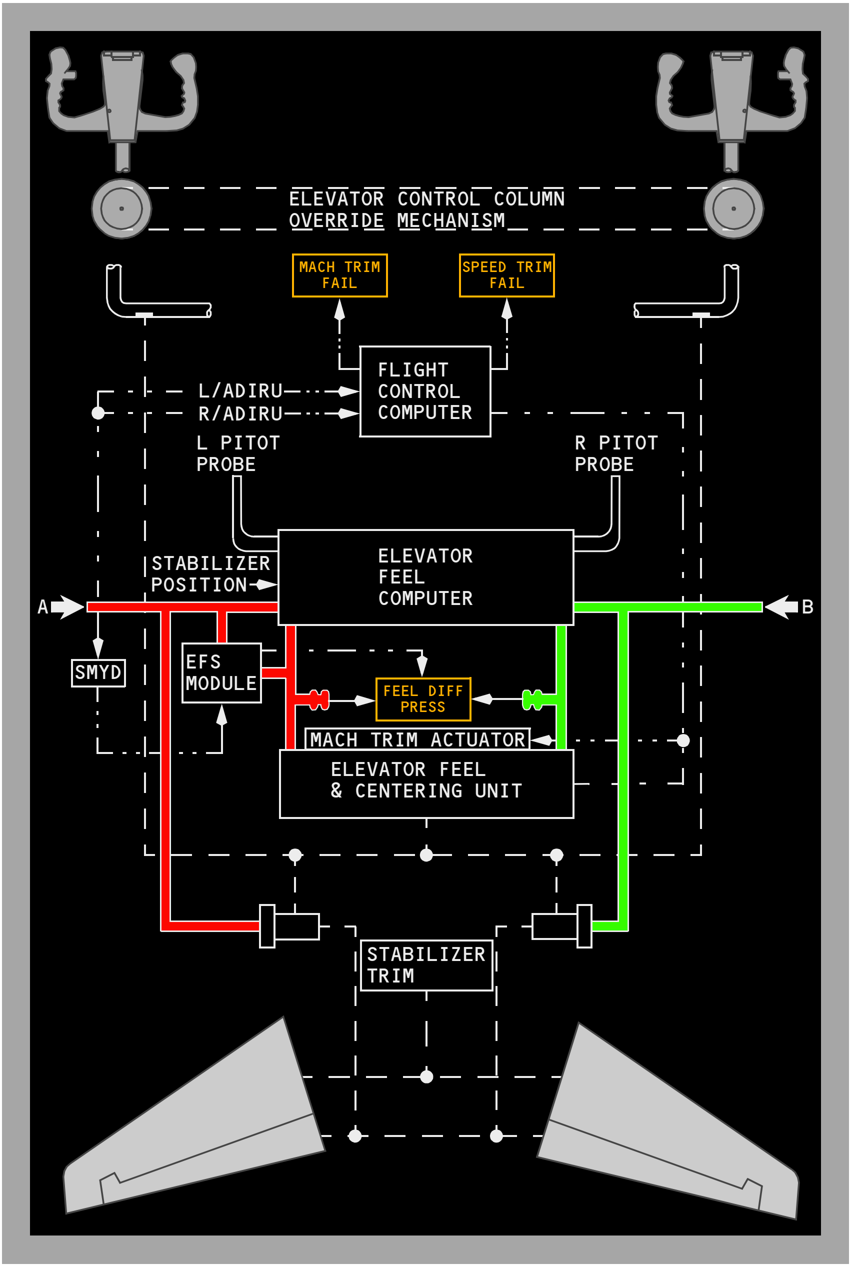
Speed Trim System

The speed trim system (STS) is a speed stability augmentation system designed to improve flight characteristics during operations with a low gross weight, aft center of gravity and high thrust when the autopilot is not engaged. The purpose of the STS is to return the airplane to a trimmed speed by commanding the stabilizer in a direction opposite the speed change. The STS monitors inputs of stabilizer position, thrust lever position, airspeed and vertical speed and then trims the stabilizer using the autopilot stabilizer trim. As the airplane speed increases or decreases from the trimmed speed, the stabilizer is commanded in the direction to return the airplane to the trimmed speed. This increases control column forces to force the airplane to return to the trimmed speed. As the airplane returns to the trimmed speed, the STS commanded stabilizer movement is removed.

STS operates most frequently during takeoffs, climb and go-arounds. Conditions for speed trim operation are listed below:

- Airspeed between 100 KIAS and Mach 0.5
- 10 seconds after takeoff
- 5 seconds following release of trim switches
- Autopilot not engaged
- Sensing of trim requirement

Pitch Control Schematic



Stall Identification

Stall identification and control is enhanced by the yaw damper, the Elevator Feel Shift (EFS) module and the speed trim system. These three systems work together to help the pilot identify and prevent further movement into a stall condition.

During high AOA operations, the SMYD reduces yaw damper commanded rudder movement.

The EFS module increases hydraulic system A pressure to the elevator feel and centering unit during a stall. This increases forward control column force to approximately four times normal feel pressure. The EFS module is armed whenever an inhibit condition is not present. Inhibit conditions are: on the ground, radio altitude less than 100 feet and autopilot engaged. However, if EFS is active when descending through 100 feet RA, it remains active until AOA is reduced below approximately stickshaker threshold. There are no flight deck indications that the system is properly armed or activated.

As airspeed decreases towards stall speed, the speed trim system trims the stabilizer nose down and enables trim above stickshaker AOA. With this trim schedule the pilot must pull more aft column to stall the airplane. With the column aft, the amount of column force increase with the onset of EFS module is more pronounced.

Yaw Control

Yaw control is accomplished by a hydraulically powered rudder and a digital yaw damper system. The rudder is controlled by displacing the rudder pedals. The yaw damping functions are controlled through the stall management/yaw damper (SMYD) computers.

Rudder

[B737 modified rudder - not installed]

The rudder provides yaw control about the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

Each set of rudder pedals is mechanically connected by cables to the input levers of the main and standby rudder PCUs. The main rudder PCU is powered by hydraulic system A and B. The standby rudder PCU is powered by the standby hydraulic system. At speeds above approximately 135 kts, hydraulic system A pressure to the rudder PCU is limited by approximately 50%. This function limits full rudder authority in flight after takeoff and before landing.

The standby rudder PCU is powered by the standby hydraulic system. The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. With the standby PCU powered the pilot retains adequate rudder control capability. It can be operated manually through the FLT CONTROL switches or automatically. (Refer to Chapter 13, Hydraulics, Standby Hydraulic System)

Rudder Trim

The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The RUDDER TRIM indicator displays the rudder trim position in units.

Rudder (with Rudder System Enhancement Program (RSEP) installed)

[B737 modified rudder- installed]

The rudder provides yaw control about the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

Each set of rudder pedals is mechanically connected by cables to the input levers of the main and standby rudder PCUs. The main PCU consists of two independent input rods, two individual control valves, and two separate actuators; one for Hydraulic system A and one for Hydraulic system B. The standby rudder PCU is controlled by a separate input rod and control valve and powered by the standby hydraulic system. All three input rods have individual jam override mechanisms that allows input commands to continue to be transferred to the remaining free input rods if an input rod or downstream hardware is hindered or jammed.

At speeds above approximately 135 kts, both hydraulic system A and B pressure are each reduced within the main PCU by approximately 25% each. This function limits full rudder authority in flight after takeoff and before landing.

The main rudder PCU contains a Force Fight Monitor (FFM) that detects opposing pressure (force fight) between A and B actuators. This may occur if either system A or B input is jammed or disconnected. The FFM output is used to automatically turn on the Standby Hydraulic pump, open the standby rudder shutoff valve to pressurize the standby rudder PCU, and illuminate the STBY RUD ON, Master Caution, and Flight Control (FLT CONT) lights.

The standby rudder PCU is powered by the standby hydraulic system. The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. With the standby PCU powered the pilot retains adequate rudder control capability. It can be operated manually through the FLT CONTROL switches or automatically. (Refer to Chapter 13, Hydraulics, Standby Hydraulic System)

An amber STBY RUD ON light illuminates when the standby rudder hydraulic system is pressurized. The standby rudder system can be pressurized with either Flight Control switch, automatically during takeoff or landing (Refer to Chapter 13, Hydraulics, Standby Hydraulic System) or automatically by the Force Fight Monitor. The STBY RUD ON light illumination activates Master Caution and Flight Control warning lights on the Systems Annunciation Panel.

Rudder Trim

The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The RUDDER TRIM indicator displays the rudder trim position in units.

Yaw Damper

The yaw damper system consists of a main and standby yaw damper. Both yaw dampers are controlled through Stall Management/Yaw Damper (SMYD) computers. The SMYD computers receive inputs from both ADIRUs, both control wheels and the YAW DAMPER switch. SMYDs provide yaw damper inputs to the main rudder power control unit (PCU) or standby rudder PCU, as appropriate.

Either yaw damper is capable of providing dutch roll prevention, gust damping and turn coordination. Yaw damper operation does not result in rudder pedal movement. Only main yaw damper inputs are shown on the yaw damper indicator. The pilot can override either main or standby yaw damper inputs using either the rudder pedals or trim inputs.

During normal operation the main yaw damper uses hydraulic system B and the SMYD computers provide continuous system monitoring. The YAW DAMPER Switch automatically moves to OFF, the amber YAW DAMPER light illuminates and the YAW DAMPER switch cannot be reset to ON when any of the following conditions occur:

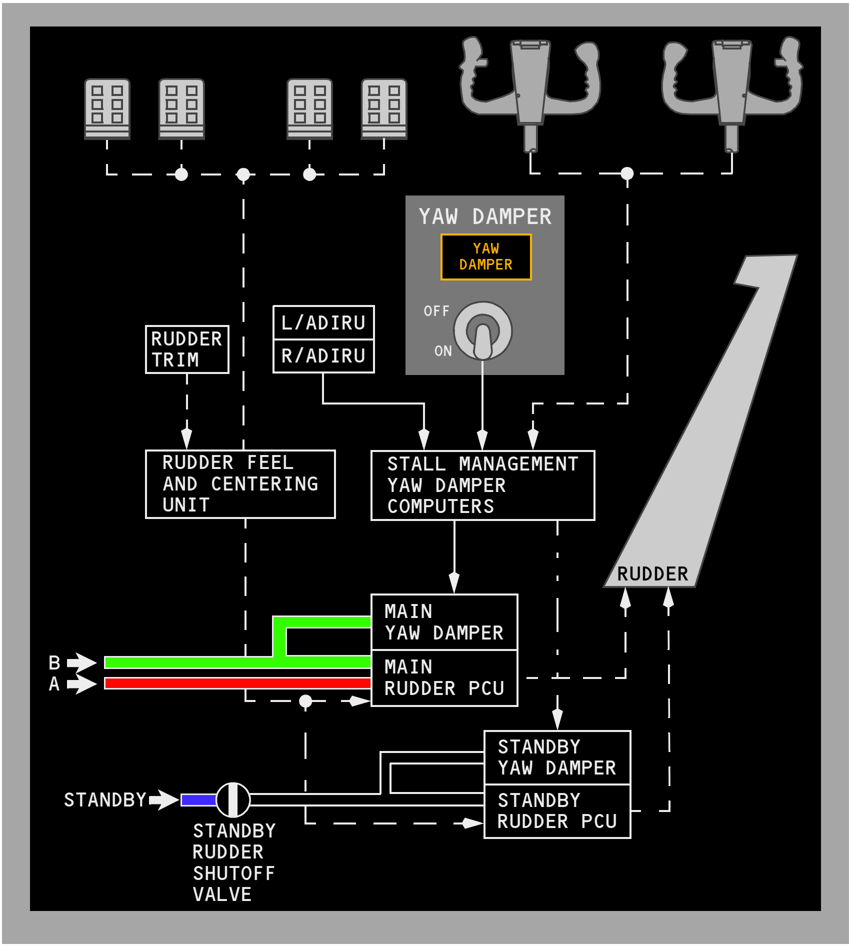
- SMYD senses a yaw damper system fault,
- SMYD senses that the yaw damper does not respond to a command,
- B FLT CONTROL switch is positioned to OFF or STBY RUD.

During manual reversion flight (loss of hydraulic system A and B pressure), both FLT CONTROL switches are positioned to STBY RUD.
In this case, the YAW DAMPER switch can be reset to ON and the standby hydraulic system powers the satndby yaw damper.

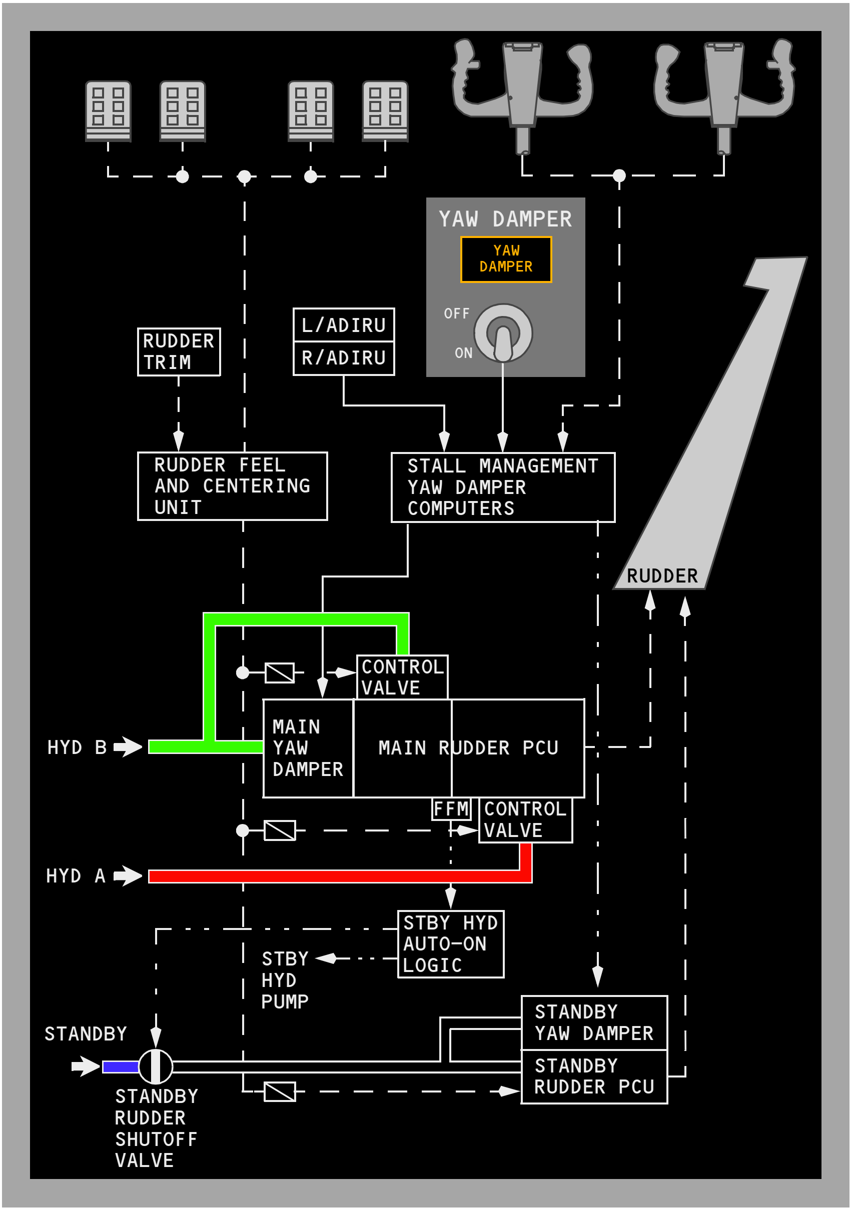
During Standby Yaw Damper operation, movement of the control wheel sends a signal to the standby rudder PCU to move the rudder. This gives rudder assist to help turn the airplane when control of the ailerons is through manual reversion.

Yaw Control Schematic

[RSEP not installed]



[RSEP installed]



Speed Brakes

The speed brakes consist of flight spoilers and ground spoilers. Hydraulic system A powers all four ground spoilers, two on the upper surface of each wing. The SPEED BRAKE lever controls the spoilers. When the SPEED BRAKE lever is actuated all the spoilers extend when the airplane is on the ground and only the flight spoilers extend when the airplane is in the air.

The SPEEDBRAKES EXTENDED light provides an indication of spoiler operation in-flight and on the ground. In-flight, the light illuminates to warn the crew that the speed brakes are extended while in the landing configuration or below 800 feet AGL. On the ground, the light illuminates when hydraulic pressure is sensed in the ground spoiler shutoff valve with the speed brake lever in the DOWN position.

In-Flight Operation

Operating the SPEED BRAKE lever in flight causes all flight spoiler panels to rise symmetrically to act as speed brakes. Caution should be exercised when deploying flight spoilers during a turn, as they greatly increase roll rate. When the speed brakes are in an intermediate position roll rates increase significantly. Moving the SPEED BRAKE lever beyond the FLIGHT DETENT causes buffeting and is prohibited in flight.

[Option: Speed Brake Load Alleviation System]
The speed brake load alleviation feature limits the deployment of the speed brakes under certain high gross weight/airspeed combinations. Under these conditions, if the speed brakes are deployed to the FLIGHT DETENT, they automatically retract to 50 percent of the FLIGHT DETENT. The SPEED BRAKE lever moves to reflect the position of the speed brakes. Manual override is available. Increased force is needed to move the SPEED BRAKE lever beyond the 50 percent position with load alleviation active. The SPEED BRAKE lever must be held in place when manual override is used between 50 percent and the UP position. The SPEED BRAKE lever will remain stationary if moved to UP with load alleviation active. When load alleviation deactivates, the speed brakes can be manually returned to the FLIGHT DETENT position.

Ground Operation

During landing, the auto speed brake system operates when these conditions occur:

- SPEED BRAKE lever is in the ARMED position
- SPEED BRAKE ARMED light is illuminated
- radio altitude is less than 10 feet

- landing gear strut compresses on touchdown

  Note: Compression of any landing gear strut enables the flight spoilers to deploy. Compression of the right main landing gear strut enables the ground spoilers to deploy.
- both thrust levers are retarded to IDLE
- main landing gear wheels spin up (more than 60 kts).

The SPEED BRAKE lever automatically moves to the UP position and the spoilers deploy.

If a wheel spin-up signal is not detected, when the air/ground system senses ground mode (any gear strut compresses) the SPEED BRAKE lever moves to the UP position and flight spoiler panels deploy automatically. When the right main landing gear strut compresses, a mechanical linkage opens the ground spoiler bypass valve and the ground spoilers deploy.

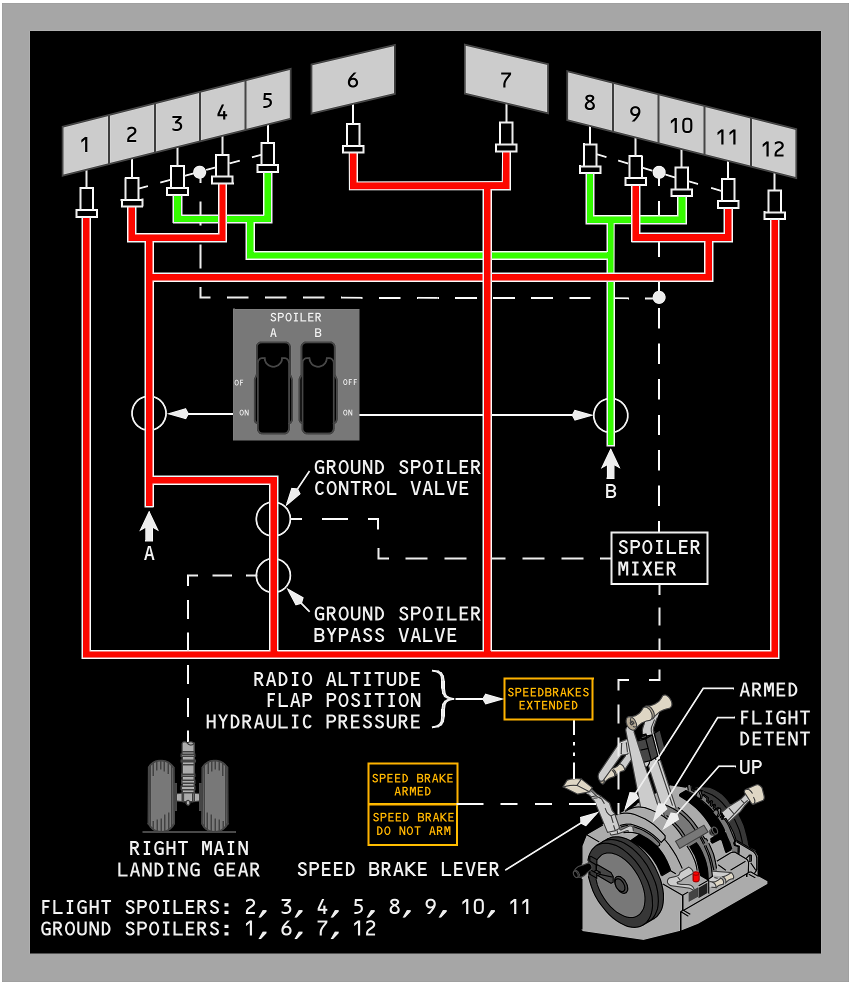
If the SPEED BRAKE lever is in the DOWN position during landing or rejected takeoff, the auto speed brake system operates when these conditions occur:

- main landing gear wheels spin up (more than 60 kts)
- both thrust levers are retarded to IDLE
- reverse thrust levers are positioned for reverse thrust.

The SPEED BRAKE lever automatically moves to the UP position and spoilers deploy.

After an RTO or landing, if either thrust lever is advanced, the SPEED BRAKE lever automatically moves to the DOWN detent and all spoiler panels retract. The spoiler panels may also be retracted by manually moving the SPEED BRAKE lever to the DOWN detent.

Speed Brakes Schematic



Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, low speed maneuvering and landing.

LE devices consist of four flaps and eight slats: two flaps inboard and four slats outboard of each engine. Slats extend to form a sealed or slotted leading edge depending on the TE flap setting. The TE devices consist of double slotted flaps inboard and outboard of each engine.

TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flaps 15, 30 and 40 are normal landing flap positions. Flaps 15 is normally limited to airports where approach climb performance is a factor. Runway length and conditions must be taken into account when selecting a landing flap position.

[Option: JAA]
TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flap positions 30 and 40 are normal landing flap positions.

To prevent excessive structural loads from increased Mach at higher altitude, flap extension above 20,000 feet should not be attempted.

Flap and Slat Sequencing

LE devices and TE flaps are normally extended and retracted by hydraulic power from system B. When the FLAP lever is in the UP detent, all flaps and LE devices are commanded to the retracted or up position. Moving the FLAP lever aft allows selection of flap detent positions 1, 2, 5, 10, 15, 25, 30 or 40. The LE devices deployment is sequenced as a function of TE flaps deployment.

When the FLAP lever is moved from the UP position to the 1, 2, or 5 position, the TE flaps extend to the commanded position and the LE:

- flaps extend to the full extended position and
- slats extend to the extend position.

When the FLAP lever is moved beyond the 5 position the TE flaps extend to the commanded position and the LE:

- flaps remain at the full extended position and
- slats extend to the full extended position.

The LE devices sequence is reversed upon retraction.

Mechanical gates hinder inadvertent FLAP lever movement beyond flaps 1 for one engine inoperative go–around and flaps 15 for normal go–around.

Indicator lights on the center instrument panel provide overall LE devices position status. The LE DEVICES annunciator panel on the aft overhead panel indicates the positions of the individual flaps and slats.

Flap Load Relief

The flaps/slat electronics unit (FSEU) provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the flaps 30 and flaps 40 positions only. The FLAP lever does not move, but the flap position indicator displays flap retraction and re–extension.

[Option: Short Field Performance]
The flaps/slat electronics unit (FSEU) provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the flaps 10, 15, 25, 30 and flaps 40 positions. The FLAP lever does not move, but the flap position indicator displays flap retraction and re–extension.

When the flaps are set at 40, the TE flaps:

- retract to 30 if airspeed exceeds 163 knots
- re–extend when airspeed is reduced below 158 knots.

When the flaps are set at 30, the TE flaps:

- retract to 25 if the airspeed exceeds 176 knots
- re–extend when airspeed is reduced below 171 knots.

When the flaps are set at 40, the TE flaps:

- retract to 30 if airspeed exceeds 171 knots
- re–extend when airspeed is reduced below 166 knots.

When the flaps are set at 30, the TE flaps:

- retract to 25 if the airspeed exceeds 181 knots
- re–extend when airspeed is reduced below 176 knots.

When the flaps are set at 25, the TE flaps:

- retract to 15 if the airspeed exceeds 196 knots
- re–extend when airspeed is reduced below 191 knots.

When the flaps are set at 15, the TE flaps:

- retract to 10 if the airspeed exceeds 201 knots
- re–extend when airspeed is reduced below 196 knots.

When the flaps are set at 10, the TE flaps:

- retract to 5 if the airspeed exceeds 206 knots
- re–extend when airspeed is reduced below 201 knots.

[Option]
The FLAP LOAD RELIEF light illuminates when the TE flap load relief function is activated.

Autoslats

At flap positions 1, 2 and 5 an autoslat function is available that moves the LE slats to full extended if the airplane approaches a stall condition.

The autoslat system is designed to enhance airplane stall characteristics at high angles of attack during takeoff or approach to landing. When TE flaps 1 through 5 are selected, the LE slats are in the extend position. As the airplane approaches the stall angle, the slats automatically begin driving to the full extended position prior to stick shaker activation. The slats return to the extend position when the pitch angle is sufficiently reduced below the stall critical attitude.

[Option - Short Field Performance]
At flap positions 1, 2, 5, 10, 15, and 25 an autoslat function is available that moves the LE slats to full extended if the airplane approaches a stall condition.

[Option: Short Field Performance]
The autoslat system is designed to enhance airplane stall characteristics at high angles of attack during takeoff or approach to landing. When TE flaps 1 through 25 are selected, the LE slats are in the extend position. As the airplane approaches the stall angle, the slats automatically begin driving to the full extended position prior to stick shaker activation. The slats return to the extend position when the pitch angle is sufficiently reduced below the stall critical attitude.

Autoslat operation is normally powered by hydraulic system B. An alternate source of power is provided by system A through a power transfer unit (PTU) if a loss of pressure is sensed from the higher volume system B engine driven pump. The PTU provides system A pressure to power a hydraulic motorized pump, pressurizing system B fluid to provide power for the autoslat operation. (Refer to Chapter 13, Hydraulics, Power Transfer Unit)

Alternate Extension

In the event that hydraulic system B fails, an alternate method of extending the LE devices and extending and retracting the TE flaps is provided.

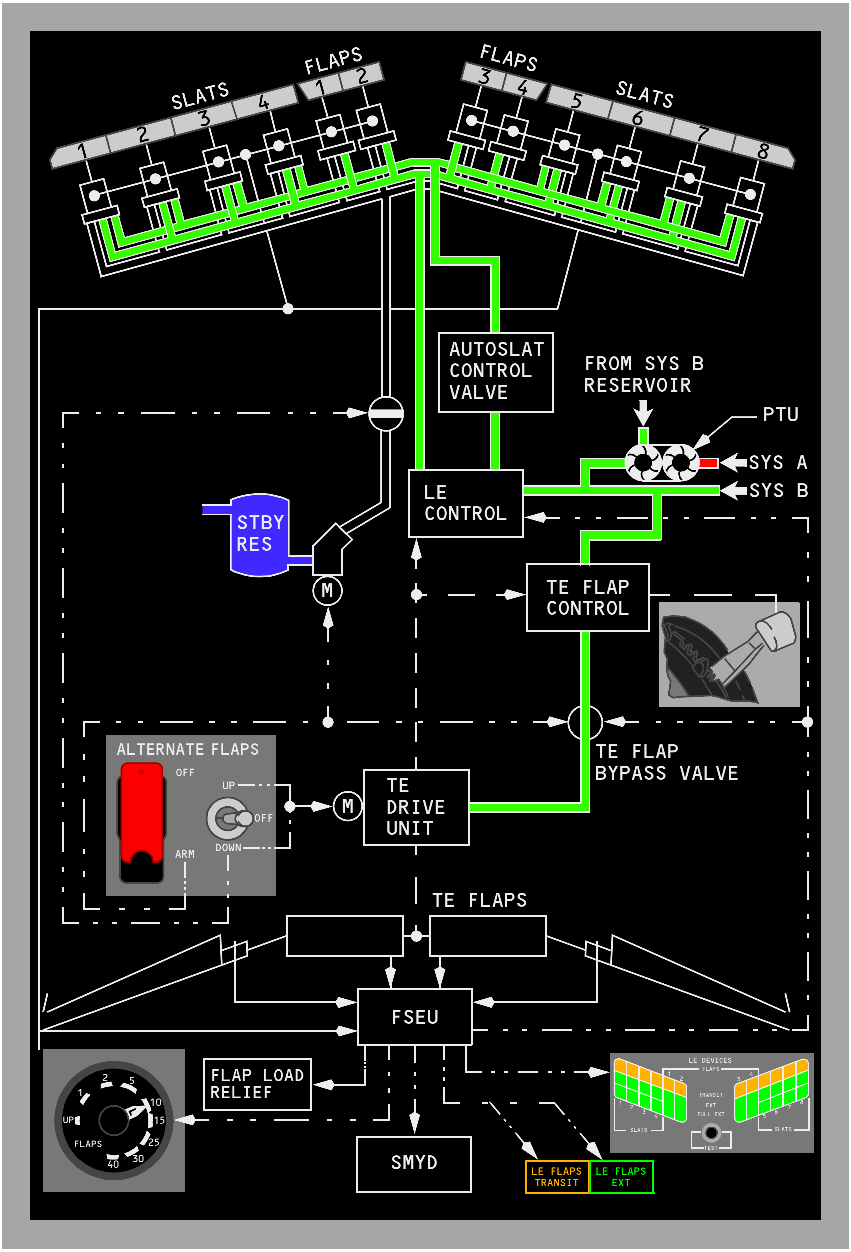
The TE flaps can be operated electrically through the use of two alternate flap switches. The guarded ALTERNATE FLAPS master switch closes a flap bypass valve to prevent hydraulic lock of the flap drive unit and arms the alternate flaps position switch. The ALTERNATE FLAPS position switch controls an electric motor that extends or retracts the TE flaps. The switch must be held in the DOWN position until the flaps reach the desired position. No asymmetry or skew protection is provided through the alternate (electrical) flap drive system.

When using alternate flap extension the LE flaps and slats are driven to the full extended position using power from the standby hydraulic system. In this case the ALTERNATE FLAPS master switch energizes the standby pump and the ALTERNATE FLAPS position switch, held in the down position momentarily, fully extends the LE devices.

Note: The LE devices cannot be retracted by the standby hydraulic system.

Leading Edge Devices and Trailing Edge Flaps Schematic

[Option: FLAP LOAD RELIEF light]



Asymmetry and Skew Detection, Protection and Indication

The FSEU monitors the TE flaps for asymmetry and skew conditions. It also monitors the LE devices for improper position and skew conditions on slats 2 through 7. If a flap on one wing does not align with the symmetrical flap on the other wing, there is a flap asymmetry condition. A skew condition occurs when a TE flap or LE slat panel does not operate at the same rate causing the panel to twist during extension or retraction.

Trailing Edge Flap Asymmetry and Skew

When the FSEU detects a trailing edge asymmetry or skew condition the FSEU:

- closes the TE flap bypass valve
- displays a needle split on the flap position indicator.

Leading Edge Device Improper Position or Skew

When the FSEU detects a LE device in an improper position or a LE slat skew condition, the LE FLAPS TRANSIT light remains illuminated and one of the following indications is displayed on the LE DEVICES annunciator panel:

- amber TRANSIT light illuminated
- incorrect green EXT or FULL EXT light illuminated
- no light illuminated.

There is no skew detection of the outboard slats, 1 and 8, or for the LE flaps. Slat skew detection is inhibited during autoslat operations.

Uncommanded Motion Detection, Protection and Indication

The FSEU provides protection from uncommanded motion by the LE devices or TE flaps.

Leading Edge Uncommanded Motion

Uncommanded motion is detected when no TE flap position or autoslat command is present and:

- two LE flaps move on one wing, or
- two or more slats move on one wing.

The FSEU shuts down the LE control and illuminates the amber LE FLAPS TRANSIT light.

In addition, to prevent uncommanded motion from occurring on the LE devices during cruise, the FSEU maintains pressure on the retract lines and depressurizes the extend and full extend lines.

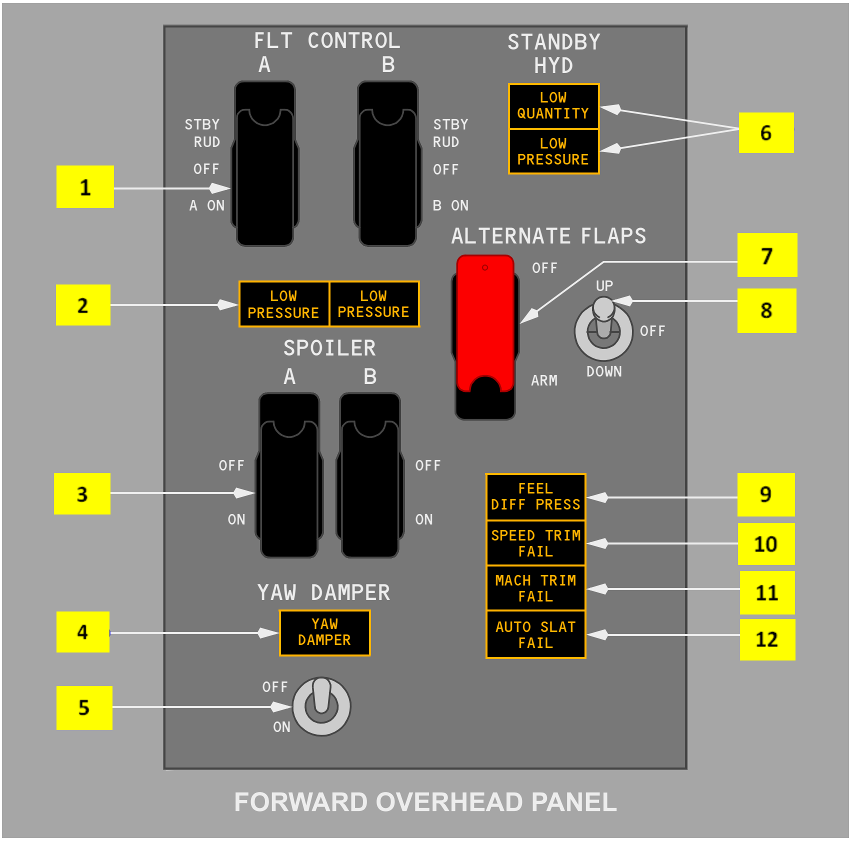
Trailing Edge Uncommanded Motion

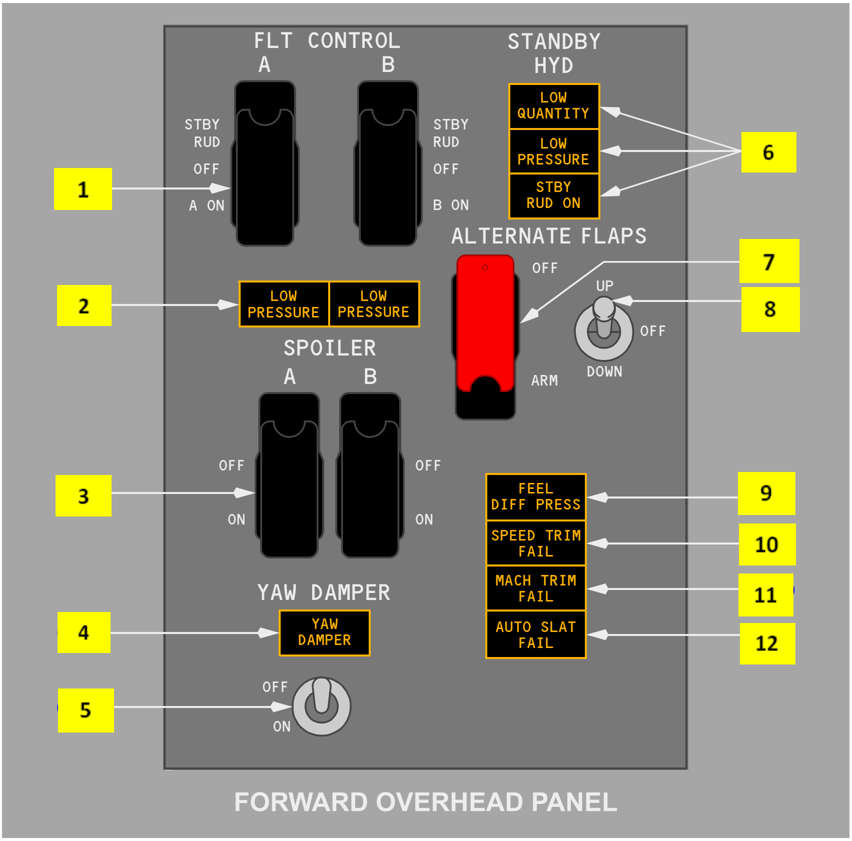
Uncommanded motion is detected when no FLAP lever or flap load relief command is present and the TE flaps:

- move away from the commanded position
- continue to move after reaching a commanded position, or
- move in a direction opposite to that commanded.

The FSEU shuts down the TE drive unit by closing the TE flap bypass valve. The TE flap shutdown cannot be reset by the flight crew and they must use the alternate flap system to control TE flaps. The shutdown is indicated by the flap position indicator disagreeing with the FLAP lever position. There is no flap needle split.

Flight Control Panel





1 FLIGHT CONTROL Switches

STBY RUD - activates standby hydraulic system pump and opens standby rudder shutoff valve to pressurize standby rudder power control unit.

OFF - closes flight control shutoff valve isolating ailerons, elevators and rudder from associated hydraulic system pressure.

ON (guarded position) - normal operating position.

2 Flight Control LOW PRESSURE Lights

Illuminated (amber) -

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLIGHT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens.

3 Flight SPOILER Switches

ON (guarded position) – normal operating position.

OFF – closes the respective flight spoiler shutoff valve.

Note: Used for maintenance purposes only.

4 YAW DAMPER Light

Illuminated (amber) – yaw damper is not engaged.

5 YAW DAMPER Switch

OFF – disengages yaw damper.

ON –

- engages main yaw damper to main rudder power control unit if the B FLT CONTROL switch is in the ON position
- engages standby yaw damper to standby rudder power control unit if both the A and B FLT CONTROL switches are in the STBY RUD position.

6 STANDBY HYD Lights

STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) -

- indicates low quantity in standby hydraulic reservoir
- always armed.

STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) -

- indicates output pressure of standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

STBY RUD ON Light

- Illuminated (amber) - indicates the standby rudder system is commanded on to pressurize the standby rudder power control unit.

7 ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – closes TE flap bypass valve, activates standby pump, and arms the ALTERNATE FLAPS position switch.

8 ALTERNATE FLAPS Position Switch

Functions only when the ALTERNATE FLAPS master switch is in ARM.

UP –

- electrically retracts TE flaps
- LE devices remain extended and cannot be retracted by the alternate flaps system.

OFF – normal operating position.

DOWN (spring loaded to OFF) –

- (momentary) fully extends LE devices using standby hydraulic pressure
- (hold) electrically extends TE flaps until released.

9 Feel Differential Pressure (FEEL DIFF PRESS) Light

Armed when the TE flaps are up or down.

Illuminated (amber) -

- indicates excessive differential pressure in the elevator feel computer.

Note: Excessive differential pressure can be caused by erroneous activation of the Elevator Feel Shift module.

10 Speed Trim Failure (SPEED TRIM FAIL) Light

Illuminated (amber) –

- indicates failure of the speed trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when Master Caution System is reset.

11 Mach Trim Failure (MACH TRIM FAIL) Light

Illuminated (amber) –

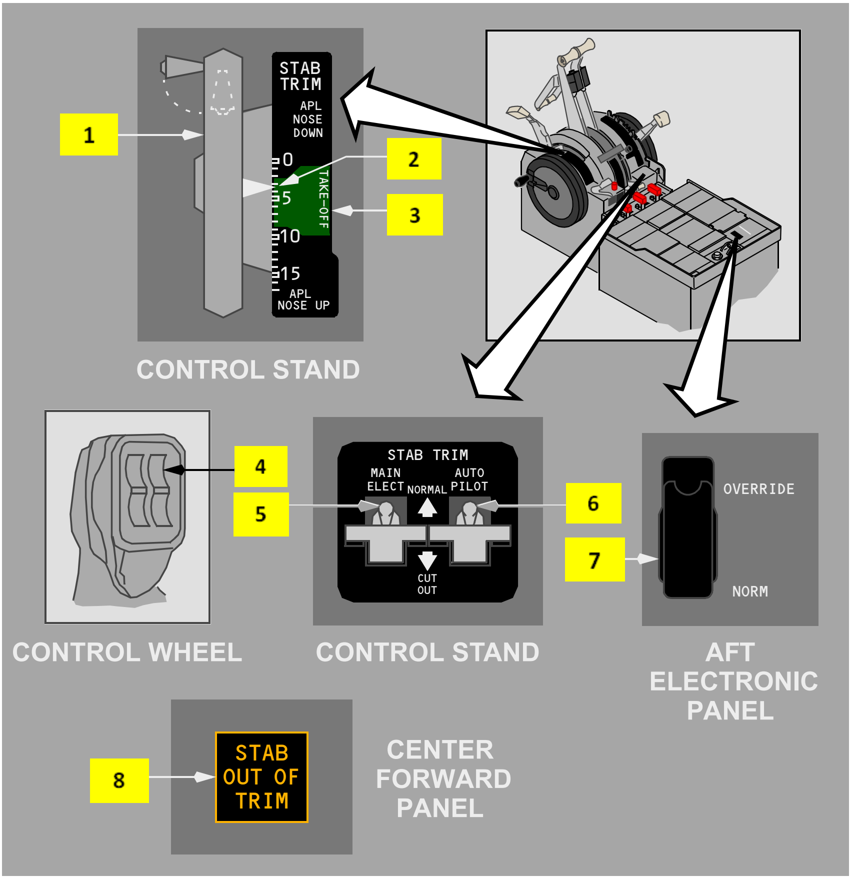
- indicates failure of the mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

12 Automatic Slat Failure (AUTO SLAT FAIL) Light

Illuminated (amber) –

- indicates failure of the auto slat system
- indicates failure of a single Stall Management/Yaw Damper (SMYD) computer when illuminated during MASTER CAUTION recall and extinguishes when master caution system is reset.

Stabilizer



1 Stabilizer Trim Wheel

- provides for manual operation of stabilizer
- overrides any other stabilizer trim inputs
- rotates when stabilizer is in motion.

Note: Handle should be folded inside stabilizer trim wheel for normal operation

2 Stabilizer Trim Indicator

Indicates units of airplane trim on the adjacent scale.

3 Stabilizer Trim Green Band Range

Corresponds to allowable range of trim settings for takeoff.

4 Stabilizer Trim Switches (spring-loaded to neutral)

Push (both) –

- electrically commands stabilizer trim in desired direction
- autopilot disengages if engaged.

5 Stabilizer Trim Main Electric (MAIN ELECT) Cutout Switch

NORMAL – normal operating position.

CUTOUT – deactivates stabilizer trim switch operation.

6 Stabilizer Trim AUTOPILOT Cutout Switch

NORMAL – normal operating position.

CUTOUT –

- deactivates autopilot stabilizer trim operation
- autopilot disengages if engaged.

7 Stabilizer Trim Override Switch

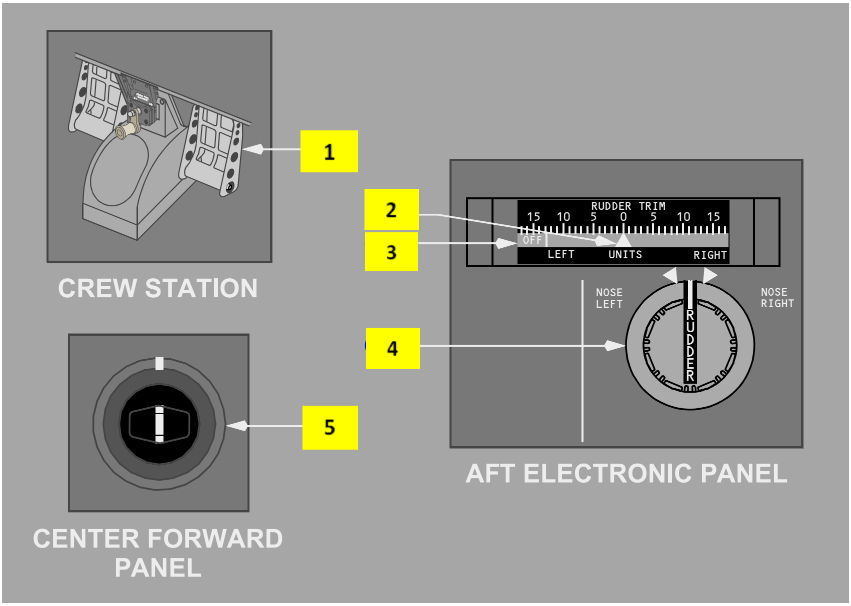
OVERRIDE – bypasses the control column actuated stabilizer trim cutout switches to restore power to the Stabilizer Trim Switches

NORM (guarded position) – normal operating position.

8 Stabilizer Out of Trim (STAB OUT OF TRIM) Light

Refer to Chapter 4 – Automatic Flight

Rudder



1 Rudder Pedals

Push –

- controls rudder position
- permits limited nose gear steering up to 7 degrees each side of center.

2 Rudder Trim Indicator

Indicates units of rudder trim.

3 Rudder Trim OFF Flag

Illuminated (amber) (in view) – rudder trim indicator is inoperative.

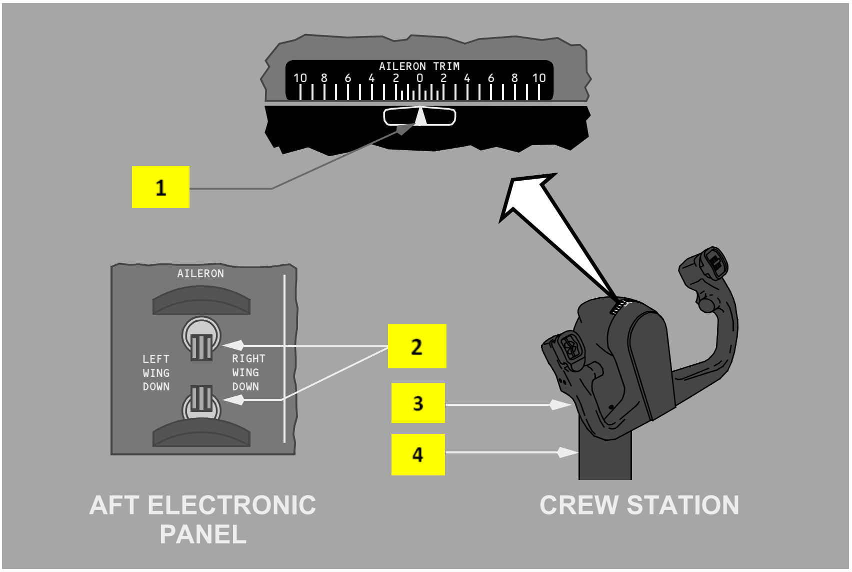
4 Rudder Trim Control (spring-loaded to neutral)

Rotate – electrically trims the rudder in the desired direction.

5 YAW DAMPER Indicator

- Indicates main yaw damper movement of rudder
- pilot rudder pedal inputs are not indicated.

Aileron / Elevator / Flight Spoilers



1 AILERON TRIM Indicator

Indicates units of aileron trim.

2 AILERON Trim Switches (spring-loaded to the neutral position)

Movement of both switches repositions the aileron neutral control position.

3 Control Wheel

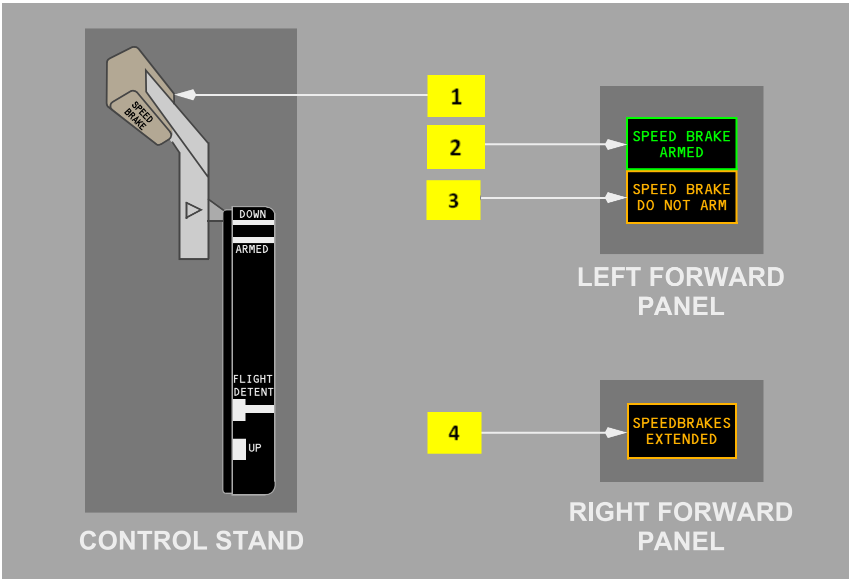
Rotate – operates ailerons and flight spoilers in desired direction.

4 Control Column

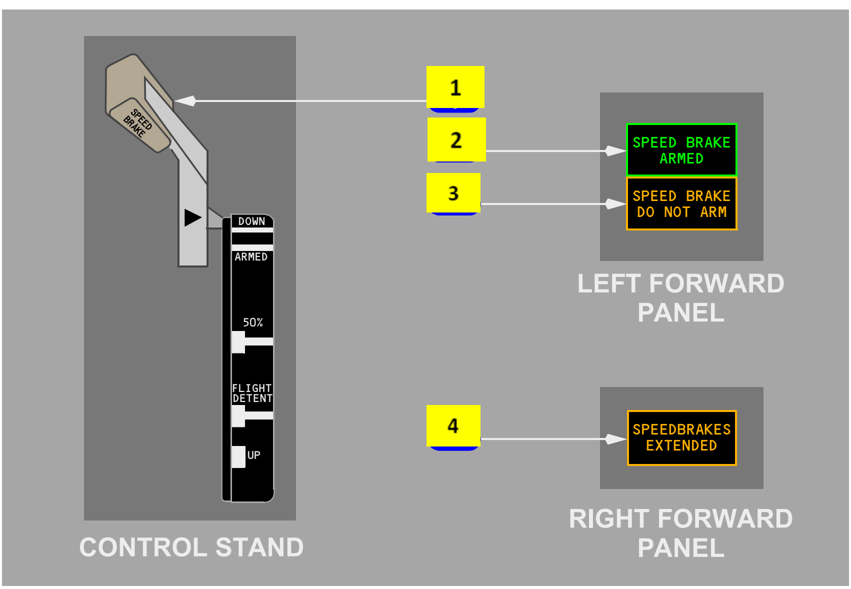
Push/Pull –

- operates elevators in the desired direction
- movement opposing stabilizer trim stops electric trimming.

Speed Brakes



[Option - Speed Brake Load Alleviation System]



1 SPEED BRAKE Lever

DOWN (detent) – all flight and ground spoiler panels in faired position.

ARMED –

- automatic speed brake system armed
- upon touchdown, the SPEED BRAKE lever moves to the UP position, and all flight and ground spoilers extend.

[Option - Speed Brake Load Alleviation System]
50% –

- if the speed brakes are deployed beyond the 50% position and the speed brake load alleviation feature is activated;
  - the speed brake lever moves to this position
  - all flight spoilers retract to one-half of their maximum position for inflight use.

FLIGHT DETENT – all flight spoilers are extended to their maximum position for inflight use. UP – all flight and ground spoilers are extended to their maximum position for ground use.

2 SPEED BRAKE ARMED Light

Light deactivated when SPEED BRAKE lever is in the DOWN position.

Illuminated (green) – indicates valid automatic speed brake system inputs.

3 SPEED BRAKE DO NOT ARM Light

Light deactivated when SPEED BRAKE lever is in the DOWN position.

Illuminated (amber) –

- indicates abnormal condition or test inputs to the automatic speed brake system
- indicates an abnormal condition or test input to the speed brake load alleviation system when the flaps are raised.

4 SPEEDBRAKES EXTENDED Light

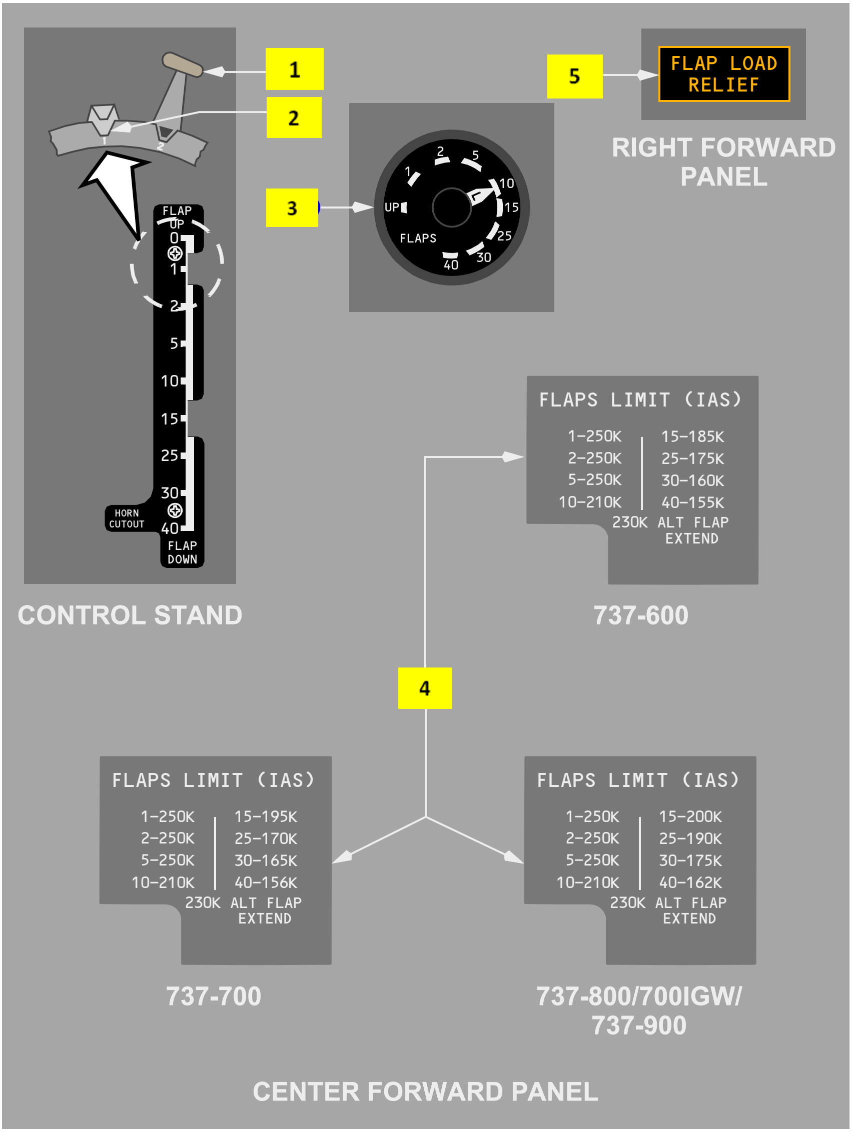
Illuminated (amber) –

- in–flight -
  - SPEED BRAKE lever is beyond the ARMED position, and
  - TE flaps extended more than flaps 10, or
  - radio altitude less than 800 feet
- on the ground -
  - SPEED BRAKE lever is in the DOWN detent,
  - ground spoilers are not stowed.

Note: On the ground, the SPEEDBRAKES EXTENDED light does not illuminate when hydraulic system A pressure is less than 750 psi.

Trailing Edge Flaps

[Option - FLAP LOAD RELIEF light]



1 FLAP Lever

- selects position of flap control valve, directing hydraulic pressure for flap drive unit
- position of the LE devices is determined by selecting TE flap position
- flap lever positions 30 and 40 arms the flap load relief system as described in Section 9.20.
- flap lever positions 10, 15, 25, 30, and 40 arms the flap load relief system as described in Section 9.20.

2 Flap Gates

Prevents inadvertent flap lever movement beyond:

- position 1 - to check flap position for one engine inoperative go-around
- position 15 - to check flap position for normal go-around.

3 Flap Position Indicator

- indicates position of left and right TE flaps
- provides TE flaps asymmetry and skew indication.

4 FLAPS LIMIT Placard

Indicates maximum speed for each flap setting.

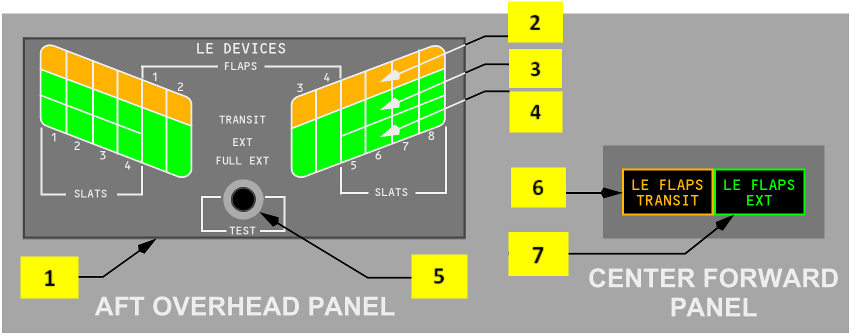
5 FLAP LOAD RELIEF Light

[Option]

Illuminated (amber) –

- if flaps are set at 40:
  - flaps retract to 30 due to excess airspeed or
- if flaps are set at 30:
  - flaps retract to 25 due to excess airspeed.

Leading Edge Devices



1 Leading Edge Devices (LE DEVICES) Annunciator Panel

Indicates position of individual LE flaps and slats.

Extinguished – related LE device retracted.

2 Leading Edge Devices TRANSIT Lights

Illuminated (amber) – related LE device in transit.

3 Leading Edge Devices Extended (EXT) Lights

Illuminated (green) – related LE slat in extended (intermediate) position.

4 Leading Edge Devices Full Extended (FULL EXT) Lights

Illuminated (green) – related LE device fully extended.

5 Leading Edge Annunciator Panel TEST Switch

Press – tests all annunciator panel lights.

6 Leading Edge Flaps Transit (LE FLAPS TRANSIT) Light

Illuminated (amber) –

- any LE device in transit
- any LE device not in programmed position with respect to TE flaps
- a LE slat skew condition exists (slats 2 through 7 only)
- during alternate flap extension until LE devices are fully extended and TE flaps reach flaps 10.

Note: Light is inhibited during autoslat operation in flight.

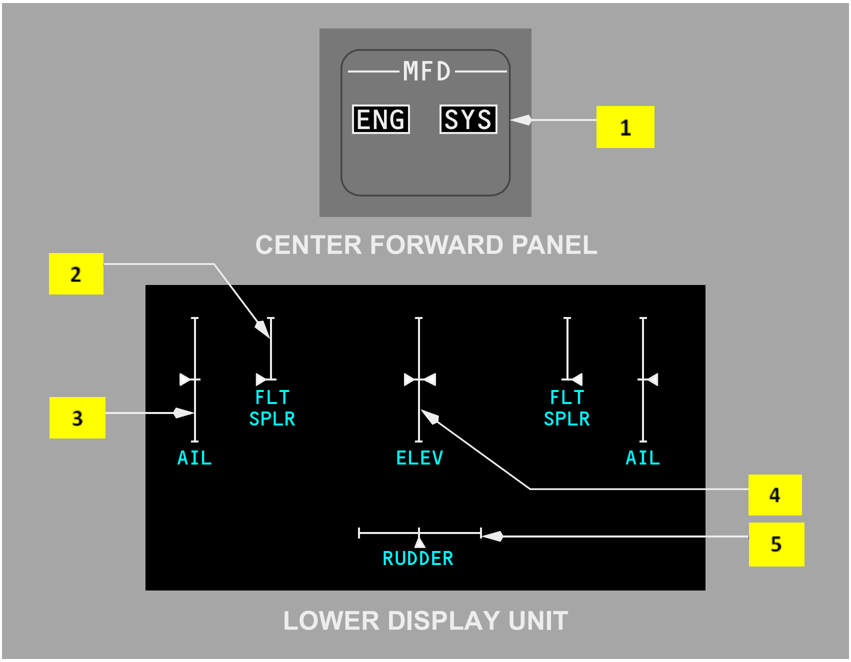
7 Leading Edge Flaps Extended (LE FLAPS EXT) Light

Illuminated (green) –

- all LE flaps extended and all LE slats in extended (intermediate) position (TE flap positions 1, 2 and 5)
- all LE devices fully extended (TE flap positions 10 through 40).

Flight Control Surface Position Indicator

[Option]



1 MFD System (SYS) Switch

Push – SYS

- displays flight control surface position indications on lower DU; or if the lower DU is unavailable, displays it on upper DU or inboard DU based on the position of the display select panel selector
- second push removes indications on the respective DU.

2 Flight Spoilers (FLT SPLR) (white)

Indicates related (left/right) flight spoilers position:

- top mark depicts flight spoilers fully deployed
- bottom mark depicts the spoilers down.

3 **Aileron (AIL) (white)**

Indicates related (left/right) aileron position:

- top mark depicts maximum up position
- center mark depicts neutral position
- bottom mark depicts maximum down position.

4 **Elevator (ELEV) (white)**

Indicates elevator position:

- top mark depicts maximum up position
- center mark depicts neutral position when on the ground and trimmed in the green band
- bottom mark depicts maximum down position.

Note: Elevator neutral position varies with stabilizer position, flap position and Mach. The center index mark is set for nominal takeoff conditions. With certain airplane nose up trim settings, the pointer will be somewhat displaced.

5 **RUDDER (white)**

Indicates rudder position:

- left mark depicts maximum left position
- center mark depicts neutral position
- right mark depicts maximum right position.

Flight Controls Limitations

Max flap extension altitude is 20,000 ft.

Holding in icing conditions with flaps extended is prohibited.

Do not deploy the speedbrakes in flight at radio altitudes less than 1,000 feet.

[Option - B737-600/-700/-800 without stiffened elevator tabs]
(PRR 38506 or Service Bulletin 737-55A1080)

Do not operate the airplane at speeds in excess of 300 KIAS with speedbrakes extended.

WARNING: Use of speedbrakes at speeds in excess of 320 KIAS could result in a severe vibration, which, in turn, could cause extreme damage to the horizontal stabilizer.

In flight, do not extend the SPEED BRAKE lever beyond the FLIGHT DETENT.

Avoid rapid and large alternating control inputs, especially in combination with large changes in pitch, roll, or yaw (e.g. large side slip angles) as they may result in structural failure at any speed, including below VA.

Note The following items are not AFM limitations, but are provided for flight crew information.

Alternate flap duty cycle:

Flap Position	Minutes Off
0 – 15	5
greater than 15	25